Virginia Smart Communities Working Group

Detailed Findings and Recommendations Report

March, 2018
Transmittal Memo

To: Esther Lee, Secretary of Commerce and Trade, Commonwealth of Virginia  
From: Virginia Smart Communities (VASC) Working Group  
Subject: March 2018 VASC Working Group Report

Dear Secretary Lee,

On behalf of the VASC Working Group, we are pleased to submit the following report with detailed findings and recommendations to advance Virginia’s Smart Communities initiative in response to Executive Directive 13.

Catalyzed by a kick-off meeting on September 18, 2017, the Working Group released its initial findings and recommendations that leveraged and built upon Virginia’s leadership in Smart Communities in October 2017. Based on a second meeting on December 15, 2017, this report provides the Working Group’s detailed findings and recommendations, which provide further insights and actions for your consideration. A final report in June 2018 will help position Virginia for continued leadership into the future in this critical area of economic growth and infrastructure.

We look forward to collaborating with you to guide Virginia’s Smart Community Roadmap and implementation strategy for the future. Thank you for the opportunity to work with you on this important initiative.

Sincerely,

Debbie Hughes       Caroline Luxhoj  
Vice President of Higher Education and Workforce     Broadband Program Administrator  
Business-Higher Education Forum     Center for Innovative Technology

David Ihrie       Janet Chen  
Chief Technology Officer     Director  
Center for Innovative Technology     Business-Higher Education Forum
In August 2017 former Virginia Governor Terry McAuliffe signed Executive Directive Number 13 directing the Secretary of Technology Karen Jackson to establish an executive work group that would develop best practices, policies, processes, and technologies to equip Virginia’s communities with the resources, support, and tools to become sustainable Smart Communities.

Now under Governor Ralph Northam’s administration and the purview of the Secretary of Commerce and Trade, Esther Lee, the Virginia Smart Communities (VASC) Working Group convenes public and private sector experts to develop a strategy and propose recommendations for ways that Virginia can align, engage, and invest with Smart Communities across the state. This report serves as the second of three reports on the findings and recommendations from the VASC Working Group for the new administration.

The effects of rapidly changing technology on daily life has presented Virginia with the opportunity to collaborate at the Federal, state, and local levels on the development of Smart Communities. Virginia defines a Smart Community as one that engages its citizens and electronically connects its infrastructure. A Smart Community has the ability to integrate multiple technological solutions, in a secure fashion, to manage a community’s assets, including local government information systems, schools, libraries, transportation systems, hospitals, power plants, law enforcement, and other community services. The goal is to promote quality of life through the use of technology in ways that improve the efficiency of services and meet residents’ needs.

Federal, state, and local governments each play a role in Smart Communities. Federal agencies can provide funding, national policies and regulations, procurement services, and share best practices. States can fund or route funding from federal agencies to localities as well as provide state policies, regulations, statewide implementations, and procurement services. Local governments are the place where citizens often have the most direct touchpoints with these new capabilities, including street maintenance and lighting, citizen engagement, and transit.
Governor Northam has a tremendous opportunity to address these challenges. A Smart Communities initiative aligns with the state’s goal to build a New Virginia Economy, implementing innovative policies and stimulating economic development in high-growth industry sectors to attract capital investment and improve citizen services. Leveraging its close proximity to federal agencies as well as strength in key related areas such as autonomous systems, cybersecurity, energy, healthcare, public safety, and transportation, Virginia is already well-positioned to align these assets and become the nation’s leader in Smart Communities.

Nevertheless, it is important for Governor Northam to continue articulating the “why” of Smart Communities and engage directly with citizens to define the need and motivate stakeholders to take action. For example, if broadband is unavailable in certain parts of the state, students may be unable to complete their homework or displaced workers may be unable to search for a new job. The use of self-driving vehicles may result in less time on the roads or fewer accidents and deaths. By engaging and communicating the returns on investment, whether monetary or non-monetary in value, as well as aligning it with Virginia’s overall vision, Governor Northam will demonstrate the passion and leadership that is critical for Smart Communities initiatives to move forward.

Finally, a Virginia Smart Communities initiative offers an opportunity for sustained engagement with the National Governors Association Center for Best Practices (NGA Center). The NGA Center, in partnership with experts from the academic, non-for profit and state government sectors, is developing a Smarter States, Smarter Communities initiative (initiative) to advance an evidence-based “smart for all” vision. The NGA Center will help governors capitalize on states’ roles as “laboratories of innovation” by developing state-wide programs that complement and enhance local successes. The initiative would begin with a three-year, three-phase effort to develop a research-informed policy roadmap and set of logic models for states that will guide a subsequent set of technology policy pilots and dissemination of results. The effort would focus on both the technological and social dimensions of creating smart and connected communities.

Most importantly, underlying all of these efforts should be an emphasis on access and equity across both cities and rural communities, so that all citizens can benefit from the advent of smart technologies; and demonstration and articulation of return on investment, so that both investors and citizens can fully understand the impact of Smart Community efforts.
Working Group Recommendations

This report provides a set of crosscutting and Committee-specific recommendations from the VASC Working Group’s seven Committees, including City Platform/Dashboard; Data Governance; Energy, Water, and Waste Management; Healthcare, Public Health, and Human Services; Public Safety; Public Wireless/Broadband; and Transportation, for consideration in Virginia’s Smart Communities strategy moving forward. Additional details on each of the recommendations can be found on corresponding pages of the report.

Crosscutting Recommendations (Pages 8-10)

1. Create a funded, independent entity, cross-agency coordinating body, and Commonwealth-wide standing Data Governance group for the Virginia Smart Communities effort. An independent entity, a cross-agency coordinating body, and a Commonwealth-wide standing Data Governance group to include a Chief Data Officer that would advance Virginia’s efforts in Smart Communities.

2. Launch a Virginia state competition. To recognize outstanding efforts within the state, Virginia should launch an annual state competition.

3. Adopt interoperability standards along with a cybersecurity and privacy plan for Virginia’s Smart Communities. Interoperability standards could ensure that the state’s activities leverage its existing efforts while a comprehensive crosscutting cybersecurity and privacy plan would address security concerns across all of Virginia’s activities.

4. Continue to support broadband expansion. Virginia should continue to support its successful broadband expansion through technical assistance programs and broadband funding opportunities.

5. Sustain Virginia’s Smart Communities efforts by connecting investments and integrating best practices. Virginia should effectively plan and coordinate across all its investments, whether monetary or non-monetary, and incorporate best practices into its Smart Communities strategy.

6. Support educational, research, and workforce efforts in Smart Communities. Virginia should embed Smart Communities content in K-12 schools, encourage colleges and universities to become leading institutions on smart technologies research and development, and develop a research agenda and new programs of study to address workforce needs.

7. Encourage and help catalyze private sector investment, innovation, and support for start-ups in Smart Communities. Virginia should encourage the private sector to invest in smart technologies and prioritize innovation, particularly through the development of new industries, to address the complex and evolving nature of Smart Communities.

8. Adopt procurement and implementation guidance for smart technologies and products. To ensure that the state and local communities are making the best decisions in procurement of smart technologies and products, Virginia should adopt a set of policies to guide its role as a purchaser as well as offer implementation guidance for local governments.

9. Conduct community outreach. Virginia should conduct and maintain community outreach efforts throughout its Smart Communities initiative.

10. Create a group dedicated to agriculture and rural communities. A group focused on agriculture and rural communities could develop projects, identify best practices, and address their unique opportunities and challenges in Smart Communities.
About the Virginia Smart Communities (VASC) Working Group

In August 2017 former Virginia Governor Terry McAuliffe signed Executive Directive Number 13 (Appendix A) directing the Secretary of Technology Karen Jackson to establish an executive work group that would develop best practices, policies, processes, and technologies to equip Virginia’s communities with the resources, support, and tools to become sustainable Smart Communities.

With the advent of Governor Northam’s administration in January 2018, this work group is now under the purview of the Secretary of Commerce and Trade, Esther Lee. The key objectives defined for the work group are to develop a strategy that builds on Virginia’s existing assets and programs to:

- Align smart systems and devices from diverse sectors in fundamentally new ways to enable communities to improve services, promote economic growth, and enhance the quality of life;
- Develop a sustainable, replicable model for Virginia Smart Communities; and
- Establish Virginia as a global leader for development of Smart Communities.

Additionally, the Working Group was asked to identify partners and resources that could be readily engaged to implement this strategy.

With support from the Business-Higher Education Forum (BHEF) and the Center for Innovative Technology (CIT), the Governor’s VASC Working Group convened public and private sector experts to develop a strategy and propose recommendations for ways that Virginia can align, engage, and invest with Smart Communities across the state.

On September 18, 2017, the VASC Working Group held a kick-off meeting at the Virginia Tech Executive Research Center (Appendix C). During the meeting, the Working Group divided into Committees to focus on areas and issues including:

1. City Platform/Dashboard. The City Platform/Dashboard Committee seeks to connect use cases of municipal service delivery to the underlying available data sets, so that all cities can apply the data to address their unique challenges and priorities regardless of the size, governance or location of the municipality.

2. Data Governance. The Data Governance Committee aims to address the challenge of building a standards-based shared open data platform and the related governance and exchange model for Internet of Things (IoT) data, and a plan for governments to successfully customize and deploy it while maintaining transparency, privacy and security.

3. Energy, Water, and Waste Management. This Committee’s purpose is to support sustainability, workability and livability in communities by leveraging smart Energy, Water and Waste infrastructure. The group brings together...
infrastructure providers, public utilities, academia, and technology partners to identify opportunities and barriers, support the development of statewide roadmap and replicable solutions for a wide variety of communities and their goals related to Energy, Water and Waste Management.

4. Healthcare, Public Health, and Human Services. The Healthcare, Public Health, and Human Services Committee will focus on how smart technologies and data will address the challenges of rising healthcare costs and access to healthcare providers, empowering patients, protecting the public health from disease and environmental conditions, and enabling human service practitioners to provide more holistic, more collaborative, and effective services. The National Institute of Standards and Technology (NIST) Global City Teams Challenge (GCTC) Healthcare SuperCluster is still in development. However, at the GCTC 2018 Kickoff healthcare Action Clusters formed within the Agriculture and Rural SuperCluster to address the healthcare challenges in a rural setting, including rural telehealth, diabetes management and suicide prevention, and aging in place. The NIST Healthcare SuperCluster has yet to publish a blueprint in this area, and the newly formed Agriculture and Rural SuperCluster will develop a blueprint this year.

5. Public Safety. This Committee is focused on developing public-private partnerships to identify new and existing technologies, processes, and strategies to enhance public safety and resilience within Smart Communities, and maintaining trust, security, and transparency to society. This group will provide resources, knowledge sharing, and best practices allowing for first responders to choose initiatives that will suit localities best.

6. Public Wireless/Broadband. This Committee is focused on the development of best practices for the deployment of high-speed wireless and broadband systems towards a goal of 100% broadband access for all citizens and organizations.

7. Transportation. This Workgroup focused primarily on the sub-domain commonly referred to as Smart Transportation. As the world transitions from an individual-centric transportation system based on personal automobile ownership to a technology-enabled one where all modes are seamlessly available as a shared community resource, an actionable Sustainable Mobility plan is essential for both intra-city and cross-region transport of people and goods. They assessed the current best practices in the Smart Transportation space and prioritized the areas that could have the best impact for the Commonwealth, to add to the body of work done by the Commonwealth’s various Transportation Strategy, Multimodal Planning, and Long-Term Development efforts and reports.

The Working Group’s October 2017 report, released by Governor McAuliffe on November 20, 2017, shared initial findings and recommendations from each of those Committees as well as overarching themes and recommendations for all the Committees.

On December 15, 2017, the VASC Working Group held its second meeting at the National Governors Association (Appendix E). During the meeting, the Working Group heard from both federal and state leaders on their Smart Communities’ initiatives, discussed the integration of federal, state, and local activities, and continued progress in their Committees.

Building on those discussions, this March 2018 report provides detailed findings and recommendations that expand on the Working Group’s initial report. By June 2018, the Working Group will host two more meetings and publish a final report to continue Virginia’s leadership in this critical area of economic growth and infrastructure.
Crosscutting Themes

The Working Group identified several crosscutting themes to inform Virginia’s Smart Communities strategy moving forward.

• Prioritize replicability, interoperability, scalability, and sustainability. To ensure rapid and successful deployment of smart solutions in its cities and communities, Virginia should prioritize ease of solution replication across communities, interoperability, scalability, and sustainability. GCTC’s long-term goal serves as a model for this prioritization given its emphasis “to establish and demonstrate replicable, scalable, and sustainable models for incubation and deployment of interoperable, standards-based solutions using advanced technologies such as IoT and Cyber-Physical Systems (CPS) and demonstrate their measurable benefits in cities and communities.”

• Lead the way at the State level. The benefits that can be realized by individual communities can be achieved at even larger scale by the Commonwealth. Increasing the availability and usability of open data, improving services through the optimizations resulting from integrated analytic understanding across agencies, and economies of scale in deployment of infrastructure assets all represent opportunities for the Commonwealth to become “smarter” while simultaneously setting an example and providing leadership that will enable local communities to realize their own priorities.

• Leverage higher education research and associated workforce investments. Virginia should leverage higher education to develop a research agenda and capitalize on the research, innovation, and workforce investments of its universities, community colleges, technical institutes, and entrepreneurial communities. These efforts are often funded by Federal agencies through programs such as the National Science Foundation’s (NSF) Smart & Connected Communities (S&CC) program where researchers and innovators are working collaboratively with community stakeholders to address municipal challenges and develop much-needed solutions for building Smart Communities in both the near- and long-term. Investments in developing innovative curriculums, course materials, instructional approaches, and pathways to commercialization are critical to effectively train the next-generation workforce in both technical and non-technical skills for Smart Communities, and help launch them into the Virginia economy.

• Emphasize cybersecurity and privacy. Smart technologies introduce new attack surfaces, which consequently pose new threats and attack vectors. Emphasizing cybersecurity is foundational to create Smart Communities that are secure, reliable, and resilient as well as protect privacy. GCTC’s “Smart and Secure Cities and Communities Challenge” and NSF’s CyberCorps®: Scholarship for Service and Secure and
Trustworthy Cyberspace programs are prime examples of education and research funding opportunities to effectively address the cybersecurity and privacy challenges of Smart Communities. Privacy is equally as important as cybersecurity as a fundamental value and as an area requiring separate consideration and implementation approaches. Compliance to a statewide privacy policy could serve as a pre-condition for private company use of public data assets in a Smart Communities framework.

- Foster economic growth. Understanding the impact of Smart Communities on the economy and job creation as well as the potential for fostering economic growth is critical for Virginia’s Smart Communities effort. Federal funding supports a variety of activities to help foster economic growth, including workshops, grants to communities for pilot programs, and focused sector projects. At the local level, Virginia’s economic development programs should place a special emphasis on accelerating smart infrastructure investments and related development projects by supporting a move to freshen dated policies and practices that impede progress, providing guidance regarding best practices and technologies, and funding and assisting in the development of pilot implementation programs.

- Encourage digital access and equity. Smart Communities encompass both big cities as well as agricultural and rural communities. While federal efforts often focus on the national perspective, states such as Virginia have the opportunity to address their communities’ unique needs and issues, particularly around digital access and equity, to ensure citizen benefit and engagement. Notably, US Ignite, Inc. aims to spur the development of application prototypes leveraging next-generation broadband networks in areas of national and societal importance, such as energy, transportation, and health. Virginia could also invest in a challenge or competition similar to GCTC and differentiate opportunities between smaller and larger communities for replication and interoperability. Underlying all of these efforts, broadband connectivity provides a fundamental building block for digital access and equity.

- Reevaluate current policies. Virginia should reevaluate its current policies to ensure industry engagement as well as removal of barriers to innovation and development. Policy incentives for commercially viable industry engagement in Smart Communities could include state contract vehicles or a hub for industry and communities to search for grants. At the same time, removal of policy barriers is also vital. Policies that encourage open data and rational integration of public and private data are also critical to achieving the potential gains that Smart Communities embody.

- Focus on innovation and commercialization. A critical challenge for Smart Communities is moving from innovative ideas and inventions to commercialization of those ideas for success in the marketplace. Virginia has already taken significant steps to address this challenge through initiatives such as Smart City Works, the first business “actuator” focused on helping startups and mature companies transition new ideas or inventions into viable growing businesses. By building on and supporting similar efforts, and finding more effective ways to help groundbreaking research make the transition into the market, Virginia can fully realize the value of innovative solutions to Smart Community challenges.

- Prioritize agriculture and rural communities. Virginia should recognize and address the unique challenges and opportunities that agriculture and rural communities face in the development and implementation of Smart Communities. By prioritizing these communities in its strategy, Virginia will demonstrate its leadership and inclusiveness in its Smart Communities efforts.
Crosscutting Recommendations

The Working Group provides the following crosscutting recommendations for consideration in Virginia’s Smart Communities strategy moving forward.

1. Create a funded, independent entity, cross-agency coordinating body, and Commonwealth-wide standing Data Governance group for the Virginia Smart Communities effort. An independent entity with the specialized skill sets to provide impartial oversight of the Smart Communities activities across the state can ensure fair and seamless coordination and collaboration to achieve Virginia’s goals. This coordinating body can serve as the internal consultants and experts for the state on innovation and digital transformation. A cross-agency coordinating body should meet on a regular basis to discuss opportunities, initiatives, challenges, and other activities underway, reporting developments to the state’s independent entity to advance Virginia’s efforts as well as educating on the benefits of Smart Communities initiatives. Virginia should also establish a Commonwealth-wide standing Data Governance group. The current Commonwealth structure for Broadband deployment provides one model for this Governance group, along with an additional identified need for a Chief Data Officer or similar to ensure data architecture, standards and integrity. It is expected that such a move would reduce overall costs to the state by reducing duplicate efforts and ensuring that an extensible path is set for technology deployment.

2. Launch a Virginia state competition. To recognize outstanding efforts within the state, Virginia should launch an annual state competition. The competition could be similar to NIST’s GCTC and invest in model cities across the state. A separate category of competition aimed specifically at smaller communities could address the unique needs and issues they face and help promote the key priorities of the Virginia Smart Communities effort.

3. Adopt interoperability standards along with a cybersecurity and privacy plan for Virginia’s Smart Communities. Interoperability standards could ensure that the state’s activities capitalize on and leverage its existing efforts, data holdings, and technologies, thereby reducing costs, while a comprehensive crosscutting cybersecurity and privacy plan would address security concerns across all of Virginia’s activities and increase public acceptance by helping ensure the protection and security of Virginia’s citizens and their information. Additionally, the adoption of such standards and policies would substantially reduce the barriers to entry for all Virginia communities.

4. Continue to support broadband expansion. Broadband is the foundation of Smart Community initiatives and is essential to enabling smart city applications as well as reaching areas where internet may not be available in a city or rural community. Virginia should continue to support its successful broadband expansion through technical assistance programs (CIT) and broadband funding opportunities (Department of Housing and Community Development (DHCD)). Additionally, NSF has supported the Platforms for Advanced Wireless Research program, which aims to allow experimentation with next-generation wireless technologies that will enhance broadband capability, particularly in light of the emerging Internet of Things. Virginia’s higher education institutions with knowledge in this area could become part of this test bed.

5. Sustain Virginia’s Smart Communities efforts by connecting investments and integrating best practices. Virginia has launched and developed a number of Smart Communities efforts with the support of key investments such as federal grants. To continue the state’s progress and sustain innovation, Virginia should effectively plan and coordinate across all its investments,
whether monetary or non-monetary, including supporting business models to help communities more optimally leverage various investments. Along with connecting its investments, Virginia should incorporate best practices into its Smart Communities strategy. For example, InnovatePGH, a public-private partnership in Pittsburgh, recently launched to accelerate Pittsburgh’s status as a global innovation city. Powered by a coalition of civic leaders representing the city, county, local universities, health organizations, and regional philanthropies, the city serves as a model for its commitment and ability to coalesce key stakeholders and resources to enact large-scale change.

6. Support educational, research, and workforce efforts in Smart Communities. Virginia should embed Smart Communities content in K-12 schools. It should also encourage colleges and universities to partner with communities in seeking federal and state grant funding to become leading institutions on smart technologies research and development as well as develop a research agenda and new programs of study to address workforce needs, such as computational thinking, in Smart Communities. In addition, to ensure all communities can benefit from high-tech Smart Communities initiatives, the state should consider supporting programs that train community leaders with the expertise to implement such initiatives. Training may consist of understanding the availability and utility of certain smart technologies as well as changing mindsets for tackling certain problems with the use of such technology.

7. Encourage and help catalyze private sector investment, innovation, and support for start-ups in Smart Communities. Virginia should encourage the private sector to invest in smart technologies and prioritize innovation to address the complex and evolving nature of Smart Communities. Given that new and early-stage companies are the primary source of job creation in the American economy, public and private sector support for the development of new companies focused on smart technologies and innovations could significantly advance Virginia’s efforts in regional economic development, developing solutions to address local challenges, and building companies that help establish Virginia as a global leader in Smart Communities. To demonstrate commitment and drive innovation for its Smart Communities effort, Virginia should support the development of new industries focused on creating Smart Community capabilities and consider conducting trials with or creating a challenge for these companies to determine feasibility and advancement of such efforts, which could be included in Virginia’s state competition and facilitated by its overseeing bodies.

8. Adopt procurement and implementation guidance for smart technologies and products. To ensure that the state and local communities are making the best decisions in procurement of smart technologies and products, Virginia should adopt a set of policies to guide its role as a purchaser as well as offer implementation guidance for local governments to do the same. Such work could be synergized with the state’s efforts to support educational efforts in Smart Communities.

9. Conduct community outreach. Virginia should conduct and maintain community outreach efforts throughout its Smart Communities initiative. As a start, the state could focus on Smart Community efforts that will save communities money, which should generate rapid interest and support. Initial outreach could provide both information about Smart Community best practices across Virginia and the country and help in soliciting community implementation priorities. By cultivating high levels of interest and involvement among stakeholders, Virginia will have the strength and support to develop and implement all of its Smart Communities efforts moving forward.

10. Create a group dedicated to agriculture and rural communities. A group focused on agriculture and rural communities in Smart Communities could develop projects and identify best practices for farmers to better manage their farms and increase the productivity and health of their land and animals, make it easier to meet federal and state reporting requirements in agricultural communities, as well as bridge the digital divide, improve healthcare and economic development, and catalyze innovation in rural communities.
Figure 1 below provides insight into the timeframe for implementation (i.e., short- or long-term) and funding requirements (i.e., no cost, some cost, high cost) for each crosscutting recommendation.

### Figure 1

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<tr>
<th>Recommendation</th>
<th>Implementation Timeframe</th>
<th>Funding Requirements</th>
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Committee Recommendations

The following provides a summary of the recommendations for each of the Working Group’s seven Committees. Detailed information on each Committee is provided in subsequent tabs.

City Platform/Dashboard Recommendations

Overview

The City Dashboard/Platform is the point of interaction between citizens, community leaders and other users and the underlying “smart” infrastructure. Our overall Smart Communities approach recommends that communities prioritize their own needs and implementation approaches with support from the Commonwealth to help lower barriers to entry for these capabilities. As such, these specific recommendations focus on the ways to encourage community engagement and buy-in, and strategies for providing support to local communities towards achieving their own priorities.

Recommendations

- Start first with the Commonwealth of Virginia, and employ the process analysis techniques to drive more open data in State Agencies and integrated data and analytics around specific high-value use cases.
- Conduct community outreach. Virginia should conduct and maintain community outreach efforts throughout its Smart Communities initiative to validate and extend the set of use cases of interest in the City Platform/Dashboard area. As a start, the Commonwealth focus on Smart Community efforts that will save communities money, which should generate rapid interest and support. Continue outreach to communities at large as implementation discussions take place.
- Extend the CIT Broadband Path process as a mechanism to help local communities evaluate their priorities and develop implementation paths to interact with technology and other vendors to implement those priorities.
- Use GoVirginia or other similar mechanisms to provide State-level funding opportunities for regions interested in moving forward with Smart Community implementations.
- Baseline the marketplaces and apps already in existence and the use cases to which they apply.
- Baseline the previously developed community resilience indicators and implementation approach.
- Formulate a plan and accompanying implementation handbook for use by communities to guide their City Platform activities. The plan should include access to available marketplaces, apps, and resources available to local communities.
- Establish a standing analytics working group at the state level to help facilitate validation of analytic tools included in the Smart Communities stack as well as addition of new analytics tools to be added to the marketplaces as community-driven needs evolve.

Data Governance Recommendations

Overview

Data Governance is the core function of establishing, managing and maintaining the ability of Smart Community capabilities to access and use disparate data holdings from a variety of sources. There are significant technical challenges associated with integrating and managing diverse data sets, and there are also significant policy challenges around security, privacy, data ownership and usage, and similar policy issues. These challenges of data governance however can generally be addressed in a centralized manner, allowing for a Commonwealth-level data governance structure that provides significant leverage and cost-savings for individual communities. These recommendations support a standing data governance structure for the Commonwealth, allowing solutions to be implemented once for the benefit of all.
Recommendations

- Baseline and leverage existing Commonwealth State-level activities around open data (such as the Virginia Department of Transportation (VDOT) data portal and others), data governance (VITA, VDOE/SCHEV and others), and integration of federated data sets (CIT Broadband, for example).

- Establish a Commonwealth-wide standing Governance group with the following charter:
  
  1. Develop and promulgate rules around Smart Community data, including participation, sourcing, access, structure, security, ownership, and other aspects of Smart Community data governance.
  
  2. Provide expertise and mentoring for Virginia communities seeking to connect into a larger Commonwealth data structure.
  
  3. Act as a clearinghouse for standards, best practices, other information related to Smart Community development.
  
  4. Develop a common Data Infrastructure & Analytics Strategy including: definition and support for an initial implementation of a reference Enterprise Data Architecture, Enterprise Data Modeling, and Business Centric Analytics.

- Adopt interoperability standards along with a cybersecurity and privacy plan for Virginia’s Smart Communities. Interoperability standards could ensure that the state’s activities capitalize on and leverage its existing efforts, data holdings, and technologies, thereby reducing costs, while a comprehensive crosscutting cybersecurity and privacy plan would address security concerns across all of Virginia’s activities and increase public acceptance by helping ensure the protection and security of Virginia’s citizens and their information. Additionally, the adoption of such standards and policies would substantially reduce the barriers to entry for all Virginia communities.

Energy, Water, and Waste Management Recommendations

Overview

In a Smart Community, the overarching community goals of enhanced quality of life, economic growth and sustainability are improved through direct citizens’ engagement and technological integration of the community’s infrastructure. Technology is driving great change and possibilities to the way communities interact with its population and control its infrastructure. Through the use of real-time communication and control systems with a robust network of sensors, information is collected from both inhabitants and infrastructure. In real-time, it can be analyzed to tackle inefficiency, divert overcapacity, predict failure, provide feedback, inform the public, and assess cybersecurity risk. All of these capabilities lead to the sustainable supply and use of energy and water as well as efficient treatment of waste. Smart solutions will lead the next phase of transformational improvements in our infrastructure.

Recommendations

Energy

1. Support state wide investment in smart upgrades to the grid which focus on resiliency, reliability, customer engagement, energy efficiency, integration of distributed and renewable intermittent energy, dynamic rate structures and capacity of electrification of transportation through legislation and regulation that includes consideration of immeasurable benefits by traditional project assessments.

2. Expand telecommunications access in areas that are challenged with sparse coverage, capacity and low latency in all areas including rural and densely structured areas. Coverage enhancements in these marginalized areas to allow all constituents to realize the benefits a smart grid at a lower incremental cost to the energy provider.

3. Establish advisory group that expands current interoperability standards of the Smart Grid Mapping Tools beyond grid devices to include other IoT and IIoT as well as addresses other types of distributed resource such as smart inverters, electric vehicle to grid and other industrial controls. The advisory group would include stakeholders to collaborate to address security, cyber security and privacy to protect consumers and critical infrastructure in conjunction with interoperability.

4. Fund a statewide outreach program to educate on the benefits of electrification of transportation and steps necessary to make the transition. Consumers, fleet managers, businesses, localities, and the heavy transportation industry need for technical training of technologies and equipment as well as economic and environmental benefits.
5. Investment in a reliable and resilient, networked, statewide fast charging network. This includes costs for real estate, equipment, electric infrastructure, and ongoing operations to maintain the network. Consistencies in permitting, signage, interoperability, and payment capability are critical elements in developing this fast charging network.

Stormwater

1. Consistent methods must be required for data collection, organization, and sharing across stormwater systems. A consistent Water Information System, used across communities within the commonwealth, would enable open data sharing between public, private, and university users. The Consortium of Universities for the Advancement of Hydrologic Science, Inc. (CUAHSI) Hydrologic Information System (HIS) serves as an example of such a system.

2. Open standards for data transmission must be required over proprietary communication approaches and existing, well-known standards should be adopted whenever possible. The Water Markup Language (WaterML) and related Open Geospatial Consortium (OGC) standards serve as examples of applicable open data standards relevant to this community.

3. While creating open data and systems is critical to the long term success of smart stormwater solution, maintaining privacy of sensitive data and systems against cybersecurity threats must also be central to any solution.

4. Systems should have public and authenticated application program interface (API) endpoints with a minimal and consistent set of standardized services to foster interoperable systems.

5. To avoid vendor lock-in, hardware and software systems should be decoupled so that water sensors, for example, are not dependent on specific cloud service providers. This will allow for easier upgrades and maintenance of both hardware and software as systems grow and become more critical.

6. Educational programs must take interdisciplinary perspectives to design, build, and manage smart city cyber-physical systems because the skills needed to create such systems stretch across traditional disciplinary boundaries. Efforts to build interdisciplinary research labs, such as the University of Virginia Link Lab, serve as an example of ways to provide students with the educational background necessary to be competitive in this new landscape.

Healthcare, Public Health, and Human Services Recommendations

Overview

Smart Community technologies and data hold the promise of improving the health and well-being of their residents by addressing the challenges of rising healthcare costs and access to healthcare providers, empowering patients, protecting the public health from disease and environmental conditions, and providing a more holistic and effective delivery of human services and social programs. Virginia faces healthcare challenges of accessibility and affordability, and at the same time has innovative companies and academic researchers that can lead the nation in the smart utilization and integration of diverse data to develop solutions to these challenges.

Recommendations

- Engage the NIH with expertise in data analysis and physical systems/hardware:
- Engage underserved and underrepresented communities from the very start, to identify unique needs and ensure inclusive innovation in this area. (Perhaps through partnering well-resourced cities with rural ones within the state)
- Consider international partnering and discussions to learn from leaders, especially in Asia and Europe.
- Consider partnering with the Veterans Administration.
- Consider participating in one of the Agriculture and Rural SuperCluster’s rural healthcare Action Clusters.
- Support the biotechnology entrepreneurial community to make advances in healthcare informatics.
- Make publicly available de-identified health and human service information that can be analyzed to improve public health.
• Health and human services agencies should develop models for appropriate data sharing agreements and engage in multidirectional communications with other government organizations, NGOs, service providers, beneficiaries and families to dynamically share information so that agencies and beneficiaries make smarter, real-time decisions and agencies can quickly identify clients at risk, allocate resources accordingly, and focus on integrated service delivery. As agencies integrate health and human services program data, they should consider analyzing community services with geolocation of available services to match community supports to hotspots of chronic needs and build ecosystem capacity where needed.

• Analytics needs to look beyond localized data points (e.g., a case management system of a single agency). It needs to draw critical information from external sources such as law enforcement, mental health specialists, educational systems, online connected applications, and even cloud-based virtualized apps that receive and analyze information from mobile applications. This will allow agencies to coordinate and collaborate across health, human, and social services as well as with private and public community-based providers to create a services inventory that moves from sense and respond to predict and act and meet the needs of a single view of the client and enhance outcomes beyond self-sufficiency.

Public Safety Recommendations

Recommendations

• Smart Community Dashboard – Dashboard of current Internet of Things (IoT) technologies and Smart Community initiatives that are taking place across the Commonwealth and the nation allowing for leaders to collaborate and observe innovative technologies, policies, benefits, and conflicts and allowing them to make knowledgeable decisions.

• Public Safety Smart Community Pilot Program – pilot program allowing for public safety agencies and departments to test innovative technologies.

• Smart Community Competitions – allow for colleges and universities to participate in Smart Community challenges.

• Conduct a statewide survey of current smart policies and initiatives throughout the first responder’s community, both at the state and local level.

• Assess current technologies and policies that are taking place within the Commonwealth.

• Ensuring public trust by providing awareness and transparency when enabling smart technologies and policies and welcome feedback from the community.

• Provide a state advocate that would focus on implementing smart technologies across the Commonwealth and can ensure data and knowledge sharing of programs already being implemented across the state. This advocate would be knowledgeable of the state’s public safety community, but also have a robust knowledge of all technologies across the other Smart Community sectors.

Public Wireless/Broadband Recommendations

Overview

Broadband is the backbone of Smart Communities and therefore essential to the success of such endeavors. Therefore, Virginia must prioritize broadband deployment and enhancement initiatives across the Commonwealth to eliminate the digital divide between rural and urban areas and establish a firm foundation on which Virginia’s Smart Communities can build. The below summary of recommendations addresses action items for the state, local communities, and private industry.

Recommendations

State

• Provide guidance and assistance to communities trying to expand broadband access. Explore ways to increase broadband funding opportunities while maintaining support for current broadband assistance programs. Consider issues with lower population centers, that may not understand and have the resources to apply for these opportunities and to leverage public-private partnerships.

• Establish a centralized broadband coordinating organization, as a mechanism for distributing information about funding opportunities and to help clarify the role of specific state agencies in improving public connectivity. CIT could serve as the broadband coordinating body, facilitating public-private partnerships and interest groups to create a more attractive and competitive region for Smart Community infrastructure investments.
• Task CIT to continue to develop a list of broadband best practices and provide education to communities. Adopt a multi-tier approach to educating Virginia communities on the benefits of Smart Community systems and key issues pertaining to community zoning/planning/policies, resilience, privacy, and security. Also, engage with communities outside of Virginia to understand and adopt best practices.
  • Promote a view that analyzes the competitive costs behind new connected technologies. Determine how well they need to perform (the metrics) and where these new technologies may or may not be applicable.
  • Assist local communities by developing tools and expertise to model the current needs and future communication needs of Virginia communities though a collaborative effort with those communities.
  • Guide communities in how to incentivize services and foster a competitive environment.

• Identify potential partnerships between Virginia information businesses, educational institutions, and communities that facilitate Smart Communities by seeking Federal Opportunities for infrastructure development and R&D that can benefit from community involvement.

• Re-examine mechanisms for encouraging service deployments for effectiveness. Adopt ‘Dig Once’ policies and encourage competition-enabling policies related to broadband deployment and enhancement efforts. Any development project should be reviewed for opportunities to install conduit, fiber, or other infrastructure during the project.

• Encourage federal representatives to address the digital divide in Virginia. Communities, state representatives, and interest groups should inform their congressional representative of the connectivity needs in their communities and propose solutions on a policy and financial support basis.

• Examine ways to reduce the affordability and access gaps between different social/economic strata.

• Compile a handbook on broadband deployment considerations that can be a starting point for communities, especially those with limited resources, to initiation their broadband deployment efforts.

Communities

• Strive for at least three competitive broadband service providers in each region. Communities should provide assistance on a non-discriminatory basis for companies willing to assume the risk of deployment of new technology like 5G or other competitive broadband services.

• Work with the surrounding communities to ensure interoperability, redundancy and to reduce costs by pooling resources for capital equipment expenditures or sharing personnel to lower the cost of deploying broadband networks.

• Reexamine existing administrative organizational structures to ensure qualified personnel are available and can work as a team. Advice from an overall state advising body could help in understanding the best approaches for organizing the governmental structures to support broadband.

• Develop programs to make public resources, e.g., in-ground fiber, poles, public property, etc. available for use by providers. Use non-discriminatory criteria, to facilitate expansion and new deployments of communication services based on fair and reasonable fees.

• Develop metrics that help ensure reasonable accountability from vendors and service providers and make data collected (especially real-time data) available to communities, within privacy and security constraints. Metrics and data-collection oversight could be developed and addressed in collaboration with CIT and/or a coordinating broadband state agency.

• Build capacity for tomorrow, not today. This can be achieved if the coordinating state agency builds the tools and expertise to be able to project communication system requirements.

Virginia Industry and Small Businesses

• Work with local communities to refine technology products. Collaboration between industry and communities to develop and test communication technologies can set an encouraging environment for businesses to locate in Virginia.

• Collaborate to achieve economies of scale in deploying broadband technologies. Strategic business partnerships, industry alliances or associations could help facilitate public-private partnerships.
• Develop metrics to assess the impact and effectiveness of Smart Communities, overcome perceived risks, and ensure accountability within the industry. A well-established set of metrics is useful for obtaining industry and government investments in the development of Smart Community infrastructure.

Transportation Recommendations

Overview
The Transportation Workgroup has developed a comprehensive set of strategic recommendations to present to the Governor’s office. We assembled a core team consisting of industry experts, VDOT and Commonwealth leaders, university and NGO experts, and US Federal Government leaders. We built upon the research and recommendations from the ongoing NIST Transportation Supercluster blueprint work, established Industry research, Virginia DOT’s Strategic Plans, and Virginia Tech Transportation Research Institute’s recommendations.

This Workgroup focused primarily on the sub-domain commonly referred to as Smart Transportation. As the world transitions from an individual-centric transportation system based on personal automobile ownership to a technology-enabled one where all modes are seamlessly available as a shared community resource, an actionable Sustainable Mobility plan is essential for both intra-city and cross-region transport of people and goods. The Transportation Working Group assessed the current best practices in the Smart Transportation space and prioritized the areas that could have the best impact for the Commonwealth, to add to the body of work done by the Commonwealth’s various Transportation Strategy, Multimodal Planning, and Long-Term Development efforts and reports.

While maintaining the current transportation network is the main priority for VDOT and associated agencies, the need to determine how best to incorporate next generation technology and disruptions into that existing infrastructure is crucial to Virginia’s place in a future where technology will transform the way people and goods are moved. These plans must also take into account both existing infrastructure and equipment as well as planned improvements to both in the Commonwealth. We recommend prioritized, incremental approaches that are ideally positioned to anticipate and be responsive to both the immediate priorities as well as the long term needs of future generations. In so doing, the Commonwealth will be prepared to integrate new technologies and innovations for the future of Virginia’s transportation networks and the users thereof.

Recommendations
Establishing Smart Transportation plans into the fabric for sustainable growth for the Commonwealth of Virginia, will require concrete actions that are visible, measurable, action oriented, community driven, and sustained over time. New approaches, materials, and technologies to ensure our transportation infrastructure is more resilient – to more quickly recover from significant weather and other hazard events – and sustainable – improving the “triple bottom line” with clear economic, social, and environmental benefits are needed.

Basing our thought process using the guiding principles of (1) Authenticity vs Flash, (2) Measurable benefit to the community, (3) Future-Proofed, (4) Clear economic impact, (5) Sustainable, and (5) Executable, the Transportation Workgroup recommends the following actions:

1. Establish an empowered Smart Transportation Coordinating Body that works under Commonwealth’s direction and is empowered to drive actions in the four prioritized transportation domains. This cross-organization body will closely engage with key stakeholders in state, federal and local government, and key private enterprises, community groups and NGOs, to enhance engagement and project execution.

2. Develop a series of Innovation Mechanisms (including grants, pilots, maker spaces, research lab engagement, start-up hubs, technology vehicles, investment packages, and P3 platforms) to foster a creativity environment across the four regional zones in the Commonwealth. Based on the deliberations, the Transportation Working Group has prioritized the following four areas for investment and focus:

   1. First Mile & Last Mile - Connected / Autonomous Vehicles: From enabling access to jobs and improving public health, to creating value in each of the four regions in the Commonwealth, to driving economic prosperity, and to engaging local communities and businesses, finding solutions for the First Mile / Last Mile problem is going to be key for the Commonwealth. The Workgroup combined connected / autonomous vehicle offerings here, to
II. Security – Vehicle Connectivity, IOT & IIOT
The power to transform transportation system usage is data, so its integrity is vital. Therefore, it stands to reason that security is an essential element in any connected transportation technology adopted. It is no simple feat; however, to secure reliable data transmission between all the vehicles, infrastructure, devices, sensors and networks that underlie and will power the Smart Transportation Infrastructure of the future. Security encompasses what in common terms is called cyber security, but in reality, extends to everything – hardware and software – that forms the connectivity tissue of the framework that produces, ingests, normalizes, analyzes, and presents data for decision support in the Transportation Sector. Securing this framework is of paramount importance, and the Workgroup has placed special focus on this area.

III. Smart & Sustainable Infrastructure Solutions
Per the latest assessment by the American Society of Civil Engineers (ASCE), Virginia’s infrastructure is aging and affects the quality of life and safety of its citizens, as well as its economic well-being. Using publicly available data, ASCE graded the condition of the state’s infrastructure assets, identifying the need for critical improvements and anticipated level of funding required to maintain Virginia’s infrastructure. While significant traditional investment is required to upgrade the Commonwealth’s infrastructure, various intermediate steps can be taken to extend the life and usage of existing infrastructure. The workgroup recommends developing a comprehensive plan to catalog critical key transportation infrastructure across the Commonwealth, both those under direct Commonwealth control, as well as those maintained by Port, Airport, Intermodal, Transit and other Federal Authorities, and Private Enterprises including Rail Companies, and P3s, and create a platform for bringing in monitoring, optimization, modeling and predictive capabilities

IV. Data Management & Governance
The common thread for becoming ‘Smarter’ in Transportation is data. As devices from watches to cars connect to the internet, the volume is increasing: some estimate that a self-driving car will generate 100 gigabytes per second. Meanwhile, artificial-intelligence (AI) techniques such as machine learning extract more value from the collected data. Algorithms can predict when a customer is ready to buy, a jet-engine needs servicing or a person is at risk of a disease. This abundance of data changes the nature of competition, planning, operations and decision making. While data management and governance issues have been part of policy discussions and standards creation since the advent of computerized systems, the recent massive changes in what is now termed as ‘big data’ is necessitating a radical re-think. The recommendation is for a formal engagement mechanism that brings together the relevant Commonwealth’s departments and other related transportation entities with Virginia private enterprises to drive the development and subsequent piloting and deployment of data governance standards in all aspects for future Smart Transportation projects.

3. Establish a Commonwealth-wide Community Engagement Program for Smart Transportation that is set up with a sustainable mechanism (with digital and physical platforms) with key Commonwealth education, civic and NGO entities to bring in collaborative, sustained participation from various community groups, for them to formally be part of the decision-making process on investment, job creation, and sustainability issues in their communities.
4. Establish an Operating Leadership Council under the Commonwealth, potentially under DOT, to focus on key policy & procurement opportunities to increase effectiveness, streamline the project permitting process across transportation infrastructure sectors, with safeguards to protect the natural environment, to provide greater clarity to regulatory requirements, bring priority projects to reality more quickly, and secure cost savings. This Council should:

a. Authorize programs to improve specific categories of deficient transportation infrastructure and support that commitment by fully funding them in an expedient, prioritized manner.

b. Identify a pipeline of transportation infrastructure projects attractive to private sector investment and public-private partnership.

c. Improve land use planning at the local level to consider the function of existing and new infrastructure, the balance between the built and natural environments, and population trends in communities of all sizes, now and into the future.

d. Create incentives for local governments, regional transportation and transit agencies, and the private sector to invest in maintenance, and to improve the efficiency and performance of existing transportation infrastructure.

e. Help develop tools to ensure that projects most in need of investment and maintenance are prioritized, to leverage limited funding wisely.

Smart investment will only be possible with leadership, planning, and a clear vision for our nation’s infrastructure. Leaders from all levels of the Commonwealth’s government, business, labor, and nonprofit organizations must come together to ensure all investments are spent wisely, prioritizing projects with critical benefits to the economy, public safety, and quality of life, while also planning for the costs of building, operating, and maintaining the infrastructure for its entire lifespan. The pace of change in the Transportation Sector means that there will not be one set of standards or solutions that will prevail, but a series of innovations that will force a constant re-imagining as we move forward. The Commonwealth must be able to invest in the right areas to foster growth, and continuously course correct, to future-proof its investments.
The Case for Smart Communities in Virginia

Implementation of Smart Community technologies are a critical economic driver for Virginia. ABI Research, a technology market intelligence company, has estimated cost savings in the tens of millions for governments, enterprises, and citizens themselves and the potential for $5 trillion in savings globally on a critical infrastructure capital investment of over $50 trillion. Virginia has begun to take advantage of this tremendous opportunity, launching signature initiatives such as the Virginia Tech Transportation Institute Smart Road and the Federal Aviation Administration-approved flight testing facility, the VDOT Smarter Roads open data portal, the Gramercy District, a $500-million private development ‘smart city’ in Loudoun County, and Smart City Works, the first business “actuator” focused on helping startups and mature companies transition new ideas into viable growing businesses supporting infrastructure development. In 2017 Newport News was selected as a finalist by the Smart Cities Council, and in 2018 both Fairfax County and the Commonwealth have also been selected as finalists.

Smart Community efforts are becoming prevalent not only in Virginia but also nationally and internationally. Among U.S. efforts, the Smart Cities Initiative, launched in 2015 by the Obama administration, is expected to invest over $160 million in federal research and leverage more than 25 new technology collaborations to help local communities tackle key smart city challenges. Since September 2014, the NIST GCTC has recruited and incubated over 160 action clusters with participation from over 150 cities and 400 companies/organizations from around the world. International initiatives on continents such as Asia, Africa, and Europe are providing further insight into the successes and challenges of Smart Community efforts. NSF continues to advance the fundamental research, innovation, and education that collectively have the potential to revolutionize our nation’s cities and communities. NSF announced $19.5M in S&CC awards in Fiscal Year (FY) 2017, anticipates nearly $20M in new funding in FY 2018 subject to the availability of funds and quality of proposals received, and helped kick-start researchers’ participation in the GCTC with over $3.3M in awards across FY 2015 and FY 2016.

- The benefits of Smart Community efforts are becoming evident through use cases across the U.S. and around the world.
- The City of Chicago Array of Things project is an open platform enabling the community to analyze open-data, add capabilities (e.g., sensors, networks), and to program “deep learning” into the nodes.
- Big Data South Hub Spokes Project on Smart Grid Data brings new knowledge and solutions offering major improvements in smart grid operation (e.g., power generation and distribution, renewable energy) and smart grid user necessities (e.g., critical infrastructure, transportation).
- GCTC Electric Shuttles for Safe and Reliable First-Mile, Last-Mile mobility project works to develop scalable and adaptable architecture and control systems for first-mile, last-mile autonomous shuttle solutions.
- A Smart Energy-Aware Residential Communities Project at Purdue University alongside the Indiana Housing and Community Development Agency provides customized feedback on energy conservation behaviors, allowing residents to make informed decisions through predictive models and novel user interfaces.
• The Dubai Blockchain Strategy will help Dubai create the future of Dubai, and make Dubai the happiest city on earth. The Dubai Blockchain strategy is built on three pillars of government efficiency, industry creation and international leadership. Industries that will benefit from Blockchain technology include: real estate, fintech and banking, healthcare, transportation, urban planning, smart energy, digital commerce and tourism.

• Inclusive Urban Development for Informal Workers in Chang Rai City, Thailand aims to increase recognition and integration of the working poor, especially women, in the informal economy in urban planning and local economic development in order to leverage supportive economic, infrastructure, legal and social services from local government.

• Sustainable Transportation initiatives in San Francisco are models of how to work successfully with businesses and community groups to phase in and scale up sustainable transportation policies that make an immediate local and regional impact. Two of their major sustainable transportation initiatives over the past few years that are capturing imaginations locally and around the world are - first, the city has worked with local business and community groups to phase in SFPark, a smart approach to parking management in commercial districts around the city. And, second, the city’s innovative Pavement to Parks program has created new street plazas and many new parklets (sidewalk platforms that replace car parking spaces) by reclaiming street space in partnerships with businesses and other community groups around the city.

Virginia is well positioned to be a leader in Smart Communities both nationally and internationally, but it is critical that the Commonwealth capitalize on and advance its early achievements by taking decisive action now to define and implement a statewide Smart Community Roadmap. A critical element of this Roadmap is an implementation plan to reduce barriers to entry so that communities across the Commonwealth can participate in the technologies, efficiencies and economic benefits that Smart Communities promise. Although there are a number of common technological challenges, including cybersecurity, privacy, and open platform implementation issues, these can most reasonably be addressed at the state level, enabling communities to adopt technologies that fit their individual priorities more quickly, less expansively, and more securely than would otherwise be possible.

Furthermore, it is clear that much of the benefit of Smart Communities stems from optimizations resulting from integrated data analysis across multiple data sets, both public and private. Virginia can set the example for localities by increasing the access to open data from State Agencies and supporting the integration of analytics across these data sets to improve State level delivery of services to its citizens. By doing so, the Commonwealth also provides significant value to local communities seeking to leverage their own locally generated data with the broader picture that State data provides.

Many efforts in Virginia and elsewhere have run aground on difficult legal and data sharing issues including ownership, data rights, data integrity, and university imperatives to publish. Virginia can set a strong precedent by bringing stakeholders together to address these issues early on. Jurisdictions such as Illinois have addressed these issues by creating a Chief Data Officer position and implementing standard data sharing MOUs (Appendix G).

Established by former Governor Terry McAuliffe in August 2017, the Virginia Smart Communities Working Group is developing a set of recommendations and an implementation plan to ensure that cities and communities across the state realize the benefits of this new wave of technology. Following on its initial October 2017 report, this report provides the Working Group’s detailed findings and recommendations to establish and maintain Virginia’s leadership in Smart Communities. With support from Governor Northam and the new administration, the momentum generated by the Smart Communities Working Group can translate into action and implementations that will help ensure the future economic development of Virginia.
The following pages provide the detailed reports on findings and recommendations submitted by each of the seven VASC Working Group Committees, and their leads:

1. **City Platform/Dashboard**: David Ihrie, Chief Technology Officer, CIT

2. **Data Governance**: David Ihrie, Chief Technology Officer, CIT


4. **Healthcare, Public Health, and Human Services**: Margie Zuk, Senior Principal Cybersecurity Engineer, The MITRE Corporation

5. **Public Safety**: Jon Selby, Director, Commonwealth of Virginia

6. **Public Wireless/Broadband**: Jeffrey Reed, Willis G. Worcester Professor, Bradley Department of Electrical and Computer Engineering, Virginia Tech; Caroline Luxhoj, Broadband Program Administrator, CIT

7. **Transportation**: George Thomas, Founder, New Urban Informatics & Global Director, Smart Infrastructure, Hatch Ltd.

Each Committee addressed a variety of areas in their report, including the current state, what other places are doing, opportunities and threats, recommendations and guiding principles, areas for future work, and alignment with the NIST GCTC SuperClusters, a multi-city, multi-stakeholder collaboration organized around common project objectives and shared solutions and that produce blueprints/playbooks to be used by cities and communities around the world as the foundation to build their own smart city strategies.

The Committee would also like to thank Gord Stevens and Nicole Francki from Hatch, Ltd., for the design and layout of the final report.
City Platform/Dashboard
1. City Platform/Dashboard

From the NIST City Platform SuperCluster\(^1\) report:

“How do you deliver essential services to your citizens in the face of already stressed aging infrastructure, shrinking budgets and a myriad of challenges that create complexity never envisioned by any civil engineer prior to the 21\(^{st}\) century based on this mass influx of people [to urban environments]?... Modern daily life and the problems associated with it, defined by data, allows deeper insight and decision-making capabilities that both city officials need, and the innovation community requires, to create better solutions to deal with the urban challenges of densification. Quality data is essential; however, making the data accessible and understandable is critical to making the data ultimately valuable.

How do cities deal with the enormous amounts of data that smart cities produce? Once collected, how do city officials interface with this data to extract the right information to make effective operational and strategic decisions? How are these decisions made in a time efficient manner without sacrificing insight, relevance or the ability to synthesize multiple disparate data sources to make a single yet complex decision based on multiple real-time inputs? These are some of the challenges cities face as they deal with the…” massive challenges of rapid urbanization.

Across the Commonwealth of Virginia these challenges vary widely from one locality to the next, and exist in every community, rural and city alike. The Hampton Roads area is seeking to provide regional integration of information across the distinct communities of Newport News, Virginia Beach, Norfolk and others in order to address challenges resulting from persistent recurring flooding and the influx of tourists during the summer. Fairfax County and other areas in the D.C. traffic vortex are looking for ways to improve congestion management and the transportation infrastructure. Many more rural areas are actively working to improve broadband accessibility and provide more economic opportunities to their residents without giving up the characteristics that make those regions attractive places to live and raise families. Agricultural areas have already begun adopting

autonomous machinery, data-driven analytics and IoT sensors to improve crop yields and better match their products and supply chain infrastructure to ever-changing market conditions.

At the State level, Virginia shares the situation with most public entities, Federal, State and local, colloquially known as “cylinders of excellence”. State Agencies control substantial, potentially valuable, data holdings and perform their internal missions well but have difficulty collaborating across Agency boundaries to achieve the proven potential of increased data sharing and the use of analytics. Additionally, private entities are eager to utilize this public data to create value-added services for their customers, providing significant opportunity for mutually beneficial public-private partnerships.

The City Platform or Community Dashboard is the mechanism by which various individuals and categories of users interact with the combined set of data holdings in pursuit of specific smart community use cases. Some of these use cases may be informational (citizens seeking public data on various topics), may provide situational awareness of community operations to community managers, or may provide access to users with special needs and interests such as researchers or Law Enforcement. Within the overall data architecture these capabilities are conceptualized to include various apps or templates that can access data; that can perform some analysis, consolidation or transformation of the data; and that can provide appropriate visualization of results in a form suitable for various groups. It also allows for cases where users (for example, researchers) may want direct access to data holdings rather than mediated access via pre-defined apps.

In all cases the construct assumes that each user is individually identified, and then granted authorization to access some specific subset of the overall federated data holdings based on their user category or individual custom authorizations. Once identified to the City Platform, individual user sessions will include authentication of the individual and controlled data access in accordance with the user authorization, and enforced by a policy engine.

The Community Dashboard is intended to be customized to the data and informational needs relevant to each local community, including access to State and Federal data holdings. The notion therefore is that local governance bodies will help customize the dashboard and grant appropriate access to local individuals and groups. However, to ensure the integrity of the overall enterprise it is expected that a State level governance entity will provide practices and policy templates for this activity. For example, it is reasonable to expect different identifiable groups such as individual citizens, community managers, law enforcement, and specialized access groups such as medical, educational or research groups to seek access, and each of these groups may have different levels of authorization that can be put into a template for use by local authorities, enforceable by a State-implemented policy engine.

Virginia has a unique opportunity to move forward at the State level by leading the adoption of “smart” processes and technologies to realize improved State efficiencies and services, while at the same time enabling communities across the Commonwealth to advance their local priorities more effectively. The City Platform is the place where these threads of process, priorities, data and analytics become real for Agency and government officials, and the people they serve.
What does a “City Platform” or Community Dashboard look like? The basic technical assumption for the City Platform is a common data platform where various data holdings can be accessed, analyzed and utilized as the basis for better delivery of public or private services to community stakeholders. For purposes of this report, the assumption is that the Data Governance area will set the rules around which data is accessible, who owns that data, how data is stored, normalized, maintained, accessed and so forth. The City Platform provides the service layer and the supporting analytic functions that connect the accessible data to the various services of interest in the community. As such, it is driven by the use cases describing those services, and those use cases provide guidance to the data governance and related verticals (transportation, healthcare, etc.) that may source various portions of the data. As a key mechanism to provide visibility into the integrated data holdings, the City Platform area touches and informs every other area in the Smart Communities stack. Thus security, access control, and privacy issues are foundational to the ongoing success of the entire Smart Communities endeavor.

Vignettes on a variety of community efforts in this area are in the NIST SuperCluster report and The Route Fifty report “Insights and Ideas for Smart Cities” among others. Because a substantial body of work is beginning to accumulate in this area, marketplaces for analysis apps tailored for Smart Community use cases are beginning to appear, from large players such as Amazon to early stage innovators such as Local Intel. Significant opportunity exists to leverage these marketplaces and smart community applications.

Several examples highlight this approach. The Hampton Roads area of Virginia is dealing with issues related to recurring flooding, including predictable road closures due to inundation events, private homes in known flood plains, and the emergency management issues associated to larger events such as hurricanes. These communities have collaborated to implement StormSense, with some Federal funding now leading to community deployment of capability.
The StormSense capability combines proven simulation models, such as that shown for New York City during Hurricane Sandy, with weather reports, real-time IoT sensor monitoring and crowd-sourced observations from citizens to provide city planners, emergency managers and others with accurate real-time and predictive capability. The result is a significantly enhanced ability to prioritize resource deployment during weather events, reach at-risk populations more effectively, and provide optimized information on road closures and evacuation routes in times of crisis. With this initial implementation complete, a platform and an engaged community process exist to add additional types of sensors and address additional priorities of interest to the Hampton Roads community.
A second example is work done under DHS contract in Virginia identifying a large set of tailorable indicators for community resilience. A series of workshops were conducted in several different regions across Virginia focused on the specific regional priorities, external factors, and areas of concern regarding resilience. A key lesson from this work was the extent of regional and local variations in focus, and the need for corresponding regional solutions, a lesson directly applicable to State-led activities supporting regional smart community efforts. Integrating the outcomes from across these regional workshops produced the Regional Resilience Dashboard concept shown in the Figure.
The community resilience work also produced a handbook for communities to tailor the indicators and dashboard to meet local needs, and provides an additional source of inspiration for broadening that capability to meet the needs of the City Dashboard focus area.

A third example from outside of Virginia is a transportation dashboard from Nevada. While many similar examples exist, and the displays on the dashboard use standard visualization technology, the process used to determine the priorities of the community, the data assets available or that can be collected, and the means by which the information can be assembled, displayed and made available take careful planning and rollout.

A number of private companies provide services that support this type of community needs analysis and implementation⁴.

⁴ https://www.idashboards.com/solutions/transportation-logistics-dashboards/
Alternatively, a vendor-neutral state-funded process to help communities get started along the smart communities path and select the solutions that best fit their needs already exists and is successful in Virginia. This is the CIT Broadband Path, a nationally recognized approach to help Virginia communities understand their priorities for Broadband adoption and prepare to engage with the private vendors that are instrumental in delivering those priorities.

In many cases this process is directly applicable to local communities where the first priority is to “get connected”, the base layer of capability for any “smart” implementation. More broadly, this process is readily adaptable across the full range of smart community priorities, especially if a state-level infrastructure exists that provides data protection and privacy, and lowers the barriers to integrating local implementations. A consolidated body of smart community expertise would significantly enable communities in realizing the potential benefits of rapid adoption.

Across all of these examples and a host of others, the most significant threat in this area is loss of citizen confidence and trust that the information is being used for positive purposes. Community involvement, transparency of operation, and protection of both data and privacy are foundational in this area. While the Governance area, for example, can provide structure around various levels of access to information (public, research, Government-only, law enforcement, etc.), the City Platform is likely to be a primary touch point for enforcement of these access controls and so needs to be designed from the ground up to include those capabilities.
**Recommendations**

- Start first with the Commonwealth of Virginia, and employ the process analysis techniques to drive more open data in State Agencies and integrated data and analytics around specific high-value use cases.

- Conduct community outreach. Virginia should conduct and maintain community outreach efforts throughout its Smart Communities initiative to validate and extend the set of use cases of interest in the City Platform/Dashboard area. As a start, the state could focus on Smart Community efforts that will save communities money, which should generate rapid interest and support. Continue outreach to communities at large as implementation discussions take place.

- Extend the CIT Broadband Path process as a mechanism to help local communities evaluate their priorities and develop implementation paths to interact with technology and other vendors to implement those priorities.

- Use GoVirginia or other similar mechanisms to provide State-level funding opportunities for regions interested in moving forward with Smart Community implementations.

- Baseline the marketplaces and apps already in existence and the use cases to which they apply.

- Baseline the previously developed community resilience indicators and implementation approach.

- Formulate a plan and accompanying implementation handbook for use by communities to guide their City Platform activities. The plan should include access to available marketplaces, apps, and resources available to local communities.

- Establish a standing analytics working group at the state level to help facilitate validation of analytic tools included in the Smart Communities stack as well as addition of new analytics tools to be added to the marketplaces as community-driven needs evolve.

**Areas for Future Work**

As outlined in the recommendations, a significant focus for later versions of this report is baselining and integrating existing and prior work/capabilities with an evolving focus on the needs of communities seeking to adopt “smart” approaches. Over time, this will transition into providing support for communities seeking to begin implementation. The CIT Broadband approach provides one successful example of how this could work in practice.
Data Governance
2. Data Governance

A smart community has a complex data challenge. Data will be sourced and owned by a variety of entities, both public and private, in different formats, with differing levels of granularity, quality and data sensitivity. Yet the benefits in a smart community environment often accrue through insights gained as a result of data analysis across this vast heterogeneous set of data.

Challenges abound on the usage side as well. A variety of stakeholders will want access to the data for varying purposes, and controlling different levels of access and security while maintaining privacy is a primary concern. The Data Governance area controls the rules of engagement for these information flows: who can participate, in what roles, with what requirements and levels of assurance.

The basic technical assumption for a Virginia Data Governance construct is a federated set of data holdings where a common set of rules are required for the information flow, in order to provide a common data platform in a smart community environment. The federated data sets are envisioned to include Federal, state and local data holdings as well as private (corporate) data, and be inclusive of protected data such as health (HIPAA), education (FERPA) or child/minor information (COPPA), and a fundamental purpose is to enable data analytics across these diverse data holdings. At the Federal level the National Technical Information Service of the Department of Commerce provides a starting point and partner for access to the envisioned Federal data sets.
To make sense of the Data Governance requirements we postulate a conceptual architecture for a State-level data architecture/infrastructure. This conceptual architecture is informed by several real-world Virginia use cases as examples of the types of data and usage to be supported by the architecture. First, the Virginia Longitudinal Data System (VLDS) has several years of experience and Governance around educational research using three distinct data sets with strict privacy requirements governed by FERPA. The three data sets cover K-12 student performance, University records, and workforce/employment records required to be collected by State law, and the VLDS system is intended to support research regarding educational experience and employment outcomes. The structure of VLDS is similar to that described here, basically a federated data commons with limits on both users and queries. A second use case is the Virginia Department of Transportation (VDOT) open data portal, which makes data collected by VDOT available on a case by case basis to third party commercial companies such as Waze. A third use case of interest is the use of local data as a basis for state-wide electronic permitting of capabilities such as 5G cellular base stations.

**Goals:** The goal of this conceptual architecture is to describe an open innovation platform that encourages public and private users and groups to continuously innovate around both data resources and the resulting service offerings. Several principles are embodied here including:

- open source concepts so that the strawman is independent of proprietary intellectual property
- cybersecurity and privacy as distinct foundational elements
- clear guidance for protecting the privacy of individuals represented in the various data sets
- clear guidelines for data structure in the underlying data sets and an accessible inventory of data assets within the Data Commons framework
- an operating structure template that can be legally supported
- compliance with relevant Federal, State and local statutes such as HIPAA, FERPA and COPPA
- a clear template for adding localities, users and data sources to the strawman
- an assumption of openness so that data and outcomes are expected to be available to everyone including researchers and the public, within the constraints of the law
Within this conceptual architecture the role of Data Governance and other aspects of data management and their inter-relationships is illustrated in this diagram from Teradata, and these aspects are addressed in the subsequent material.

**Enterprise Data Management Framework**

**Proven Approach to Data Management**

- **Data Quality** – The assurance that data is fit for its intended use
- **Data Integration** – Includes all aspects of processing required to combine transaction and master data to provide a consistent, meaningful, and trusted view of the data across business units and subject areas
- **Data Security and Privacy** – Information security, data privacy, and regulatory compliance across data subject areas, including monitoring and audit capabilities
- **Metadata Management** – The people, processes and technical components necessary to ensure that metadata is easily accessible, consistent, current, accurate, timely and complete
- **Master Data Management** – Focus on master, reference and relationship data for product, customer, supplier and organizational data to ensure data consistency
- **Data Architecture** – The logical and physical data modeling plus other activities needed to understand business information needs and design for effective data usage

**Architecture**: Bringing all of these elements together is the conceptual architecture in the figure below. The core notion of that architecture is a “Data Commons”, with specific analogy to the open source concepts of a commons for intellectual property, open source software licensing, open APIs, GITHUB, and related structures. Three color coded areas in the figure show the Community Dashboard in white (included here to show the interrelationships), external (third party) data sources in green, and the scope of the Data Governance in blue. The Data Commons itself is not envisioned here as a repository for data, but rather as a transitory, controlled, protected mechanism for many classes of users to access a disparate set of data resources in support of specific use cases of interest to the communities involved.
The notional data flow in this architecture is that an authorized user interacts via either pre-approved apps and visualization or via direct queries with the Data Commons, initiating access to some set of data resources potentially distributed across multiple data sets (and to include IoT or video streams for example). The Data Commons acting in the role of data broker mediates access according to a set of pre-defined policies and query limitations (to protect privacy), and then provides access to the intended data. The apps and visualization transform the resulting data to provide data products and output back to the user. It is easy to envision a cloud-based implementation of this architecture, where each user session is mapped to a separate cloud virtual machine (VM) for the duration of the session.

**Legal Structure:** Successful smart communities will require government, industry and citizens to all collect, use and share data with each other on a regular basis. As a result, any law, regulation or policy that impacts the collection, use, storage or distribution of data by any of these groups will likely have an impact on others in the smart community data chain. Legal and policy frameworks concerning data are unclear and evolving. Key legal issues that will impact smart communities include privacy, intellectual property, liability, and national security. Some sort of license/data sharing agreement/terms of service will be needed to share data between the three groups. Such agreements not only transfer rights to use the data, but also allocate any risks associated with the quality of the data (timeliness, completeness, accuracy, precision, fitness for use, etc), its provenance or its use.
It is important to develop agreements that properly allocate risk, particularly given the evolving nature of the law in this area.

Given this legal status there are three initial legal issues that can be addressed, other than authorization for some group to implement such a structure at a State or locality level. First is the Governance structure and authority itself, including clear authorities for State and local groups that participate; second is data ownership and terms of use for access, derivative products, the allocation of risk and similar; third are issues around privacy, security and liability. Certainly there will be other legal issues as well, and the intent of this conceptual architecture is not to resolve any of those issues, but rather point to some suggested approaches for implementation that will then direct the associated legal discussions that ensue.

Our recommendation is for Virginia (through Legislative and/or Executive action) to authorize a core standing Governance group to provide State-level guidance (with access to support from the Office of Attorney General, OAG), and then to incorporate separate regional level Governance groups to interact with the State level resources and guide local implementations. One mechanism at the regional level could be the GOVirginia regions/groups, which are already established to provide regional structure and focus as well as a funding path. The core Governance group should also include membership from relevant State Agencies, and a lead Data Scientist or Chief Data Officer to help ensure data validity and integrity. Note that this same Governance group can help State Agencies also adopt open data and smart analytics in addition to enabling localities.

From a data ownership perspective the Data Commons should not affect the data ownership of the underlying data set participants. The intent is that participation in the Data Commons will be via a pre-defined set of access agreements between data owners and the Governance body, and that data will not be replicated in the Data Commons (other than for temporary access) but will remain under the control and ownership of the participating data owner. The Data Commons will have a mandated, auditable requirement to validate and log what data have been shared and that the data have been appropriately deleted at the end of each session. Similarly, users will also access data under clearly defined rules enforced by the policy and query control portions of the architecture. A legal mechanism here could be a limited Right to Use License for data between the Data Owner and the Governance group, which could in turn be sub-licensed to specific users. Concepts such as a “link contract” or blockchain record could be applicable here.

Issues around privacy, security and liability are the trickiest. Security of data within the Data Commons portion of the architecture is the responsibility of the Governance group via its oversight of the Data Commons implementation; security of the external data sources is the responsibility of the respective data owners, and liability should follow these boundaries.

The most difficult aspect is privacy, in two different areas. The first is the notion of “differential privacy”, which aims to maximize the accuracy and information content of queries to data sets while minimizing the chances of identifying the underlying records. Such identification could occur via either repeated queries to a single data set or correlation of data across multiple data sets. Limiting access in a way that seeks to achieve differential privacy is the role of the Policy Enforcement and Query Control
portions of the architecture, but this is a challenging area of active research, and researchers with insight in this area should be engaged to help drive these policies.

The second area of privacy concern is with derivative products, third party groups generating data products incorporating data via the Data Commons, generally in conjunction with private data. It is explicitly a goal of the Smart Communities effort to encourage such derivative products and provide the Data Commons specifically as an open innovation platform for third parties, so the need is to balance that goal (for example allowing researchers to publish results of their research) with the legitimate privacy concerns of individuals/entities represented in the underlying data sets.

Several concepts seem relevant here. The first, from the open source software domain, is that derivative products are governed by the same limitations as the basic Data Commons agreements; that is, they become a de facto addition to the external Protected Data Sets group, where the protection is provided by the set of Data Commons agreements. A second concept is the notion of aggregate data, where in general statistical aggregation of data (for example, definition of different user categories based on a set of traits) is reasonable since it removes the underlying record information via aggregation. This is different than anonymization of individual records, where individual records may still be identified via other means.

A third concept is limitations around the uses of derivative data. In common practice, most people seem to accept the tradeoff of a primary stated use case of service in exchange for access to personal data, for example the provision of a ride-hailing service based on individual location. Privacy objections seem to occur either in cases where non-transparent additional use cases are implemented by a third party (such as derivation of individual travel patterns on the basis of ride-hailing locations), or where personal data is in turn re-sold for purposes such as marketing. A final concept is the notion of “opt-in/out”, most restrictively implemented in Europe, where any use of individual records must receive opt-in approval from each individual user, separate from overall service agreements. A combination of these techniques would go a considerable way to addressing many privacy concerns.

Implementation of these privacy concepts around derivative data will require extensive additional work, both technical and legal. Models to consider include European Union privacy laws (GDPR takes effect in May 2018 and impacts many Virginia and U.S. companies), constraints imposed on Federal Agencies around privacy, and work done by the FTC in this area. While private interests have in many cases litigated against these constraints, their implementation is nevertheless resulting in technology solutions consistent with these limitations.

Role of Governance Group: The role of the Governance group in this construct would ideally be several-fold, as has been alluded above. First, it provides a standing, organized group at the State level with specific authorizations to initiate and operate the Data Commons structure. Second, it provides a focal point and oversight for technical implementation of the Data Commons and associated capabilities including cybersecurity, privacy and policy, thus providing significant data infrastructure for regional or local smart community groups that choose to participate. Third, it provides a single point of contact for access to data sets under various agreements, including Federal and State level open data assets as well as potentially more restricted access to protected or private data sets. Fourth, it provides a mechanism to significantly support local or regional smart community initiatives, providing templates
(such as data use agreements and associated process including agreement timelines) to onboard those jurisdictions, provide access to the data and infrastructure, guidance and training, best practices, access to additional legal, technical or other resources, etc. Fifth, the Governance group provides an ongoing mechanism, perhaps overseen by a Chief Data Officer, to provide oversight of the evolving data sets and data models to ensure errors or omissions are corrected, data is current and valid per usage agreements, analytic apps are accessing the correct set of data and the analyses are correct, and similar data integrity oversight functions.

Data Sets: Three types of data sets are identified, Public, Protected and Private. Given the Data Commons architecture and the concept of a federated data structure, it is assumed that ownership, control and Governance of each individual data set remains with the originator or otherwise a priori identified data owner, and that this status is not changed as a result of participation in the Data Commons. The data owner is responsible for the protection, correctness, timeliness and access to their data, as well as control over the subsets of larger data holdings that may be accessible via the Data Commons. This implies a metadata description of each integrated holding and unique/succinct tagging of the data assets themselves. One role of the Governance function is to mutually define with the data owner what the metadata and access structure will entail.

Clearly, all the normal questions come into play here around data quality, ETL functions, change control over data schema and the impact of that on data analytic functions higher up the stack. More detail is required describing a coherent Enterprise Data Architecture for this type of implementation. Industry solutions in this space are complex (example below courtesy of Kylo), and a role of the Data Governance group will be to provide technical expertise from various Subject Matter Experts (SMEs) to help localities understand those complexities.

Cybersecurity: The cybersecurity implementation contemplated in this architecture is fundamental to the overall success of the initiative. In this construct, responsibility for the security of the underlying data set remains with the data owner. The Data Commons contemplates protected data access in a controlled environment; thus the actual access session for example could take place within the
construct of an individual VM instance in the cloud with security controls implemented by the cloud provider and all data and the VM deleted at the end of the session. The Community Dashboard portion of the architecture contemplates both user and device identification, authorization and access control. Actual data access is controlled by both Policy (per user) and Query controls (per data set). It is assumed that all communication links will established via SSL, VPN or similar to identified endpoints. Additional normal controls and approaches (firewalls, SIEM, logging, etc) are also assumed where appropriate5,6.

Virginia is the first State to formally adopt the NIST Cybersecurity Framework7, has State-specific controls identified via the SEC-501 series, and has a professional organization in the Virginia IT Agency (VITA) dedicated to provide secure computing and communications for State-level capabilities. It is recommended that a senior VITA representative be a permanent member of the Governance Board, and provide coordination with VITA for support in defining and implementing the overall architecture and specifically the cybersecurity architecture for the Data Commons. This provides one mechanism where the State-level capabilities may be extended in support of regions and localities.

Data Analytics: Analytics is where the real value of Smart Communities information is realized. Analytics will provide both short term (situational awareness) and longer term (resilience) views of a community’s health and function, help improve delivery and efficiency of Governmental services, and provide support as an innovation platform for value-added data-driven products and services from the private sector. Some users of the City Dashboard platform may be able to conduct their own statistical or other analyses directly on data accessed via the Data Commons, but most users will rely on a fixed or slowly evolving set of analytic applications and visualizations to interface with the data.

The value of these analytics is closely linked to the integrity of the underlying data in terms of accuracy, completeness, temporality, and correlation across data sets that may use different schema or tags. While it is desirable to have a readily accessible set of the most commonly used “pre-packaged” analytics (and some commercial vendors such as AWS are beginning to support these libraries), it is recognized that the careless use of analytic tools may result in misleading or inaccurate results. An important role of the Data Governance group and specifically the Chief Data Officer is to solicit feedback and provide oversight ensuring the synchronization of the data and the analytics it supports.

**Recommendations**

- Baseline and leverage existing Commonwealth State-level activities around open data (such as the VDOT data portal and others), data governance (VITA, VDOE/SCHEV and others), and integration of federated data sets (CIT Broadband, for example).
- Establish a Commonwealth-wide standing Governance group with the following charter:
  1. Develop and promulgate rules around smart community data, including participation, sourcing, access, structure, security, ownership, and other aspects of smart community data governance.
  2. Provide expertise and mentoring for Virginia communities seeking to connect into a larger Commonwealth data structure.

5 [https://webstore.iec.ch/publication/7033](https://webstore.iec.ch/publication/7033)
3. Act as a clearinghouse for standards, best practices, other information related to smart community development.

4. Develop a common Data Infrastructure & Analytics Strategy including: definition and support for an initial implementation of a reference Enterprise Data Architecture, Enterprise Data Modeling, and Business Centric Analytics.

- Adopt interoperability standards along with a cybersecurity and privacy plan for Virginia’s Smart Communities. Interoperability standards could ensure that the state’s activities capitalize on and leverage its existing efforts, data holdings, and technologies, thereby reducing costs, while a comprehensive crosscutting cybersecurity and privacy plan would address security concerns across all of Virginia’s activities and increase public acceptance by helping ensure the protection and security of Virginia’s citizens and their information. Additionally, the adoption of such standards and policies would substantially reduce the barriers to entry for all Virginia communities.

**Areas for Future Work**

As indicated in the recommended charter of the Governance group outlined above, there is a substantial amount of work involved in implementing a functional data model and related Governance structures. The issues are well-known in terms of data quality, integrating dis-similar data structures, metadata to describe the data holdings, APIs and other components, and so forth. However, developing a functional structure here will provide substantial value across the Commonwealth for communities seeking to adopt “smart” practices, in a way that is likely beyond the capacity of each community on its own.
Energy, Water, and Waste Management

In a smart community, the overarching community goals of enhanced quality of life, economic growth and sustainability are improved through direct citizens’ engagement and technological integration of the community’s infrastructure. Technology is driving great change and possibilities to the way communities interact with its population and control its infrastructure. Through the use of real-time communication and control systems with a robust network of sensors, information is collected from both inhabitants and infrastructure. In real-time, it can be analyzed to tackle inefficiency, divert overcapacity, predict failure, provide feedback, inform the public, and assess cybersecurity risk. All of these capabilities lead to the sustainable supply and use of energy and water as well as efficient treatment of waste. Smart solutions will lead the next phase of transformational improvements in our infrastructure.

Benefits of Smart Grid
A Smart Grid is an integral part of a smart community. Many benefits of a smart grid are readily apparent, but as data gathering and analytics become more robust and ubiquitous, new applications and benefits will emerge. A well implemented smart grid delivers quality, low cost energy without disruption. Investing in a smart grid is the foundation in all communities’ of all sizes at all socio-economic levels, to meet their goals; sustainability, livability, and workability.

While recent modifications have focused on improvements in transmission capability, today in Virginia the distribution grid is aging, outdated, and inadequate for both changing expectations and threats. Significant investment is needed and may be accomplished to deliver long term, evolving, and exponential improvements. A smarter grid will benefit Virginians both directly and indirectly. While consumers will directly see lower operational costs, they will also experience more efficient consumption of electricity and reduced impacts on their environment while both, the State and our Nation, benefit from improved security, environment, and economic growth.

Resiliency and Reliability – Fewer power disruptions and power quality disturbances. As grid infrastructure continues to age, natural disasters become more prevalent, and distributed energy resources (DERs) lead to higher load fluctuations on the grid, maintaining reliability and resiliency becomes a greater concern for utilities and consumers. Reliability delivers power when and where it is needed; while resiliency reduces the magnitude and duration of a disruption. Both are equally important in delivering quality electric service. A modernized grid allows utilities to better understand and address weaknesses in the distribution system, reducing both the frequency and duration of outages.

A smart grid delivers a superior understanding of the state of the electrical grid at any point in time – when sensors and communication systems on the grid alert to conditions and expedite resources in a more timely and efficient manner to repair outages. A smart grid’s ‘islanding’ capabilities can maintain sections of the grid in operation when the broader grid is down – a
particularly useful capability when designed around critical infrastructure. Emerging technologies for remote monitoring provide a more cost-effective way of protecting assets and access points from theft, vandalism and malicious attacks.

**Customer Engagement – Enabling consumers to engage with their own energy use and make their own choices.** The traditional pricing of electricity encourages customers to consume electricity in a predictable fashion, albeit one that does not optimize for cost, system efficiency or environmental impacts. Consumer usage information unlocked by advanced meter infrastructure (AMI), otherwise known as smart meters, empower utilities or third-party providers to create new tools and technologies that offer customers greater understanding of, and control over, their energy consumption choices. Customers can engage in a choice (omni) of channels and service offerings to more effectively undertake energy efficiency upgrades or save money by reducing use during peak power periods, if offered in a rate design. It also enables greater integration of distributed renewable energy technologies that customers are increasingly demanding – as increasingly seen in the deployment of rooftop solar systems or behind the meter battery storage deployment. Customers may play a more active role in the electric power system, made possible by a smart grid with visibility and control to mitigate strain on grid equipment.

**Rate Reform – Detailed interval data on energy use enables customer choices that can save everyone money while improving grid operations.** Smart meters open an opportunities for several innovative rate designs that can empower and reward customer behavior that cuts costs for all users, enables cleaner energy choices, and improves grid stability. Because smart meters enable visibility of the time of energy use in addition to the amount of energy used, electricity rates can be tied to the time at which they use energy. This can allow customers to shift energy use to off-peak periods when costs are lower, and thus see financial reward for doing so. This then reduces energy consumption at peak periods, reducing the need for the most expensive generation and bringing down costs for all.

**Integration of Distributed Energy – Improved management of the grid allows for greater and more efficient integration of intermittent renewable energy, whether distributed (e.g. rooftop solar) or large scale (e.g. wind farms).** Smart grids can better manage the complex responses to variable renewable energy resources, matching changing demand to generation resources more effectively, and enabling innovative peak reduction and energy storage technologies. Renewable energy resources reduce the environmental impact of electricity generation and have zero fuel costs, but when deployed at scale (either as large projects or as high penetration of distributed generation), the grid must be more proactively managed to ensure that generation matches demand. A smart grid improves real time situational awareness across the grid so that operators are able to deploy standby resources, energy storage or other components when weather or time of day simultaneously or unexpectedly impacts renewable generation to cause large scale power fluctuations. Additionally, energy storage resources can be deployed effectively shift the peak of renewable generation (e.g. a
wind farm producing more power at night when demand is low) to times of peak demand. If used in tandem with more robust peak reduction and rate incentives, they can reduce both peak loads and compensate as renewable generation decreases.

Smart Communities are seeking ways to improve sustainability by improving efficiency, shifting consumption and using lower-polluting sources of generation. Siting distributed generation resources closer to loads may reduce the need for transmission investments and line loss inefficiencies. A modernized system that reduces consumption and supports energy efficiency and renewable generation helps the State to lower energy consumption and increase the use of lower-polluting generation on the grid.

**Efficiency – Reduces the cost to deliver energy as well as new ways to lower peak capacity requirements for the same load served.** Although electricity demand has slowed in recent years, growth in demand at times of peak consumption (for example, polar vortex) has grown, driving up the costs of electricity as expensive power plants are used inefficiently. Modern technologies help the grid become more cost-efficient by: delivering power to end-use customers more efficiently; more accurately balancing demand with the lowest-cost supply available; communicating data to end-use customers that facilitate reductions in energy consumption during high-cost periods; requiring less cost in grid operations and maintenance; and faster restoration times.

The improved situational awareness that smart grid technologies provide grid operators is a way to reduce the number of field calls and in many cases allow for remote resolution of faults. Smart meters can eliminate the need for manual meter reads (eliminating the need for vehicles to travel all over the service territory), while also automatically informing operators of outages – instead of waiting for customers to phone in problems. Better knowledge of conditions on the grid and at the meter enable predictive asset maintenance and replacement, identifying imminent faults before they result in outages or more costly equipment failures. The grid can also be operated much more efficiently and safely at much tighter tolerances. Sensors and communications technologies allow higher voltage efficiency through multi-node voltage data gathering, analysis and control.

**Electrification of Transportation – Meeting increased demand from EVs and leveraging mobile battery capacity.** As demand for electric vehicles increases, atypical electricity demands may be placed on the grid. A smart grid is better able to respond and manage vehicle charging to the benefit of the grid. Peak loads caused by countless electric vehicles arriving home (or a bus depot) and concurrently plugging in every evening may pose challenges for dated electric grid infrastructure; however, smart technologies can manage this load by leveraging many of the capabilities referenced above; battery storage, peak reduction, time-of-use rate designs, and other innovative approaches like smart connected vehicle chargers. This can help reduce the need for traditional (often more polluting) generation to meet these vehicle loads.
Availability of numerous vehicle batteries plugged into a smart grid may also enable more innovative ways to manage grid stability; ‘vehicle-to-grid’ technologies would draw small amounts of power to ensure that, for example, electricity frequency is maintained on the local distribution grid – allowing the system to run more efficiently than meeting frequency demands via central power stations ramp ups. In emergencies, the batteries in the cars in peoples’ garages could even power homes during shorter power outages.

Economics – A catalyst to stimulate economic growth, innovation and competitiveness in Virginia. Lower cost of energy with efficiency gains and fewer outages is an advantage to Virginia business, residents and communities. Faster restoration times lead to less loss to businesses and are more attractive to companies locating in Virginia. Smart grid innovation and deployment creates new jobs in higher technical fields such as data science, monitor and control systems, and information technology as well as for linemen, electricians, and installers. Support for innovation in Virginia’s universities and businesses, for example through technology incubators and spinning off new technologies developed in the state’s world class academic sector can be driven with local demand for deployment of these technologies, along with traditional R&D support programs. These institutions can be used to assist in new approaches to solutions through events known as “solvathons”, which provide data sets for development of use cases and algorithms. It will also drive demand for STEM skills in schools and vocational skills at all levels of education. The knowledge, skills, experience and innovation can be leveraged to enhance smart solutions in other industries and services in Virginia.
What is a Smart Grid

A Smart Grid as all solutions of a Smart Community, is made up of devices that communicate information, which most importantly lead to automated response, improved decisions and real time control by both operators and consumers. As aging infrastructure is replaced on the grid, it should be upgraded with smart technology. It requires an interoperable, robust and protected communications network, and most importantly the capability to analyze and use the information to take actions either automatically or through remote active control.

A variety of critical components are required to ensure the smart grid is capable of achieving these expectations and its benefits. Upgrades to infrastructure must include key equipment but smart versions of this equipment. Smart meters, smart transformers, smart reclosers, and smart substations are essential for a smart grid. These components must communicate and integrate into intelligent platforms that address both grid management and customer engagement. Platforms such as Advanced Distribution Management Systems (ADMS) provide the backbone for consolidating lakes of data, the ability to access, analyze and use information and take action as needed. Similarly, modern customer engagement platforms provide customers real time information, analysis and control to meet their energy needs in an individualize way.

Smart Components and Design

A Smart Grid begins at the customer service point. Smart meters installed at every customer’s premise provide two way communications and 24-7 real time control and information. In addition to information for the customer, smart meter information is more accurately aggregated to determine the consumption and needs on a feeder including capacity requirements, voltage control, theft prevention and outage identification. Remote control of these meters allows real time connects, disconnects and active voluntary peak capacity reduction. They are a key component in driving consumer behavior for rate structures that allocate costs appropriately to rate payers and collects the data required to provide individualized customer information and support dynamic rate design.

Electric lines travel long distances to connect meters and service transformers to the substation. Along these routes vegetation, birds and other animals, near lightning strikes and other elements cause both permanent and transitory faults that disconnect the power. The installation of smart reclosers, sectionalizers and line sensor supports automated recognition and isolation of non-transitory faults and reconnects service when these elements have a temporary effect on the line. Self-healing significantly reduces the number of outages from temporary events. The line sensors also provide information on the health and operation of these feeders as well as indicate potential issues so they can be addressed in advance and more economically.

Installation of smart transformers that monitor their health and automatically regulate voltage to a specific level provides a more efficient grid as well as significantly improves power quality for the consumers. Power quality fluctuations become more unreliable from intermittent renewables like solar and wind on the grid, smart transformers, which are integrated with other line sensors, automatically maintain voltage, which mitigates damage caused by uncontrolled intermittent power supply outside acceptable tolerances.

At the substation, connection and data streams from critical equipment such as remote terminal units, microprocessor-based relays and digital fault recorders can provide new capabilities and approaches
to remotely monitor and control substation operations. Other advanced technology and equipment include battery storage and capacitor banks to enhance power quality as well as temporarily store energy during low demand periods and discharge for instantaneous or long periods of high demand. These mechanisms require real time information, automated controls and prolonged historical data sets for analysis.

A smart grid is designed to provide higher levels of resiliency for critical service points such as hospitals and emergency services. This would be achieved through microgrids and islanding, where this subset of generating and storage components provides rerouting of or back-up power during disruptions. Persistent outages and outages at critical service points can also be significantly reduced by undergrounding portions of the grid where most needed. This reduces the drain on restoration resources during severe weather events so that they can be redirected to the worst places of damage and restore system-wide service faster.

**Operators Getting the Most from Connected Devices and their Data**

Grid operation and asset management platforms are essential to realize the benefits of continuous real time control and information gathering for a smart grid. These platforms must address the operators’ ability to manage smart assets and components in a geographically dispersed and physical environment. ADMS is a key platform which incorporates information from traditional systems like distribution, outage, meter data and global information/mapping management systems in a more robust version of supervisory control and data acquisition (D-SCADA/SCADA) system. An ADMS platform enhances operator awareness through real time information, alerts, simulation, and visual representation (aerial and design maps) of grid activities. Underlying algorithms are constantly improved with the integration of new data and outcomes. An interoperable approach to a smart grid will accommodate a wave of emerging technologies in augmented reality, mobile and field applications, visualizations and geographical representations, and video/audio edge computing capabilities. As data collection, integration and experience continues to mature, modern computing processing coupled with more effective machine learning tools will layer a new set of analytics for further improving operation and performance.

**Evolving Expectations and More Engaged Customers**

A Smart Community is motivated by Smart consumers. Consumer expectations are now free flowing moving from one experience to the next. This is challenging energy providers to keep pace with standards set from other industries that would never before been applicable. Digitization of everything, and expectations of hyper-relevant personalization, a relentless obsession with customers is no longer an option, but a must. Customers expectation’s vary in degree of engagement from those seeking a fast, simple and effortless solutions, while others want personalization that align with their lifestyle or values requiring – convenience, control, access, information and choice. A thorough understanding of who customers are and what they want yields more targeted outreach—and better delivery of services. Better service begins at the nexus between the customer and their utility, physically at their location with smart meters and connecting through customer engagement platforms. These provide personalized information on usage and outages. Consumer engagement platforms facilitate meaningful interactions between the utility and the customer, largely driven by detailed usage information but also by providing omni-channel communications. Detailed energy usage information and communications may drive greater change when coupled with new rate structures and peak reduction programs that financially incent customer. This leads to greater behavior changes for more
relief to generation assets during peak times. When consumers are informed on their usage they are able to make smarter choices when it comes to their energy consumption benefiting both the utility and the consumer.

Individualized usage and localized weather information is a baseline to predict near term usage so that customers can manage to a budget as well as understand drivers behind a high bill. Projections with alerts provide actionable information to control their energy usage. Awareness linked with action helps them choose setting on their thermostat or installation LEDs lightbulbs, insulation and weather stripping to meet their own needs. Predicted usage may help prepare customers during extreme weather events, and help lower bad debt for the utility, when customers are unable to pay unanticipated large bills.

Energy disaggregation empowers the customer to more proactively control their energy consumption and thus, lower or modify their electricity usage as they choose. It leverages a customer’s meter data to identify unique electrical signatures from appliances and electronics for an individualized, real time breakdown of their energy usage. These actionable insights include ways to lower their energy usage by improving or replacing inefficient systems, alerting to malfunctioning equipment or change the schedule of use appliances like washing machines, dryers, and dishwashers. Below is an illustration of the distinct difference in consumer interaction when the customer engages in the energy saving recommendation by purchasing an energy efficient air conditioner with a rebate.

By combining this platform with connected smart home products, peak demand reduction programs may become more popular as they may satisfy the needs of more customers. Most peak reduction programs are passive for the customer and often times result in inconveniences that outweigh customer incentives. A platform allows for real-time communication to alert customers to curtail their usage during a specified time through non-monetary or financial incentives. These alerts may reach out for participation as much as a week in advance or just hours prior to the event using the omni-channel capability. If they voluntary opt in or are in a program, the curtailment of usage would be controlled through the utility at the agreed upon time and duration, significantly enhancing convenience and
choice. As part of the consumer engagement platform, smart home or energy efficient products may be presented via a marketplace concept to also enhance their adoption.

Customer engagement platform with smart meters, not only provide these enhanced features but more proactively manage traditional customer expectations for outages, bill pay and connects/disconnects. Push notifications to the customer notifying them of an outage, the cause, expected restoration time, and confirming power restoration to close the ticket, instead of the customer reporting an outage. Deposits can be replaced with prepaid account for those in need type of service. It also enhances the opportunity and methods for paying a bill as well as accessing and retrieving information on the history of your energy usage. The enhancements and new options provide many benefits for the customer to make their own choices as well as significantly improve convenience and communication.

**Status of the Transmission Grid and the Energy Market**

Ideally a smart transmission organization would improve transmission reliability and efficiency, while managing congestion on the transmission system. Additionally it could integrate certain aspects of the distribution system operations with transmission operations. Smart transmission includes substation automation, advanced protection and control, modeling, simulation and visualization tools, advanced grid control devices and materials, and the integration of all these tools with markets, operations and planning functions.

The Commonwealth of Virginia is fortunate to be served by PJM, the regional transmission organization that coordinates the movement of wholesale electricity in all or parts of Delaware, Illinois, Indiana, Kentucky, Maryland, Michigan, New Jersey, North Carolina, Ohio, Pennsylvania, Tennessee, Virginia, West Virginia and the District of Columbia. PJM operates a competitive wholesale electricity market and manages the high-voltage electricity grid to ensure reliability for more than 65 million people.

PJM embraces innovation and fosters collaboration with other key players in the power industry to explore new and emerging technologies that could assist in the development of Smart Communities in Virginia. Specifically, PJM is working with its members and leading industry organizations to support research and deployment of synchrophasor (PMU) technology, which is providing system operators with new insights into the dynamics of the grid.

The synchrophasor system can provide system operators with information on the state of the power system with much higher detail and granularity than the conventional SCADA systems used in the industry. This higher-speed, synchronized phase data enables operators to observe and evaluate grid conditions such as oscillations and wide area network disturbances in real time.
The technology is being combined with advanced analytical software to support wide-area monitoring, power system planning and the analysis of grid disturbances. The technology is expected to provide significant benefits especially as renewable and intermittent resources introduce unique challenges to grid operations. Capabilities include: automating controls for transmission and peak reduction, managing transmission congestion and improving system modeling. All these capabilities will produce both reliability and economic benefits. A map of the Phasor Measurement Unit locations is shown in figure (Source: PJM).

Additionally, PJM is involved in numerous proposed or active emerging technology pilot projects across its footprint. These projects cover a broad spectrum, including electric vehicle charging, energy storage, dynamic load response, renewables, transmission operations, load forecasting, microgrids and resiliency planning. Examples include the following:

- **Interoperability and Electric Vehicle Charging** - PJM and a partnering company are developing methods to show how newly adopted industry smart grid standards can communicate wholesale electricity pricing signals to electric vehicles. Managing electric vehicle charging based on pricing signals – either wholesale or dynamic retail rates – not only ensures vehicles are charged when the grid is less stressed but also reduces the already low fuel costs of plug-in vehicles.

- **Charging Electric Vehicles with Renewable Energy** - A partnering motor company and PJM recently completed a demonstration of a potential new “green charging” service for electric vehicle customers. By using real-time renewable energy production on the PJM grid, the company could match renewable energy availability with customer charging needs to charge a fleet of electric vehicles.

- **Nuances of Battery Storage** - A battery storage company first tested battery energy storage technology on the PJM campus. The company began offering an array of lithium-ion batteries and regulation service in the PJM market in 2009. This project allowed PJM and the storage industry to better understand the operational and market nuances of this new technology. As a result of this work, the company has deployed more than 100 MW of merchant battery energy storage resources across the PJM footprint.

- **Reliability using a Microgrid** - The combination of increasingly cost-effective distributed generation, environmental motivations and the 24/7 digital economy has given rise to the deployment of microgrids. These small clusters of energy assets and loads can be controlled to achieve a variety of benefits for the operator. The result is increased reliability during grid system disturbances such as storm outages. PJM works with industry partners, universities and states to better understand how microgrids operate, how they can impact the grid in a positive way and how to access wholesale market services.
While the majority of these emerging technology projects are outside Virginia, PJM actively promote them to ensure improvements in reliable grid operations, fair and efficient wholesale electricity markets, and regional transmission planning.8

**Importance of Connectivity, Interoperability, Cybersecurity and Privacy**

For a smart grid to realize its full value and potential, it must be interoperable and connected by a secure and reliable network while maintain consumer privacy. Proprietary built systems and components significantly impair innovation and new ways of leverage component, platforms and communication systems. However, this open environment elevates the risk of comprising the system and risk to obsolescence. Every added component, access point, and smart device as well as dependency on automated or remote controlled technology increases the magnitude and impact of a data breach and disruption when dependent on communications systems. Communications and interoperability must be equally weighed with protecting consumer privacy and this critical infrastructure from both physical and cyber-attacks.

**Connectivity**

A smart community and its smart grid are dependent on secure, reliable two-way communications system – a “system of systems”, connected devices with system-wide, multi-service communications to a service point and back. Connectivity allows data collected throughout the smart grid to be transmitted for analysis and action. Communication systems must be able to meet the appropriate speed, coverage and bandwidth at a justifiable cost. Coverage needs to include areas where traditional or current telecommunication access is already challenged. For example, rural and densely structured areas require signals to travel long distance or among terrain and buildings that hamper or block signals. The design and upgrade to this infrastructure must include communication protocols and systems that plan against obsolescence and facilitate updates to support a smart grid for many years.

**Interoperability**

A Smart Grid will be a system of interoperable systems where two or more networks, systems, devices, applications, or components exchange and readily use information—securely, effectively, and with little or no inconvenience to the user. The systems will share a common meaning of the exchanged information, and this information will elicit agreed-upon types of response. The reliability, fidelity, and security of information exchanges on the smart grid must achieve requisite performance levels. This interoperability should facilitate adding new technology, functionality and components.

Utilities around the world have already started building smart grids and realized early on that one stumbling block was a lack of standards – and as imagined there are numerous elements of a smart grid that work together and talk to each other. A number of standards bodies undertook the task of developing specifications knowing issues that plagued the smart grid pioneers. Interoperability targets, including one that specifically applies to energy, adhere to open standards to increase choice and decrease costs. With open standards products can be mixed and matched from different vendors. Both purchasers and sellers must be committed and demonstrate knowledge and commitment to using open standards. Currently, the standards selection process is easier in the energy sector than in others with a free [Smart Grid Standards Mapping Tool](http://www.pjm.com/markets-and-operations/~/media/markets-ops/advanced-tech-pilots/pilot-program-questionnaire.ashx) from the International Electrotechnical Commission. It allows easy identification of any standard in relation to its role within the smart grid. New standards

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are added regularly for emerging systems and equipment. Additionally, the Sensor Web Enablement standards of the Open Geospatial Consortium are specifying interoperability interfaces and metadata encodings that enable real time integration of heterogeneous sensor webs and the Internet of Things into the information infrastructure. Developers will use these specifications in creating applications, platforms, and products involving Web-connected devices such as flood gauges, air pollution monitors, stress gauges on bridges, mobile heart monitors, Webcams, and robots as well as space and airborne earth imaging devices.

For example, distributed generation is enabled with interconnection standards – to make distributed generation work effectively, there are straightforward, easy-to-use interconnection standards that define how the energy sources tie in to the energy grid. While it is a relatively new business model more utilities are adopting interconnection standards and protocols to accommodate distributed generation. As well, distributed energy developers and providers should be using these same standards. Getting it right gives the community and its residents more options for economical and clean power generation without compromising secure and reliable grid operations because a standard reduces the cost of interconnecting.

**Security and privacy**
A smart grid must ensure security and privacy as it is recognized as critical infrastructure by the State and Nation. Security breaches can have a ripple effect. Developing a comprehensive security framework mitigates risk by identifying and addressing threats before they can cause damage. This is critical for energy infrastructure – even more so given its inherent importance to the operation of other key infrastructures. Cyber-attacks against energy companies in the U.S. have been well-documented. But what were once thought to be attempts to steal information or trade secrets are now focused on causing serious damage to networks and equipment, according to warnings from the U.S. government. Implementing cybersecurity safeguards early on maximizes protection while avoiding the potentially significant costs associated with an attack. The National Institute of Standards provides a Cybersecurity Framework Approach:

- **IDENTIFY**: generate and maintain a detailed, accurate inventory of all devices and systems
- **PROTECT**: harden the environment to minimize exposure and reduce the capability for malicious threat actors to compromise systems
- **DETECT**: increase situational awareness to identify and alert upon anomalous behavior by centralizing and distributing security events to a centralized operations center
- **RESPOND**: investigate events to determine root cause and minimize the potential for future occurrence
- **RECOVER**: ensure appropriate procedures and configurations are available to restore environments to normal operating conditions

A smart grid also supports a diversity of customers that desire to maintain their privacy. For example, smart meters have raised privacy concerns as customers worry that their daily habits are being tracked. Operators should not only protect private information, but also publish and adhere to privacy rules so customers are proactively informed. Making privacy a priority can help ward off consumer backlash that could stall smart grid deployments.
Status of the Grid in Virginia: How Smart is it today

The Gridwise Alliance annually surveys and publishes the Grid Modernization Index (GMI) to rank states in their progress towards modernizing their grid. In 2017, Virginia ranked 31 of the 50 states and the District of Columbia. The current rank for Virginia has fallen well below its rank of nine in the 2014 GMI. The index is established through a questionnaire measured in three categories;

1. State Support: State policies and regulatory mechanisms that facilitate grid investment;
2. Customer Engagement: Investments throughout the state in customer—enabling technologies and capabilities;

The strength of Virginia’s 2014 GMI rank was dominated by its number one position in the grid operations component. This component was supported by Virginia’s participation in the wholesale PJM market, investment in various connected intelligent sensors for dynamic line rating, fault detection, transformer monitoring and PMUs, utilization of global information systems, and the state’s early progress towards smart meter penetration at 10% in 2014. Since then, the pace of grid modernization has quickened in other states relative to Virginia. Smart meters, not only remote read meters, are a critical, foundational component of a modernized grid. Smart meters support a diversity of improvements and capture a wider variety of benefits. According to EIA (Form 861), Virginia’s smart meter penetration is at 20% in 2016. At this level of penetration, Virginia is in the bottom third of all states. Other states received higher scores in grid operations, this year due to rich data streams and advanced analytics tools that enable enhanced decision making in platforms like ADMS. Insights from these technologies improve performance in managing operations, assets and service. Increased penetration of smart connected components is driving software platforms and control systems to automate operations and increase efficiency and situational awareness. For example, Volt VAR optimization is used on many circuits in states with high scores such as Georgia, Pennsylvania, California and Texas. Virginia has Volt VAR optimization on less than 5% of its 4,000 distribution circuits.

Under the Customer Engagement component in the GMI, Virginia declined 14 positions to a ranking of 28 for 2017. Again, foundational investments in smart meter substantially contribute to success in this component. Smart meters facilitate individualized customer communication and information as discussed through customer engagement platforms. Dynamic pricing models also require daily interval usage information. Five states have more than a 10% of their customers using dynamic pricing and Virginia has less than 1 percent of its customers participating in a dynamic pricing rate structure. Again, there is a strong correlation between penetration of smart meters and dynamic pricing. Thus, the customers in these states have more control and options over the economic impact of their energy consumption, as well as costs are more fairly and appropriately assessed to users. High scoring states also focused on outreach campaigns to educate consumers on new programs and values of a smart grid.

In the State Support component, Virginia ranked 46 out of 51. High scoring states have a more comprehensive approach to grid modernization through policy and regulatory proceedings that Virginia currently lacks. Themes and trends of policy in other states include focus on adoption of electric vehicles, distributed energy generation and storage, resiliency and reliability, cyber and physical security and changes in regulatory models, include rate design. Some states have mandated or
incented electric vehicle infrastructure, renewable portfolio standard goals and energy storage technology deployment. For grid modernization, many states notes that utilities taking an active role in continued education, outreach and technical assistance of all key stakeholders must continue, as a smart grid is a complex issue.

**A Virginia Example of a Smarter Grid with Smart Meters – Rappahannock Electric Cooperative**

Rappahannock Electric Cooperative (REC)\(^9\) has successfully used evolving forms of Advanced Metering Infrastructure (AMI)\(^10\) since 2000. First used to gather once-a-month meter readings for monthly retail billing, today AMI provides the foundation for multiple operational efficiencies, reliability improvements, and customer engagement opportunities. Through AMI, REC efficiently remotely reads its more than 165,000 meters, gathering hourly usage data that is then used for not only monthly billing, but to also explain to its members how their daily activities affect energy use throughout the day. By overlaying weather data, REC is also able to demonstrate how fluctuations in outdoor temperature impacts energy use. This information helps explain not only billing questions, but also demonstrates in real time the benefits of energy management and efficiency efforts. Through AMI, REC offered Virginia’s first prepaid electric service, allowing participants to avoid deposits and to directly manage their energy budgets. Through remote access to the meter, AMI has allowed REC to eliminate in-field activities related to transfers, and to reduce the number of manual disconnect and re-connect activities. Further increasing operational efficiencies, the same power line carrier-based communications system used for metering also facilitates REC’s peak reduction efforts, controlling more than 40,000 load management devices (30,000 on water heaters and 10,000 on central air conditioners) at the homes of voluntarily participating consumers, reducing wholesale power costs by hundreds of thousands dollars each year. AMI also contributes to improved reliability, by allowing REC to monitor service conditions at the meter. This data feeds into the Outage Management System (OMS), helping identify the protective device affected and predicting both the number of meters off and the outage locations, all of which helps REC more accurately dispatch repair crews and thus minimize outage times. REC is also installing smart reclosers that provide better coordination with other protective devices and that support distribution automation.

**A Smart Grid Supports Electrification of Transportation**

The transportation sector is the largest contributor to nitrogen oxide and carbon dioxide emissions in Virginia\(^11\). Transportation electrification can significantly reduce emissions and improve air quality in the Commonwealth. Transportation electrification can also provide economic benefits in the form of new businesses and skilled labor for the electric vehicle industry and fuel cost savings. As discussed below, electric transportation adoption levels are at the early stages. To achieve economic and environmental benefits of any significance, Virginia will need a comprehensive commitment to electric transportation including investment in the grid, infrastructure, workforce development, and education.

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\(^9\) Rappahannock Electric Cooperative provides electric service to over 165,000 connections in parts of 22 Virginia counties. With its general office in Fredericksburg, Va., Rappahannock maintains more than 17,000 miles of power lines through its service area, which ranges from the Blue Ridge Mountains to the tidal waters of the Chesapeake Bay. For information about REC, please visit www.myrec.coop.

\(^10\) After significantly increasing its service area through an acquisition in 2010, REC used funds from the US Department of Energy Smart Grid Grant to replace all 50,000 meters in the acquired area with AMI-enabled meters. The DOE grant funded 50% of the project costs related to the deployment and integration of advanced technologies along the distribution system. Please see Appendix H for a summary of the DOE project.

As of October 31, 2017, there were approximately 9,200 electric vehicles registered in Virginia\textsuperscript{12}; an inconsequential amount when compared to the approximately 8 million total registered vehicles\textsuperscript{13}. There are approximately 390 electric vehicle charging stations in Virginia, excluding private stations\textsuperscript{14}. However, the vast majority of these stations are slower level 1 or level 2 charging (as compared to level 3 fast charging stations) and they have inconsistent operating hours, charging ports, and payment methods. In order to mitigate range anxiety, electric vehicle drivers need to be confident they can find and use charging stations whenever they need them.

A smart grid enables an efficient and sustainable electrified transportation system. Just as consumers value the highest level of reliability in their homes and businesses, grid reliability, resiliency, and security are integral to electric transportation. The smart grid provides communications infrastructure to monitor equipment and analyze electric usage data. Smart metering enables innovative rate designs and technologies such as smart charging and demand management to meet the atypical electric demands of fast charging stations. Further, the smart grid may enable technologies such as battery storage to more efficiently respond to increased electric demand, and in certain cases, provide benefits to the grid.

In addition to consumer passenger vehicle electrification, there are economic and environmental benefits to electrifying fleets and other energy intensive industries, such as heavy duty transportation, heavy machinery, buses, airports, ports, and other transit. Electrifying these segments requires a substantial investment, but also results in substantial reductions in fuel costs and emissions.

As a result of the Volkswagen Group of America Clean Air Act violation and associated settlement agreements, Volkswagen AG has agreed to spend $14.7 billion to settle allegations of cheating emissions standards. Of that amount, $2.7 billion will be used to establish an Environmental Mitigation Trust and allocated to the states based on the number of affected vehicles in each state. The Commonwealth of Virginia will receive about $93 million administered by Department of Environmental Quality. Fifteen percent is dedicated to establishing a Statewide Public Electric Vehicle Charging Station Network. The remaining eighty-five percent can be used to electrify the energy intensive industries discussed above. It is imperative that decision makers in these industries have the tools and resources to develop actionable plans for using this funding effectively.

There is a general lack of education and advocacy both of the benefits of transportation electrification and the steps necessary to make the transition. Consumers, fleet managers, businesses, localities, and the heavy transportation industry require education and awareness. There is also a need for technical training for the technologies and equipment. Investment is needed in a reliable and resilient, networked, statewide fast charging network. This includes costs for real estate, equipment, electric infrastructure, and ongoing operations to maintain the network. Consistencies in permitting, signage, interoperability, and payment capability are critical elements in developing this fast charging network.

The Importance of Outdoor Lighting and Grid Infrastructure in Supporting a Smart Community

\textsuperscript{12} https://autoalliance.org/energy-environment/advanced-technology-vehicle-sales-dashboard/
\textsuperscript{13} https://www.dmv.virginia.gov/webdoc/pdf/tss03.pdf
\textsuperscript{14} https://www.afdc.energy.gov/locator/stations/
Smart community solutions are reliant on connected sensor or data gathering equipment that often needs to be mounted with electric service. Smart street lights can be the mounting surface, electric service and communication hub for many Smart Community applications. They provide both available electricity and height that is needed for connectivity and remote equipment. Grid infrastructure such as poles and wirelines can also provide support to communication networks through mounted antennas, small cell equipment, communication hubs (Wi-Fi, RF, Zigbee) and power line communications.

Street lights in their own right, may be made smarter with intelligent sensors or remote controls for dimming, on and off that triggered with motion, a photo-sensor or by an operator. Intelligent lighting is even capable of reporting its own malfunction, pole tilt and metering its own energy usage. These upgrades along with new LED lighting technologies can reduce the electricity usage, street light outages and maintenance costs of an outdoor lighting plant. This savings offset the replacement and higher cost of a smart LED fixture. Smart street lighting is one application that would be supported by a community’s dashboard or data management platform. Through energy conservation and improved operations, it supports the sustainability, livability and workability of a community.

New and adaptive street lights have the capability to provide as many eight to 12 additional applications for Smart Communities. They can power and support data collecting hubs for information from remote sensors the measure soil moisture content, trashcan capacity, pollution, and weather. Audio and video equipment can be mounted on street lights and transmit full data for public safety or traffic monitoring. A smart street light may include an edge processing that analyzes high bandwidth data like video to report a state versus the entire collected data stream. For example, video may be analyzed at the camera and communicate if a parking spot is occupied or open. Beacon technology can be incorporated into street lights so they flash during a nearby public safety call as well as transmit localized public address and event information to mobile devices. In some places, they may be the best infrastructure to support a public Wi-Fi and augment cellular/ broadband service. This wide variety of applications improves community maintenance services, public services, connectivity by further leveraging already needed infrastructure for many beneficial services, information and communications.

In Virginia, the current streetlight inventory has varying degrees of age, types of light fixtures and conversion to LEDs. When converting to LED lighting, these fixtures should at a minimum have 7 pin NEMA sockets to add photo-sensors or light pole routers. This is not the most economical approach as adding this component later will require labor costs. Planning should also include appropriate network, bandwidth, capacity and speed needed for the applications that would connect at the street light access point.

In many communities, not all street lights are owned and operated by the community. Multiple electric utilities, state transportation departments and telecommunication companies may own some, most or all the outdoor light plant in an area. This can add complexity when implementing a smart community solution on street light infrastructure. Some communities have addressed this with public private partnerships.
Energy Recommendations
6. Support state wide investment in smart upgrades to the grid which focus on resiliency, reliability, customer engagement, energy efficiency, integration of distributed and renewable intermittent energy, dynamic rate structures and capacity of electrification of transportation through legislation and regulation that includes consideration of immeasurable benefits by traditional project assessments.

7. Expand telecommunications access in areas that are challenged with sparse coverage, capacity and low latency in all areas including rural and densely structured areas. Coverage enhancements in these marginalized area to allow all constituents to realize the benefits a smart grid at a lower incremental cost to the energy provider.

8. Establish advisory group that expands current interoperability standards of the Smart Grid Mapping Tools beyond grid devices to include other IoT and IIoT as well as addresses other types of distributed resource such as smart inverters, electric vehicle to grid and other industrial controls. The advisory group would include stakeholders to collaborate to address security, cyber security and privacy to protect consumers and critical infrastructure in conjunction with interoperability.

9. Fund a statewide outreach program that educates on the benefits of electrification of transportation and steps necessary to make the transition. Consumers, fleet managers, businesses, localities, and the heavy transportation industry need for technical training of technologies and equipment as well as economic and environmental benefits.

10. Facilitate investment in a reliable and resilient, networked, statewide fast charging network. This includes costs for real estate, equipment, electric infrastructure, and ongoing operations to maintain the network. Consistencies in permitting, signage, interoperability, and payment capability are critical elements in developing this fast charging network.

Smart Stormwater Management

Introduction
Stormwater infrastructure protects the health of our water resources, the streams, rivers, lakes, reservoirs, wetlands, groundwater, estuaries and bays across the Commonwealth. Stormwater infrastructure includes both “gray infrastructure” like storm drains, pipes, and ponds that has been used for decades and “green infrastructure” like rain gardens, rain barrels, and rooftop gardens increasing used now for stormwater management. Both forms of stormwater infrastructure are designed with the same goal in mind: to mitigate the impact of increased impervious surfaces caused by land development to store, slow, and treat runoff from roofs, parking lots, and roadways. Ineffective stormwater infrastructure results in numerous consequences including erosion, eutrophication, and localized flooding.

In the past, stormwater infrastructure has been designed and built to be largely static systems taking advantage of gravity to move water with limited monitoring and control. New “smart stormwater” approaches enabled through the larger “smart community” revolution are changing this. For example, it is now possible to have connected stormwater systems where water levels and water quality pollutants can be measured in real-time and automatically sent to cloud-based database systems for monitoring and decision support. Computer controlled valves and pumps are becoming more common in stormwater infrastructure, making it possible to adapt systems to changing environmental
conditions. These innovations have the potential to make stormwater infrastructure systems more effective, while also reducing the overall costs for building and operating this infrastructure.

This section provides four exploratory case studies of how smart stormwater technologies are already beginning to impact Virginia. The case studies grow in scale from individual sites benefiting from smart stormwater approaches, to city-scale approaches, to how these approaches could play a critical role within river basin-scale water management strategies. The City of Lynchburg and Fairfax County case studies demonstrate the site-scale benefits of smart stormwater approaches for Continuous Monitoring and Adaptive Control (CMAC). These examples demonstrate what is already possible with smart stormwater approaches. The City of Norfolk example places these smart stormwater approaches within the larger context of Smart and Connected Communities where stormwater infrastructure monitoring and control is part of a larger, city-scale sensing and monitoring infrastructure. Finally, the Rappahannock River Basin section describes how increased data availability, sharing and coordination can play a significant role in creating smart water management approaches across river basins to improve water resources both within the basin and the receiving waterbody.

Following the description of each of these exploratory case studies is a section outlining key recommendations for achieving the full potential of the smart stormwater revolution. Ultimately, to be most effective, these systems must adopt open, transparent, and interoperable technologies and data communication standards. This will allow competition and innovation within smart stormwater technologies engaging a variety of stakeholders across government, industry, and academia. The blurring lines between traditional educational disciplines must also be addressed so that, for example, civil engineers and landscape architects designing stormwater infrastructure systems can work alongside computer scientists, electrical engineers, and systems engineers to create smart technologies that complement and extend their designs.

**Case Studies**

**City of Lynchburg**
The City of Lynchburg (the City) successfully implemented an innovative solution that helps meet its water quality goals by adding CMAC technology to the existing Warren Avenue Stormwater Basin in the City. CMAC retrofits automatically control the discharge with an actuated valve based on real-time site conditions and weather forecast data. This cost-effective approach to stormwater management has provided the City with access to real-time data and insight into how its facilities function, optimizing the facilities for multiple environmental objectives and empowering stakeholders with the ability to adapt the facilities operations over time as regulations, land-use, and the climate changes.

An independent city in the James River watershed, Lynchburg is a major tributary of the Chesapeake Bay. The City is required to reduce 274 lb/yr of Total Nitrogen (TN), 65 lb/yr of Total Phosphorus (TP), and 29,289 lb/yr of Total Suspended Solids (TSS) by the end of MS4 Permit Cycle 1. The storm basin at Warren Avenue was selected as a pilot test site out of four candidate sites to install CMAC. The selection was based on the constructability, feasibility of conversion to Level 1 or Level 2 Virginia Department of Environmental Quality (VADEQ) Stormwater Design standards, ability to increase water quality treatment, repeatability, and representativeness of a typical CMAC installation. Initial calculations have projected that this retrofit provides 43 treated acres and reductions of 443 lb-TN/yr, 54 lb-TP/yr, and 32,466 lb-TSS/yr.
Recently approved and endorsed by the Chesapeake Bay Program as a means to obtain pollutant removal credits, CMAC represents a new and unique approach to managing stormwater, and has emerged as an alternative to passive stormwater management facilities. CMAC can more effectively use storage volume to increase retention time and minimize downstream erosive flows for channel protection. The innovative technique uses a water level sensor, an actuated valve, control panel, and cloud-based software to make automated, real-time control decisions based on National Weather Service forecast data. CMAC technology has achieved water quality, flood control, hydromodification, and water reuse objectives at over 130 sites across 21 US states.

**Fairfax County**
Fairfax County was looking for a cost effective way to enhance water quality performance of their existing stormwater infrastructure while also decreasing the downstream impacts of hydromodification. To address this need, they implemented a CMAC based retrofit solution at a 11.5 ac-ft dry detention pond. The pond manages 284 acres, 40% of which is impervious, in the Difficult Run Watershed.

In January of 2017, the pond was retrofit with CMAC technology converting it from a dry pond to an intermittent permanent pool wet pond. The retrofit included installation of an actuated valve, a water level sensor, a control panel, and an associated solar power system. The CMAC technology uses data from connected on-site sensors, weather forecasts, and site specific parameters to make intelligent and predictive control decisions about when and at what rate water is discharged from the pond. Automated control decisions are transmitted over a secure encrypted connection to on-site hardware that actively controls a valve at the pond outlet.

Fairfax is able to achieve significant new pollutant removal credits as a result of this installation. Besides improving water quality, Fairfax can now modulate downstream flows via the CMAC system in real-time thusly improving erosive velocities downstream. Additionally, real-time data is available via web-based dashboards and for detailed analysis via download. The dashboards are also highly useful for direct visualization of operations and available for manual remote control if necessary.

| Table 1: ROI Analysis of CMAC Retrofit in Fairfax, VA for Water Quality Improvement |
|-----------------------------------------------|---------------------------------|---------------------------------|
| **Project**                                  | CMAC Retrofit for Water Quality | Enlarge Physical Ponds by >50%  | Both solutions achieve water quality goals |
| **Capex (y1 hardware, design, construction, install)*** | $29,000                        | $200,000                        | CMAC 85% lower                             |
| **Annual Opex (O&M, Control Software, upgrades)** | $15,500/yr                      | $8,000/yr                       | CMAC is 95% higher                         |
City of Norfolk

The historic City of Norfolk, Virginia (City) faces many stormwater and flooding challenges. To help address these issues, the City is working on a range of innovative, smart community solutions. The goal is for Norfolk to be national leader in designing the coastal community of the future by identifying innovative infrastructure for stormwater management to meet the City’s resilience goals. To this end, Norfolk is offering itself as a living city laboratory or testbed for researchers, entrepreneurs, and businesses to turn our challenges into opportunities. Outcomes for this work can then be replicated elsewhere around the state and world.

The list below outlines some of the key actions the city is taking towards using smart community solutions for stormwater and flooding management. This effort is multi-faceted and is part of a larger “smart community” effort that includes but goes beyond stormwater infrastructure and flooding.

Development of Wireless Communications and Internet-of-Things Sensor Networks
1. Water Level Monitoring System Pilot (WLMS)
2. Wireless Communications Network Pilot (RISE, Resilience Innovation)
4. dMIST Project with UVA funded by the U.S. National Science Foundation
5. StormSense Project with VIMS (National Institute of Standards and Technology – Global Cities Team Challenge Action Cluster)

Custom Application Development and Data Collection
1. STORM - MAP, MOBILE (System to Track, Organize, Record, and Map)
2. TITAN (Tidal Inundation Tracking Application for Norfolk)
3. RAIN (Runoff Analysis In Norfolk) Retain Your Rain Initiative
4. Adopt-a-Drain Application (Developed with Code for Hampton Roads)
5. Open Data (including from sensors)

Innovative Urban Design with Green Infrastructure: Includes stormwater runoff quality and quantity benefits
1. Stormwater Fee Reduction Program
2. Urban Bio-swales
3. Street Corner Basins
4. Pervious Paving

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<thead>
<tr>
<th>25yr total cost – Gross</th>
<th>$416,000 (Gross)</th>
<th>$400,000 (Gross) (NPV)</th>
<th>CMAC 20% lower</th>
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<td>$313,000 (NPV)</td>
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<td>Project time to completion</td>
<td>2 months</td>
<td>4-8 months</td>
<td>CMAC is 2-6 months faster</td>
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<td>Total Value of CMAC solution</td>
<td>Financial: 85% Savings Year 1, 21% lifetime cost savings</td>
<td>Other benefits: Greater certainty of service, tracking performance and compliance. Potential 5 year value: Save Fairfax County $34M in Capex and $13M in lifetime cost</td>
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</table>
5. Subsurface Road Cisterns
6. Multi-use Stormwater/Recreation Parks
7. Living Shorelines
8. Daylighting Historic Tidal Creeks

While each of these activities represents a significant effort to bring smart stormwater approaches to Norfolk, one specific activity to highlight is the WLMS pilot project. WLMS is an innovative approach to gathering real-time water level data in six frequently flooded intersections/streets in and around the Hague area in Norfolk, VA. The Hague is an inlet of the Elizabeth River in the Ghent neighborhood that regularly experiences nuisance tidal flooding. The low-cost sensors were developed with the City’s partnership with our local makerspace (757 Makerspace) and local technology company (Green Streams). This data is transmitted from the sensors to a cloud-hosted database for analysis and storage using LoRaWAN technology, a low power wide area network specification intended for wireless battery operated devices. Data from these sensors has captured inundation from storm events in the fall of 2016 caused by high tides back flowing through stormwater pipe outfalls and precipitation runoff induced flooding. The data is also being shared with state academic institutions as part of the City’s open data program. The data has been used with the US National Science Foundation (NSF)-funded dMIST Project led by the University of Virginia that is focused on the City, and the regionally focused Virginia Institute of Marine Science led project called StormSense, a GCTC Action Cluster that Norfolk also participates in.

This long range wireless, cost-effective technology serves as the foundation of a “smart community” stormwater and flood inundation monitoring system. Eventually, the data will be used to send geographically targeted alerts to residents, city staff, and other stakeholders to make informed decisions about flooding. Also, the city is exploring using this technology to actuate flashing street closure/flooded signs, or even smart stormwater infrastructure, such as, pump stations and stormwater control valves. This project has also sparked a wireless communications pilot through a partnership with the City’s Office of Resilience and the non-profit organization RISE to support their wireless water sensor testbed program starting in 2018.

Rappahannock River Basin
The Rappahannock River Basin Commission was created by Virginia’s legislature to foster sound stewardship for the Rappahannock River Basin. The Commission has worked with many stakeholders, public, private and educational institutions to craft cutting edge solutions to the challenges faced in this watershed. It is a model that can be replicated throughout the state to address similar issues and meeting the Chesapeake Bay goals. Increased availability of high resolution geospatial data, such as terrain data and land cover data, provide new ways to inventory, model, and manage water resource efforts at a basin scale.

Virginia has significant responsibilities regarding stormwater management to meet the Chesapeake Bay TMDL (Total Maximum Daily Load) as set by the U.S. Environmental Agency. More than $1.2 billion has already been invested by the Commonwealth to meet the 2017 TMDL targets. A primary focus for achieving this goal is pollution from so called “non-point sources” like runoff from urban and agricultural lands. A wide range of approaches including regulatory, tax-based incentives, and zoning recommendations are needed to address basin-scale water quality goals (Evans, 2017). It is commonly recommended to address the water quality issue on a watershed basis and connect the needs and
abilities of differing communities to address the issue of meeting the TMDL goal. The ability to collaborate with data gathered consistently and shared over a wide area is required for sound decision making. This consistent and openly shared data will have many benefits including in building integrated models, supporting water quality credit markets, target and prioritize best management practices (BMPs), and other related efforts.

The ability to make sound decisions will rely on data gathering, sharing and modeling. Observational data on streamflow, water quality, and other conditions is done by various agencies, but this data is often scattered and rarely organized into integrated information systems. Real-time collection and transmission of these data are becoming increasingly common, making the ability to know current conditions within systems now possible. Geospatial data is also critical to basin-scale water management. There is a need for the expanded use of one meter land cover imagery and LIDAR elevation data to provide a foundation for river basin-scale water information systems. Now that Virginia has one-meter imagery available throughout the Chesapeake Bay watershed and should have it throughout the entire Commonwealth soon, building a comparable dataset for all Bay localities would lend more credibility to the Bay model and the relative non-point contributions of urban and suburban non-point pollution versus rural, non-point agricultural pollution detected from water quality sampling stations throughout the Bay watershed.

High-resolution geospatial data presents significant challenges due to its size that must be addressed to take full advantage of the data for basin-scale water management. These high-resolution land cover data are hosted on a web server by the Virginia Geographic Information Network (VGIN) as a mosaic of tiled image files which require significant technical capability to create more useful locality-specific datasets for the 134 independent cities and counties and 190 independent towns of the Commonwealth. The Virginia Healthy Watersheds Forest/TMDL project team recommends that the Commonwealth pre-process such large spatial datasets to create downloadable files at the independent city, county and town level, providing more “user-friendly” data better related to the political geographies that make land use and stormwater management decisions on a watershed basis (Evans, 2017). The report also recommended the use of ESRI’s Green Infrastructure Initiative as a modeling tool.

**Recommendations**

These four exemplar case studies, which vary from urban to rural communities and stretch from single sites, to city-wide applications, to river basin-scale approaches, have resulted in a set of recommendations aimed at achieving open, transparent, and reusable data and approaches across communities.

1. Consistent methods must be required for data collection, organization, and sharing across stormwater systems. A consistent Water Information System, used across communities within the commonwealth, would enable open data sharing between public, private, and university users. The Consortium of Universities for the Advancement of Hydrologic Science, Inc. (CUAHSI) Hydrologic Information System (HIS) serves as an example of such a system.

2. Open standards for data transmission must be required over proprietary communication approaches and existing, well-known standards should be adopted whenever possible. The Water Markup Language (WaterML) and related Open Geospatial Consortium (OGC) standards serve as examples of applicable open data standards relevant to this community.
3. While creating open data and systems is critical to the long term success of smart stormwater solution, maintaining privacy of sensitive data and systems against cybersecurity threats must also be central to any solution.

4. Systems should have public and authenticated application program interface (API) endpoints with a minimal and consistent set of standardized services to foster interoperable systems.

5. To avoid vendor lock-in, hardware and software systems should be decoupled so that water sensors, for example, are not dependent on specific cloud service providers. This will allow for easier upgrades and maintenance of both hardware and software as systems grow and become more critical.

6. Educational programs must take interdisciplinary perspectives to design, build, and manage smart city cyber-physical systems because the skills needed to create such systems stretch across traditional disciplinary boundaries. Efforts to build interdisciplinary research labs, such as the University of Virginia Link Lab, serve as an example of ways to provide students with the educational background necessary to be competitive in this new landscape.

Areas for Future Work
The group intends to broaden its efforts to further address smart solutions in water, wastewater, and solid waste management as well as other energy delivery infrastructure. The final product is intended to provide a recommended statewide strategic roadmap for this critical infrastructure. The roadmap will define overall and interim goals to measure success of implementation of and recommended value pathways for success. Pathways will include research, technology and innovation, workforce development and economic development value. These areas will contribute to improvements and implementation of sensors, communication networks, software platforms and data analytic solutions for critical infrastructure. The group also intends to recommend near term replicable solutions that support a wide variety of communities and their goals, thereby establishing Virginia as a leader in smart community adoption. For example, Smart Street lighting provides a platform for multifunctional sensors, communications and edge computing. The group will explore near term and feasible solutions that demonstrates significant return on investment and direct value to communities and it constituents.
Healthcare, Public Health, and Human Services
4. Healthcare, Public Health, and Human Services

Current State
Smart community technologies and data hold the promise of improving the health and well-being of their residents by addressing the challenges of rising healthcare costs and access to healthcare providers, empowering patients, and protecting the public health from disease and environmental conditions. Access to health information for community level and state-wide analyses can provide critical public health information on disease trends, cost trends, and areas for improvement, intervention, and success.

Sensor networks, drones, and remote imaging can identify sources of food and water contamination, measure pollution and air quality and identify the breeding grounds of disease-transmitting rodents and insects. Access to advanced networking and high performance computational infrastructures for securely moving data and providing integration and analytical tools for research and clinical care across the Commonwealth and beyond. Healthcare delivery can be made more efficient through automated capture of patient data from medical and fitness devices, supplementing or replacing office visits with telemedicine, and seamless sharing of clinical data. With these diverse sources of data with different levels of privacy concern and diverse variables, data integration and harmonization are key aspects to making the most of these rich data to gain insights into community health and human services.

Human services such as healthcare assistance, child placement and care, food or nutrition assistance programs are provided to individuals and families in the Commonwealth to assist citizens to transition from dependence on public programs to self-sufficiency. Health and human services providers face many challenges. They must balance increased demand for services as many families rely on multiple social programs to thrive, yet often these programs exist in silos of isolation and even duplication as a result of disconnected systems and processes. Human services organizations need to effectively identify recipients, verify eligibility, simplify enrollments, improve management of benefits, and provide consistent services and benefits to those eligible. Many agencies are operating with reduced budgets and must incorporate legislative and policy changes into programs challenged by reduced staff and the retirement of experienced employees, a reduction that can cause delays in enrollment, verification, and benefit delivery, as well as errors in benefit administration.

Organizations need consumer-centric technologies capable of transcending traditional organizational boundaries to provide 360-degree holistic views of customers' social, health, and economic well-being. Human services practitioners need to partner with multiple government and nongovernment organizations (NGOs) to provide holistic, more collaborative, and effective service delivery. That means client data must be aggregated across related programs. The convergence of health, human services, and social programs that provide a coordinated, agile, and holistic view of clients and families will contribute to stronger, healthier beneficiaries; healthier families and communities; and a healthier and more productive workforce.

A new SuperCluster formed as part of the 2018 GCTC Smart and Secure Communities Challenge, the Agriculture and Rural SuperCluster. The SuperCluster will focus on projects and best practices for bridging the digital divide and closing the homework gap, improving healthcare and the ability to age in place and improving economic development and spurring innovation in rural communities. During
the 2018 GCTC kick-off healthcare-related Action Clusters were identified, including a rural telehealth project to demonstrate how telehealth can improve care and reduce costs; using smart technologies to advance diabetes management and suicide prevention; and using telehealth and other technologies to enable “aging in place.”

An effective healthcare and human services smart community spans all layers of the NIST IOT and Smart Cities Architecture:

**Physical systems/hardware layer** - A crucial component of connecting healthcare within cities and communities is the hardware. Wearable technologies have entered the market en masse in the last few years, with notable, ubiquitous examples being the Apple Watch and the Fitbit. Smartphones, heart rate monitors, insulin pumps, rings, watches, and even clothing are promising gatherers and transmitters of health data that in the near future could allow for preventative and maybe even predictive medicine at purportedly lower cost, as doctors could assess patients from afar (medication adherence and mental health, for instance) and patients need not take time out of their day for routine office visits. And maybe it’s not even connecting to a real medical professional, as start-ups like IDAvatars have created virtual doctors.\(^{15}\) These wearable technologies which gather health data and deliver treatment introduce attack surfaces and potential threats to patient safety and privacy.\(^{16}\) It is important to develop technical approaches to making these systems secure, reliable, and resilient.

In addition, patients can claim ownership over their own health when they keep track of their own data. For example, the northern Virginia biotech company Aperiomics Inc.\(^ {17}\) allows individuals to send in their own samples or work through physicians to examine microbiomes associated with health issues. Yet these data require robust security for access, analysis, and storage. To be a truly SmartHealthCare State, we must devise appropriate controls AND access to health related data to allow for community analyses as well as personalized health. Coupled with these data, measures of air and water quality and

\(^{15}\) https://www.idavatars.com/virtual-assitants-solutions/
\(^{17}\) https://aperiomics.com
infectious disease trends can be used by individuals and community health organizations to deliver improved healthcare.

**Communications:** Healthcare data have unique privacy issues that require unique agreements and infrastructure. Therefore, it is important to put into place appropriate agreements for sharing sensitive data and stripping sensitive data of identifying tags for initial query and analyses. This all takes exceptional communication, trust, and agreement, as well as secure environments for data storage and analyses (see physical systems). Significant advances can be effectively made at the community and population levels with open access to de-identified patient data that can then be integrated with environmental, finance, etc. data for robust inferences to advance practices in health and human services. In addition, new technical approaches are emerging to securely share clinical analytics to apply on diverse, distributed data source. For example, MITRE has developed Computational Analytic Sharing Architecture & Ecosystem (CASAE) which keeps data in place, where it is secure and protected, and moves analytics to the data. MITRE and its partners, including University of Virginia, “are piloting CASAE in support of Pre-Vent, the first multi-center shared analytic study in the nation. Under Pre-Vent, clinicians and researchers from multiple neo-natal intensive care units around the country are developing predictive analytics for early detection of apnea and other respiratory diseases in premature infants.”

Communications with ecosystem partners is critical for smarter communities. An example of this is the Los Angeles Police Department (LAPD). The LAPD has built an ecosystem to help providers help and house the homeless, help the vulnerable, create safer cleaner neighborhoods, and build trust and relationships among the homeless and the community at large by connecting homeless citizens in their jurisdiction to services. The LAPD has created a collaborative partnership, the Homeless Outreach and Proactive Engagement (HOPE) program to assist the almost 25,000 homeless people in that city. HOPE was initiated by a directive from Los Angeles’ mayor to all city departments to address homelessness. HOPE partners cops with professional homeless outreach, sanitation, and mental health workers. All HOPE law enforcement officers have been through mental health training. The team covers the city, meets with homeless people, discusses services, and works to build relationships so that the homeless trust law enforcement. LAPD is working with diverse partners from many different government entities, including Veteran Affairs, California Highway Patrol, Los Angeles Sheriff Department, Los Angeles Homeless Services Authority, Department of Mental Health, and Los Angeles Fire Department. One city agency, the Los Angeles Department of Sanitation (LASAN) provides cleanup and trash removal services for the team and makes determinations of immediate risks to public health for both the homeless population and the general public.

**Data Analytics:** “Big data” analytics that collects large volumes of data from multiple sources to enable translational medicine, generate evidence-based treatments, and produce predictive analytics for public health. Virginia companies like Vibrent are leading the development of analytical approaches for data integration and mining to empower people to change behaviors and improve health. They integrate environmental, social, behavioral, and omics data in novel and highly informative ways.

18 MITRE, 2018
20 [https://www.vibrenthealth.com](https://www.vibrenthealth.com)
Likewise, Ampel Biosolutions, a Charlottesville based company catalyzing the identification and development of new autoimmune and inflammatory treatments, develops novel approaches for integrating diverse data types to inform treatment and prediction approaches. Many recent advances in health and human services and many Virginia companies are based on our ability to integrate, harmonize and effectively analyze diverse data and human health, environment, finance, etc. With broader availability of data, especially human health data, and novel analytics, Virginia can lead the nation in smart utilization and integration of such data and advance companies that can lead the nation in such work.

As an example of big data, Allegheny County, Pennsylvania Department of Human Services determined that it needed to use integrated data to inform better decision making for child protection. More than 10 years of health and human services data was available to case workers to help inform initial maltreatment screening decisions at the child protection hotline, but standardized protocols for using data to make referral screening decisions didn’t exist. The county also didn’t have a method of systematically weighing its information in an equitable manner across all referrals, and it didn’t have an understanding of what information could be correlated to predict future adverse outcomes for children.

Human services researchers built a screening score model based on information that was already collected and identified more than 100 factors in child and family history such as mental health, alcohol and drug abuse, parent history, and community indicators that predict future referral or placements. The county developed a screening score based on each general protective service (non-child protective services [CPS]) call of alleged child maltreatment it received. The screening score is made up of the risk of re-referral (if screened out) and the risk of placement in foster care for those screened in the agency scored thousands of historical maltreatment calls, then followed the children in subsequent referrals to see how often the model was correct. The model showed that the higher the risk score, the higher the chance of a future event (e.g., abuse, placement, and re-referral), and 9 out of 10 children with the highest risk score were re-referred within two years of the initial call. Only 1 out of 10 children with the lowest risk score were referred within two years of the initial call. The county concluded it would be able to use this analytic model to improve its child welfare decision making because, under previous practices, 27% of the highest risk cases were screened out and 48% of the lowest risk cases were screened in.

Service: With healthcare data, the ultimate goal is to improve both individual and community health through better targeted interventions, treatments, prevention strategies, and education. Much of this comes down to service, but service through data analytics in a secure cyber environment with healthcare data.

As an example, GW is working on several components of the NIST architecture. At the Physical/Hardware layer GW is developing SCEPTRE, an Open Science Platform for shared research in Smart Communities, IoT, Environmental sensing, and cybersecurity education, and with Children’s National, a Regulated Data environment in the Azure cloud. At the Communications layer, GW has developed agreements between academic, corporate, and government entities to enable sharing sensitive data. At the Data Analytics level, the GW-Children’s Center for Translational Science Institute (CTSI) has developed tools to integrate medical informatics (patient records, wearable device data,
etc.) and bioinformatics (genomics, transcriptomics, lipidomics, metabolomics) into a comprehensive biomedical informatics platform for improving health and medicine from both a patient centric perspective, but also from a translational research perspective. Through data analytics in a secure cyber environment, GW and its partners are moving towards really providing Services to better inform both healthcare providers about treatment options and successes under different scenarios, and community health workers for areas of targeted intervention to avoid or curtail outbreaks disease or illness.

**Cybersecurity and Privacy**

The adoption of electronic health records has facilitated the sharing of health information data, but at the same time has exposed the healthcare sector to new threats and attack vectors. As smart healthcare technologies are adopted, it is even more important to secure health data, medical devices, and emerging wearable and IoT technologies.

The Industrial Internet Consortium’s healthcare task group is addressing some of these issues. They are leveraging the Industrial IoT Reference Architecture and the Trustworthiness and Assurance concepts from their Industrial IoT Security Framework efforts of the consortium while focusing on some of the major problems facing healthcare by identifying how to provide device interoperability to improve patient safety (see Case Study) and to provide for more efficient support of at-home patients through the integration of clinical and remote medical devices into a single data management and analytics platform (see Connected Care Testbed). The IIC’s Reference Architecture works well with the NIST IOT and Smart Cities Architecture, which focuses on four aspects of the implementation, by also addressing the business context of the systems, the usage aspects, and the functional decomposition.

All connected concepts are critical to the development of the healthcare capabilities of the future smart communities.

- **What other places are doing**
  - Singapore is mapping the location of its elderly population for tele-health. They are also exploring “tele-rehab”. Taiwan is experimenting with including a chip with one’s medical history in his/her national health card. In India, the people have taken air quality monitoring into their own hands, to make their own decisions on health and maybe even hold the government accountable. They use publicly available data, including from the U.S. Embassy (New Delhi) and Consulates in the country. If we go beyond data and virtual connections, a Rwandan company, Zipline, is using drones to deliver medicine or blood around the country faster than roads can take people; this isn’t telemedicine, but it does make cities and communities smarter and more connected, if local expertise and supplies are not available.

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24 [http://www.iiconsortium.org/IISF.htm](http://www.iiconsortium.org/IISF.htm)
26 [http://www.iiconsortium.org/pdf/June_2017_IoI_Improving_Smart_City_Healthcare.pdf](http://www.iiconsortium.org/pdf/June_2017_IoI_Improving_Smart_City_Healthcare.pdf)
In the United States, the City of Boston has the Mayor’s “dashboard” that is tracking myriad aspects of city life. One can imagine using this for tracking health-related incidents as well (especially if the mechanism is self-reporting).

Smart America Healthcare Challenge - a 2014 White House Presidential Innovation Fellow project with the goal to bring together research in Cyber-Physical Systems (CPS) and to combine test-beds, projects and activities from different sectors, such as Smart Manufacturing, Healthcare, Smart Energy, Intelligent Transportation and Disaster Response, to show tangible and measurable benefits to the US economy and the daily lives of American citizens.

Opportunities and threats

There is an opportunity for Virginia to be a leader in the healthcare space, building on the emerging partnerships that are forming in the region.

**Recommendations**

- **List of recommendations**
  - Recommend engaging the NIH with expertise in data analysis and physical systems/hardware:
  - Recommend engaging underserved and underrepresented communities from the very start, to identify unique needs and ensure inclusive innovation in this area. (Perhaps through partnering well-resourced cities with rural ones within the state?)
  - Consider international partnering and discussions to learn from leaders, especially in Asia and Europe.
  - Consider partnering with the Veterans Administration.
  - Consider participating in one of the Agriculture and Rural SuperCluster’s rural healthcare Action Clusters.
  - Support the biotechnology entrepreneurial community to make advances in healthcare informatics.
  - Make publicly available de-identified health and human service information that can be analyzed to improve public health.
  - Health and human services agencies should develop models for appropriate data sharing agreements and engage in multidirectional communications with other government organizations, NGOs, service providers, beneficiaries and families to dynamically share information so that agencies and beneficiaries make smarter, real-time decisions and agencies can quickly identify clients at risk, allocate resources accordingly, and focus on integrated service delivery. As agencies integrate health and human services program data, they should consider analyzing community services with geolocation of available services to match community supports to hotspots of chronic needs and build ecosystem capacity where needed.
  - Analytics needs to look beyond localized data points (e.g., a case management system of a single agency). It needs to draw critical information from external sources such as law enforcement, mental health specialists, educational systems, online connected applications, and even cloud-based virtualized apps that receive and analyze information

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28 [https://www.cityofboston.gov/mayorsdashboard/](https://www.cityofboston.gov/mayorsdashboard/)
from mobile applications. This will allow agencies to coordinate and collaborate across health, human, and social services as well as with private and public community-based providers to create a services inventory that moves from sense and respond to predict and act and meet the needs of a single view of the client and enhance outcomes beyond self-sufficiency.

- Guiding principles
  - Recognizing that every community will have a unique identity, skill set, and needs, and that solutions can come from anywhere, we should ensure multistakeholder input from the outset.
- Detailed explanation of recommendations

**Areas for Future Work**
- The team will continue to gather information on related efforts, national and international, and engage with stakeholders.
- The team will evolve the definition of a healthcare smart community.
5. Public Safety

**Current State**

State and local agencies and departments have been acquiring and implementing new and innovative technologies into their current day-to-day activities. This enables departments to provide quick and efficient services while increasing the overall safety of their constituents. Localities have the right to incorporate these new technologies into their separate departments, which allows them to be adaptive and remain flexible in emergency situations. Incorporating a smart community mindset for public safety and emergency management requires collaboration from all smart community clusters. Providing robust resources and data services will allow for departments to raise their awareness and resiliency to current and future threats ranging from cyber security to natural disasters. “The Public Safety SuperCluster (PSSC) was formed with the goal of identifying technologies, processes, and strategies from amongst GCTC members to enhance public safety, emergency preparedness and management, disaster recovery, and community resilience.” This description from the NIST PSSC report is structured to allow for each focus area to be incorporated into a community. Our first responders have multiple scenarios that they have to face day to day. Communities can develop policies and resources for each of these public safety groups.

- Many other states and departments are integrating new and disruptive technologies. A premier program is FirstNet. Virginia was the first state to adopt the First Responder Network Authority (FirstNet). FirstNet is an independent authority within the U.S. Department of Commerce chartered in 2012. The mission of FirstNet is to create a broadband network solely dedicated for first responders, giving them priority to voice and data services across the AT&T LTE network during emergency scenarios.

- The U.S. Department of Homeland Security Science and Technology Directorate develop the Smart Alerts Pilot project. This project seeks to provide flood level alerts by sending location and time details to the public. This technology is valuable to Virginia due to it being a coastal state and the higher chance of flooding due to large storms.

- Many departments across the nation have been implementing video surveillance technologies to law enforcement personnel or vehicles. While this is not a new technology, the abundance and availability to record every detail from the vantage point of the first responders is. Many localities have adopted some form of body worn cameras, while there are clear benefits to having this technology, there also needs to be thoughtful policies put into place on how and when data is captured and the privacy and accessibility of this data is protected.

- There are a plethora of technologies available for first responders on the market today ranging from smart fingerprint technologies, biometric scanners including iris scanning and facial recognition, to unmanned aerial vehicles. All of these technologies allow for a quicker response to data that is needed at the current moment increasing the safety and efficiency of all first responders. Since there are many implemented technologies and policies across the nation, Virginia could benefit by studying what policies are effective and tailoring those policies to our localities needs.
The Virginia Fusion Center (VFC) is a partnership between Virginia State Police, Virginia Department of Emergency Management to improve Virginia's resiliency to terror attacks and to deter criminal activity including cyber security crimes. Other partners include federal, state, and local law enforcement, military, critical infrastructure, and other public and private industries. VFC facilitates information collection, prioritization, classification, analysis, and sharing of threats to its partners allowing for expedient and efficient dissemination of threats and to protect Commonwealth information and assets.

Use Cases

- **Data Integration for First Responders** - Computer-Aided Dispatching (CAD) already provides valuable data to first responder. Integrating data from multiple sources would improve response and safety of this system. Responders could have access to schematics of structures, utilities, or other smart technologies present when on scene. These range from on demand road conditions, pipelines, electrical lines, hazardous materials, and other sensors. Integrating such a system among local agencies can improve knowledge awareness during an emergency situation. Capitalizing on this system, first responders could use wearable technologies to provide instant data and augmented services to improve response and safety while on scene.

- **Advanced Resiliency Response** – During an emergency situation, first responder need to have access to various data and be able to access this data remotely. For example, a train incident involving hazardous materials creates many scenarios depending on the cargo and location of the incident. First Responders may need to have access to nearby water sources, weather conditions, wind speed and direction, temperature, barometric pressure, and many other data sources to ensure the safety of nearby citizens. Developing a plan for on demand and reliable sources of information can ensure that a disasters footprint will remain as small as possible.

- **Location Based Tracking** – Loudoun County, Virginia is a perfect example of implementing disruptive technologies to benefit its local citizens. Loudoun County Sheriff's Department is part of Project Lifesaver, which allows for location devices to be worn by citizens that might be at risk of wandering and posing life threatening situations to themselves. Loudoun County has implemented the use of Unmanned Aerial Systems to assist with this program and has already had success in searching for lost personnel.

Opportunities and threats

- Getting the public to accept these technologies is key for successful implementation. These technologies usually provide more in-depth and efficient data gathering services and it is important for the community to understand the benefits, cost savings, and safety of these technologies have to offer. Observing the implementation and policies that other communities have enacted will allow for intelligent decisions to be made in the Commonwealth.

- The capacity and availability for technology to gather data is constantly growing and many constituents may have concerns on how and what data is captured. Along with what data is captured, the need to secure this data is important and the public agency's responsibility to


31 [https://projectlifesaver.org/](https://projectlifesaver.org/)
keep it safe. While most of these issues will be addressed in the data governance super cluster, their needs to be close collaboration with the public safety and data governance cluster.

- The opportunity for bad actors to adopt and/or exploit new sensor or actuator technologies deployed in a smart community faster than local public safety officials can incorporate those technologies poses a potential public safety threat beyond simply the known issues with cybersecurity. Current cases of private drones being used to harass responders, the possibility of arsonists using smart buildings to slow or prevent fire response, or the possibility of law enforcement evaders using smart sensors to track police response all pose new types of threat. Additionally the increased challenge of forensics and evidence-gathering with a host of potential new technologies pose additional training and legal challenges. Existing public safety groups and State Agencies (VDEM) can provide important support and oversight in ensuring that local authorities have the training, expertise and funding to remain current in potentially rapidly evolving environments.

**Recommendations**

- **Smart Community Dashboard** – Dashboard of current Internet of Things (IoT) technologies and smart community initiatives that are taking place across the Commonwealth and the nation allowing for leaders to collaborate and observe innovative technologies, policies, benefits, and conflicts and allowing them to make knowledgeable decisions.

- **Public Safety Smart Community Pilot Program (PSSCPP)** – pilot program allowing for public safety agencies and departments to test innovative technologies. Many technologies are available and allowing departments to test these technologies in their localities will not only benefit the community, but will allow for the public to gain an insight on these technologies before they are fully implemented.

- **Smart Community Competitions** – allow for colleges and universities to participate in smart community challenges. These competitions can provide insights and innovative ways to integrate technologies in all the clusters of a smart community. These competitions have a second benefit of spreading awareness of these technologies to the communities. Getting the public to accept these technologies is import for the public safety cluster to grow as a smart community.

- **Assess current technologies and policies that are taking place in the Commonwealth** – The Commonwealth is already a leader on many technology fronts including cyber security and unmanned systems. Many programs are known and kept at the local level. In order to take advantage of smart technologies, Virginia should catalog all current smart activities taking place today. Conducting a survey of what technologies are being utilized today and the benefits from them can save other communities time and cost of implementing a similar program. This collection of data will also feed into other clusters and allow for refined policies and standards to be implemented.

- **Public Transparency** – When introducing certain technologies, public perception is key to successful implementation. Making citizens aware of polices, technologies, and the purpose for implementing these technologies will allow for increased public acceptance. Community
feedback can ensure correct policies are created and welcomed. Localities should implement disruptive technologies at a steady pace. This allows the public to gain trust and furthermore allow for more advanced smart technologies to be implemented. Implementing search and rescue or any immediate lifesaving technologies first can allow for easier acceptance when trying to utilize the same technology for other purposes, such as, traffic monitoring or property surveillance.

- Smart Communities Advocate - A state advocate that would focus on implementing smart technologies across the Commonwealth and can ensure data and knowledge sharing of programs already being implemented across the state. This advocate would be knowledgeable of the state’s public safety community, but also have a robust knowledge of all technologies across the other smart community sectors. They would be able to tie technologies and policies from one sector and cross thread to other industry sectors, allowing for increased networking and policy sharing of smart communities and create new partnerships as this industry grows and as the technologies begin to mesh with more than one sector.

**Federal, State, and Local Direction**

- **Federal**
  Utilize existing federal programs to assist in funding future smart technology and policy developments. Many organizations have funding available for develop smart community solutions, the Commonwealth should take advantage of these programs and ensure that this information is passed on to the local level. Regions that are susceptible to certain types of disasters should be aware of certain programs that are currently available or available in the near future.

- **Commonwealth**
  The state in short term can conduct asset evaluations that assess policies that have already been implemented and developing a dashboard for all localities to observe and gain knowledge on disruptive technologies. Providing a thorough survey that is results driven and focuses on fire, law enforcement, and other relating associations could develop a valuable source of information and provide outcomes, policies, and technologies that are already implemented across the Commonwealth. The Commonwealth can also assist with sharing resources from different sectors and develop public/private partnerships. Such partnerships are already being conducted, such as, AT&T & FirstNet partnership with the Commonwealth. First responders can utilize and develop new strategies and policies for increase response, resiliency, and safety as communities begin to adopt more smart technologies.

- **Local**
  Understanding the value and capabilities of smart technologies would be beneficial to local first responders. Localities can take advantage of state best practices and policies, especially on data governance and the security and storage of data. Localities can implement technologies as their constituents see fit, but it should be the responsibility of the localities to provide information and to spread public awareness of the benefits of these technologies and policies.

32 https://www.firstnet.com/
Areas for Future Work

• Collaboration between Data Governance and Transportation clusters. Data that is gathered by law enforcement needs to be secured and maintained in the proper jurisdiction along with other policies that may be in place. As driverless cars start to enter the public road in the near future, enforcing certain vehicle regulations will need to be addressed by both public safety and transportation clusters.

• Encourage large public safety departments to assist rural communities’ knowledge of smart technologies and share knowledge and resources to strengthen those regions of the state.

• Develop a security and a retention policy of data gathered by smart technologies. Public Safety departments are held to a higher standard of professionalism and security. The Commonwealth should assist with authenticating or producing certain standards for use or implementation of disruptive technologies. As these technologies advance and evolve, the data they can produce will continue to grow. Many manufactures of new disruptive technologies conduct software updates that may have access to secure information that the technology captured. The Commonwealth should ensure that technologies that are implemented are secure and the data they produce is secure and held in a timely manner.

• Most first responders need real time information in dynamic situations. Access to data can be restrained due to the amount of resources needed and the availability of network access depends on location. This information needs to be provided quickly and current wireless capabilities in certain areas may not be able to sustain such data services needed. This is an ever growing importance that is only going to demand more priority as smart communities increase and more technologies begin to be implemented.
Public Wireless/Broadband
6. Public Wireless/Broadband

Communications Supporting Smart Communities

Current Status
Broadband is the backbone of any smart community and enables the communication required by smart city applications. The communication requirements can vary from high-speed data to support video, to low speed telemetry and sensor networks. Most communication is one-way, bringing sensor data into a centralized region for data analysis, but there are instances where control data is essential such as in smart vehicles and transportation systems.

Communications support a wide variety of applications that rely on collecting sensor data and performing control functions. Examples of ways communications support smart community applications include water monitoring and control, transportation flow sensing and control, parking assistance and many others.

International Smart Communities
According to Juniper Research Smart Cities Ranking 2016, Singapore, Barcelona, London, San Francisco and Oslo represent the leading smart cities in the world and serve as models for smart communities’ interconnection. Communities such as San Francisco are known for their extensive Wi-Fi deployments. Singapore is recognized for the city’s fixed and cellular broadband services, city apps and strong open data policy. Barcelona is probably the city best known for its use of smart technologies and is often referred to as a model for smart communities. It had the advantage of an extensive fiber network that had already been put in place that gave access to most of the residents of the city. Examples of innovations that arose from this network include smart bus stops that provide interactive real-time bus information and Wi-Fi access. The city also developed a parking information and payment service that directs drivers to open parking spots and allows them to pay for the parking online. LED lampposts were installed throughout the city, of which there were multiple benefits. First, the new lampposts reduced energy consumption and the city’s power bill by $37 million by dimming the lights when people were not present. Second, the lampposts served as a sensor platform to monitor air pollution. Third, the lampposts served as a platform for deployment of a city-wide Wi-Fi network. Barcelona estimates that the deployment of smart city applications has created nearly 50,000 new jobs, saved $58 million on water by reducing water needed for city properties such as parks, and increased parking revenues by $50 million per year.

“Barcelona estimates smart city deployment has created nearly 50,000 new jobs, saved $58 million on water by reducing water needed for city properties such as parks, and increased parking revenues by $50 million per year.”

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One practical example of public benefit to be derived is savings in water costs, which is a very significant potential gain for smart communities. Once a communications network is in place within a city, sensors can be installed to detect water leaks. The American Water Works Association indicated that approximately 237,600 water lines break each year in the U.S., costing public water utilities approximately $2.8 billion annually.35 The Town of Olds in Alberta, Canada was facing the prospect of major capital expenditures to improve the capacity of its water system. However, like many cities, much of the water is lost due to leaks, and in their case about 39% of the water could not be accounted for. The city installed a sensor network for water leaks and within the first six months it identified 21 leaks to be repaired, recovering 287,691 cubic meters of water and a savings of $177,336.

**Virginia**

In Virginia, Virginia Beach and Hampton Roads are aggressively building their communications infrastructure and the county of Arlington has been working with Virginia Tech to plan a wireless test bed that will demonstrate how local governments can benefit from advanced wireless technologies. In the more rural areas, Mid-Atlantic Broadband Communities Corporation has been bringing fiber connectivity to remote regions of central and southern Virginia. The city of Danville has been deploying fiber aggressively and was nicknamed the “Comeback City” by Broadband Communities Magazine for innovative use of broadband technology as a catalyst for economic growth to overcome losses in jobs in tobacco and manufacturing.

While Virginia has done well compared to most states in deploying a communications backbone, it still has its challenges. There are many areas in the Commonwealth that lack access to high-speed broadband, and even more that have access to only one internet service provider. This lack of competitive alternatives leads to high costs and poor service (see figure 1). The Commonwealth currently aids localities to address these issues by way of two primary resources, the Center for Innovative Technology (CIT) and the Department of Housing and Community Development (DHCD). CIT provides broadband technical assistance to unserved, underserved and rural localities, and DHCD provides broadband planning and infrastructure grant opportunities.

![Average Number of Providers Supplying Broadband by County](image1.jpg)

![Average Number of Providers in Each Census Block](image2.jpg)


37 [https://www.wired.virginia.gov/sites/default/files/Policy%20Assessment%20Tool%20Guide_0.pdf](https://www.wired.virginia.gov/sites/default/files/Policy%20Assessment%20Tool%20Guide_0.pdf)
Broadband Technologies

There are numerous broadband technologies, both wireline and wireless, that support smart community applications. Among the wireline technologies, fiber and cable are capable of the highest capacities with fiber surpassing cable. The challenge with these technologies is the cost of deployment. Physically laying wireline systems, especially in sparsely populated or geographically-challenged areas can be cost prohibitive. Nevertheless, wireless technologies always terminate with a wireline connection. As wireless deployments grow, fiber access must grow as well. The two technologies are complementary.

There are several forms of wireless broadband technologies in addition to traditional fixed wireless provided by a Wireless Internet Service Provider (WISP), namely cellular, satellite, and other emerging technologies such as TV Whitespace. Wireless technologies are useful for serving the rural and geographically-challenged areas, but most wireless technologies depend on “line-of-sight”, which simply means that the transmitter and the receiver at both networking locations can see each other. In such rural and geographically-challenged areas, it is not surprising that line-of-sight can easily be disrupted. Many of the offerings from wireless providers limit the amount of data that can be used, which can be costly to users who need to exceed the allowable data amount in order to accomplish necessary tasks.

Wi-Fi is a technology used for wireless local area networking (WLAN) which allows WLAN-enabled devices to access the internet without physical boundaries. Wi-Fi service is provided by either a wireline or wireless broadband provider. Typically, Wi-Fi systems have limited coverage but are provided for free near public facilities and businesses. In 2017, IEEE published a new Wi-Fi protocol standard 802.11ah, to be called Wi-Fi HaLow (pronounced “HEY-Low”) specifically designed for smart communities. The key benefits of this new Wi-Fi protocol is extended range, up to 1km, very low power (below Bluetooth 5.0), and can manage thousands of devices with a single access point. This technology will soon be commercial, and may play an important role particularly as communities roll-out wireless sensor networks.

Wireless broadband technologies, especially cellular, are poised for the most radical changes. By 2020, the impact of 5th generation wireless technology (5G) should become clear. It promises to provide services to a variety of applications, from low data rate and densely deployed Internet-of-Things (IoT) devices, to low-latency (delay) devices such as smart automobiles, to high-speed data services that could potentially compete with legacy wireline service providers. Low-cost launch vehicles are enabling very low-cost satellite services to reach remote locations, such as OneWeb based in Arlington, VA and O3b Networks with an operation center in Manassas, VA. Vehicular communication systems such as DSRC and cV2x are on the verge of deployment. Dish Network, which has major facilities in Virginia, has also announced a nationwide IoT network that will leverage 5G technologies. White space systems that leverage unoccupied TV bands are now beginning to be deployed in the Commonwealth to reach rural residents. It is imperative that community planners are aware of and understand these emerging technologies, since they offer many benefits for smart cities. They also pose many challenges, namely

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**Figure 1** Average number of broadband providers and maximum advertised speeds available by census block.

https://www.link-labs.com/blog/future-of-wifi-802-11ah-802-11ad

https://members.cta.tech/ctaPublicationDetails/?id=57a079a4-25c7-e611-9400-000d3a00493e&reload=timezone
that wireless infrastructure will need to be deployed more densely than in the past to support the new applications and short-range communication systems. However, the ultimate benefit will be realized in the ability to accelerate the deployment of new infrastructure and the wireline communications necessary to interconnect the base stations with the network.

**Risk**

All implementations of a robust broadband infrastructure are at risk of downtime due to physical failure of the infrastructure or through cyberattack. Inherent in the move towards smart connected communities is the threat of physical failure and cyberattacks (both insider threats and outsider threats). Once a community becomes connected and its vital infrastructure is seamlessly tied together, that community will inevitably become dependent upon the service provided and by inference the broadband backbone it rides upon. Another risk is the encroachment upon the right and expectation of individual privacy, both intentional and unintentional. A connected community will have the ability to collect and disseminate all types of data on its users. The question then becomes what data should be collected, who has the right to access it, and under what circumstances. Such questions are a frequent cause of friction between law enforcement and private citizens and businesses in communities, as striking a balance is challenging.

**Recommendations**

The following recommendations are addressed with a focus on classifying action items for the state, local communities, and private industry.

**State**

1. Provide guidance and assistance to communities trying to expand broadband access.
   a. Assess if the state has sufficient data to evaluate how well current broadband initiatives are supporting smart communities. If no such data exists, then determine what data needs to be collected.
   b. Increase broadband funding opportunities, but do so in a way that communities, especially lower population centers, can understand and have the resources to apply for these opportunities and leverage public-private partnerships. Some funding programs are not fully utilized due to lack of knowledge of the opportunity, onerous application requirements and regulatory issues that necessitate hiring a lawyer or consultant.
   c. Continue to support and promote state broadband assistance programs (CIT and DHCD).
   d. Identify and publicize the intended role of state agencies involved in broadband assistance and deployment. Suggest roles of current state organizations in deployment of communication technologies to support smart cities. For example, should some state entity be responsible for

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**Example of a Virginia Public-Private Partnership to Build Communications Infrastructure**

The City of Norfolk has and is leveraging public-private partnerships to extend deployment of wireless broadband services in underserved areas as an offshoot of the Rockefeller Foundation’s 100 Resilient Cities program and other federal and state grants. Working with organizations such as the citizen-based Norfolk Forward group (norfolkforward.org), Rise Resilience (riseresilience.org), the local startup community, and concerned citizens, Norfolk is building a broadband wireless strategy that will leverage the power of city infrastructure, local tech/resilience non-profits in partnership with interested citizens.
identifying vital systems within the connected community and ensure those systems are available 24/7 throughout the community.
e. Designate and/or create model communities and provide recognition for their efforts. This exercise will also assist the state in developing best practices by examining the various approaches taken by regions around the state and the results behind those approaches.
f. Recommend strategies for communities to determine if and how much investment should be put into communications infrastructure.
g. Evaluate the possibility of coordinated actions through establishing a centralized broadband coordinating organization, which exists in several states, as a mechanism for distributing information about funding opportunities. Such a coordinating body could help coordinate and clarify the roles of various state agencies that impact broadband deployment. CIT could also serve as the broadband coordinating body and help in facilitating public-private partnerships or pool together communities and interest groups to create a more attractive and competitive region for smart community infrastructure investments. Currently there are no state-funded initiatives focused solely on broadband as it relates to smart community applications.

2. Task CIT to continue its support by developing and distributing a list of broadband best practices and providing educational opportunities to communities. Specific goals would include:
   a. Educate communities about the public benefits to be derived from smart systems, especially cost savings and efficiencies that can be realized while providing new capabilities.
   b. Provide guidance on how set up and maintain a smart community by making available information about the required technologies and policies, and providing continued training on new developments and best practices.
   c. Educate communities about trends and resources for key issues such as community zoning, planning, policies, resilience, privacy, and security.
   d. Promote a new view that analyzes the competitive costs behind these new connectivity technologies, how well they need to perform and what metrics should be employed for measurement, and where these new technologies may or may not be applicable.
   e. Assist local communities by developing tools and expertise to model the current needs and future communication needs of Virginia communities though a collaborative effort with those communities.
   f. Engage with communities outside of Virginia to understand and adopt best practices.
   g. Develop a handbook on broadband deployment considerations to provide additional guidance to communities. Assess what communities can do to incentivize services and instill a competitive environment while maintaining non-discriminatory practices. This is challenging when the government entity is constrained by the legal restrictions when providing public resources to a private company.
   h. Compile a bibliography of resources for communities building smart infrastructure.

3. Identify potential partnerships between Virginia information business, educational institutions, and communities that facilitates smart communities:
   a. Seek federal opportunities for monetary and in-kind assistance for infrastructure development. The Dept. of Commerce and the Dept. of Agriculture in the past have presented grant opportunities for infrastructure development. Past examples of federal broadband opportunities include the broadband funding opportunities made available by the American
Recovery and Reinvestment Act (ARRA) which included the National Telecommunications Information Agency’s (NTIA) Broadband Technology Opportunities Program (BTOP) and State Broadband Initiative (SBI) as well as the Rural Utility Services’ Broadband Initiatives Program (BIP).

b. Seek federal support for research and development opportunities that can benefit from community involvement. For example, the National Science Foundation (NSF) has a “Smart and Connected Communities Grant Opportunity”, which can be found at: [https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=505364](https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=505364). Awards may be requested for total budgets ranging from $750,000 to $3,000,000 for periods of up to four years. It is mandated by NSF that universities must work closely with communities in performing this research.

c. The Commonwealth should consider allocating funds to CIT or some coordination body to help facilitate these partnerships.

4. Encourage federal representatives to address the digital divide. The focus on the digital divide is beginning to gain attention in Washington as a critical problem of economic stagnation for rural regions that needs to be finally and quickly remedied. Communities, state representatives, and interest groups should reach out to their congressional representative to inform them of the needs of the communities and what they believe are potential solutions to their problems from both a policy and financial support basis.

Communities
1. Foster better service and affordability by adopting competition-enabling policies:
   a. Strive for at least three competitive broadband service providers in each region. The roll-out of 5G over the next few years offers a unique opportunity to inject competition into the local market. Communities should, to the extent legally possible, assist in deployment efforts on a non-discriminatory basis for companies willing to assume the risk of deployment of new technology or competitive broadband.
   b. Encourage the community leaders to think “outside-the-box” for connectivity solutions and alternatives. For instance, 5G wireless systems can provide competition to local cable TV companies, especially for lower-tier speeds such as video streaming and internet access typical of home usage. The deployment of 5G does, to some extent, depend on fiber to a base station in a neighborhood or a group of neighborhoods, but it does not require the burden of placing fiber to each home. Local policies that facilitate the provision of fiber to the base station, along with streamlined tower siting policies would be instrumental in maximizing coverage and minimizing costs.

2. Re-examine mechanisms for encouraging service deployments for effectiveness.
   a. Adopt “Dig-Once” policies. The Dig-Once policy requires a community to involve its Planning Departments, Public Utilities, Public Works, and any department responsible for planning and deployment of fiber at a base station. This policy can significantly reduce costs by reducing the need for multiple digging and burying of fiber optic cables.

Examples of Virginia Communities Facilitating Competition

Virginia Beach has been working with Wildfire 5G, Inc. on deployment of wireless broadband services to an underserved area as a pilot project. The City has offered use of its city-owned fiber at no cost for each month that Wildfire is able to provide free connectivity to students in their homes in the pilot area. The hope is that this will allow the company to further expand into other areas of the City. Additionally, the Community can publish Requests for Information (RFI), Requests for Proposals (RFP) to identify possible public-private partnerships.
approving development projects and installing and maintaining rights-of-ways in a fiber laying decision. Any development project should be reviewed for opportunities to install conduit, fiber, or other infrastructure during the project. For example, a sewer system for new residential development in a strategic growth area can include cost participation by the locality to lay fiber while the road is open and exposed, thus reducing cost and disruption for the public.

b. Reconsider existing administrative organizational structures to ensure that qualified personnel are available and can work as a team. Advice from an overall state advising body could help in understanding the best approaches for organizing the governmental structures to support broadband. An example of this would be a cross-departmental team, to include Information Technology, Planning, Legal, Public Works, Public Utilities and any others that may have an interest in the infrastructure needed for broadband deployment. Specialized technical expertise could be shared among collaborating regions to reduce costs. If all stakeholders are not onboard at the planning stages, there will be resistance when the actual deployment takes place. Municipal involvement and public input will be necessary for equipment attachment to poles, traffic signals, fiber installation, etc. A broad range of stakeholders should be involved in the planning and implementation process.

c. Work with the surrounding communities to ensure interoperability, redundancy and to reduce costs. Pooling together either for capital equipment expenditures or sharing personnel could significantly reduce the cost of deploying networks.

d. Develop programs to make public resources such as in-ground fiber, utility poles, and public property available for use by providers, using non-discriminatory criteria, to facilitate expansion and new deployments of communication services based on fair and reasonable fees.

3. Develop metrics that help ensure reasonable accountability from vendors and service providers. Metrics could be developed in collaboration with CIT and/or the coordinating broadband state agency.

4. Ensure that data collected, especially real-time data, is available to neighboring communities within privacy and security constraints. Again, working with a coordinating broadband state agency can help facilitate this.

5. Build capacity for tomorrow, not today. This can be achieved if the coordinating state agency provides communities with the tools and expertise to be able to project communication system requirements.

**Virginia Industry and Small Businesses**

1. Work with local communities to refine technology products. For example, there are numerous companies that are working in Virginia developing communication products for smart communities and having local communities willing to work with them in the product development and testing stage can set an encouraging environment for businesses to locate in Virginia.

2. Collaborate to achieve economy of scale in deploying technologies. Companies within Virginia should begin the formation of an association to help facilitate these business partnerships. Companies may be able to reduce overall costs by identifying and utilizing synergies.

3. Develop metrics that help ensure accountability within the industry. Metrics are needed to assess impact and effectiveness of smart communities and to help overcome perceived risks. A well-established set of metrics will be useful for obtaining industry and government investments in the development of smart community infrastructure.
4. Publish rates to be charged to the residential, commercial, and governmental customers for broadband connectivity. Be transparent in price structures, discounts, and premiums to be charged. Consumers in all sectors deserve to be able to obtain this information readily in order to make informed decisions. Ultimately, such transparency will benefit the industry by instilling consumer confidence and trust.

Areas that Require Additional Funding

Some of the preceding recommendations will likely require additional funding from the state. The expanded role of CIT or some coordinating broadband body will certainly require more resources. Establishing a fund for broadband deployment or providing leverage for the coordinating organization to create public private partnerships is also something that could require additional funds.
7. Transportation

1. Current State
   1.1. Overview

   The Transportation Workgroup has developed a comprehensive set of strategic recommendations to present to the Governor’s office. We assembled a core team consisting of Industry experts, VDOT and Commonwealth leaders, University and NGO experts, and US Federal Government leaders. We built upon the research and recommendations from the ongoing NIST Transportation Supercluster blueprint work, established Industry research, Virginia DOT’s Strategic Plans, and Virginia Tech Transportation Research Institute’s recommendations.

   This Workgroup focused primarily on the sub-domain commonly referred to as Smart Transportation. As the world transitions from an individual-centric transportation system based on personal automobile ownership to a technology-enabled one where all modes are seamlessly available as a shared community resource, an actionable Sustainable Mobility plan is essential for both intra-city and cross-region transport of people and goods. The Transportation working group assessed the current best practices in the Smart Transportation space and prioritized the areas that could have the best impact for the Commonwealth, to add to the body of work done by the Commonwealth’s various Transportation Strategy, Multimodal Planning, and Long-Term Development efforts and reports.

   While maintaining the current transportation network is the main priority for VDOT and associated agencies, the need to determine how best to incorporate next generation technology and disruptions into that existing infrastructure is crucial to Virginia’s place in a future where technology will transform the way people and goods are moved. These plans must also take into account both existing infrastructure and equipment as well as planned improvements to both in the Commonwealth. We recommend prioritized, incremental approaches that are ideally positioned to anticipate and be responsive to both the immediate priorities as well as the long term needs of future generations. In so doing, the Commonwealth will be prepared to integrate new technologies and innovations for the future of Virginia’s transportation networks and the users thereof.

1.2. Mapping to NIST GCTC Transportation Supercluster

   The NIST Transportation Supercluster\footnote{https://pages.nist.gov/GCTC/uploads/blueprints/20170822-TransportationBlueprint.pdf} focuses on preparing transportation infrastructure for new technologies that aim to provide better, more equitable services at lower cost. It explores the opportunities provided by first and last mile vehicles including shared, low speed and autonomous modes of operation. It explores the opportunities for building vibrant communities around transfer
points and mobility hubs and addresses how these vehicles and hubs can play a role in the last mile delivery of packages and other freight.

To support these opportunities, the Supercluster works with teams developing new and advanced transportation models and environmental sensors that allow both the prediction of probable outcomes and the measurement of actual outcomes of introducing these technologies. Finally, the supercluster works with teams to ensure the portability and interchangeability of solutions and propose regulatory and policy changes that support the safe deployment of these technologies. The proposed Supercluster Blueprint is intended to address the range of opportunities offered by new mobility-related technologies. It will provide data about the readiness of these technologies and how they might influence city and community planning offering potential short and long-term improvements in safety, equity, climate, employment and congestion. The Workgroup mapped recommendations from the NIST Transportation Supercluster as part of its prioritization process.

1.3. Mapping to VA DOT Strategy & Long term Planning Reports

There has been significant work done by the Virginia Department of Transportation to study the short-term and long-term development and growth of the region, and to evaluate possible options for transportation planning needs to meet the Commonwealth’s needs.

Virginia’s population and economy are anticipated to grow at moderate levels through 2040\(^4\), a slower rate than had been the case during the years prior to the 2008-2009 recession. As a primarily service and knowledge sector economy, the movement of people will continue to be critical, especially as government, knowledge and service sector employment increases throughout the state including areas that were once more rural. As these industries will account for the vast majority (89%) of statewide employment growth, their development will continue to strongly influence the passenger and freight transportation needs of the state. Manufacturing will continue to be an important industry, particularly in the non-metro regions along the US 29 and I-81 corridors, as well as in the areas around Norfolk. Some of Virginia’s key pilot projects and test bed innovations in Smart Transportation include Smart Road, a 2.2 mile unique, state-of-the-art, full-scale, closed test-bed research facility in Montgomery County VA, where more than 20,000 hours of research have been conducted since opening in 2000; and Smart Scale, an innovative citizen engagement portal where the Commonwealth’s Transportation projects are scored according to an objective, outcome-based process that is transparent to the public and allows decision-makers to be held accountable to taxpayers.

The Workgroup mapped recommendations from various available Commonwealth strategy documents as part of its prioritization process.

1.4. External Environmental Considerations

Competition for prosperity heightens the urgency of providing high-quality transportation infrastructure and services that can help the Commonwealth to retain and attract first-class companies, successful entrepreneurs, and high-value workers.

**Economic Drivers:**
An important measure of economic success is Virginia’s contribution to the total national economic output. Despite significant growth projections, Virginia’s percentage of total US economic output is forecasted to decline between now and 2040. This is an important metric, as America’s states compete vigorously to retain and attract high-growth and high-wage economic sectors and labor forces. Virginia's anticipated downward slide in the national competition for prosperity heightens the urgency of providing high-quality transportation infrastructure and services that can help the Commonwealth retain and attract first-class companies, successful entrepreneurs, and high-value workers.42

**Attraction of Talent:**
A key element of the ability to support the economy of the future is the capacity for the state and local economies to support it through its existing and future talent pools. As noted in the latest Virginia Economy report, Virginia must align educational priorities with the needs of public and private sector employers in order to supply students, workers and transitioning veterans with the skills they need to thrive in a diversified 21st century economy.43 Important considerations are what the infrastructure requires in terms of jobs and technologies that design, construct, operate and maintain the commonwealth infrastructure systems. Infrastructure occupations generally require higher levels of knowledge and skills compared to many other professions. For Virginia to be prepared for a smart communities future, the skills required to support emerging technologies, as well as the supporting infrastructure, is critical.

In order to develop, attract, and retain the smart community workforce, not only does the Commonwealth need to focus their attention on the broad array of occupations involved in infrastructure and emerging supporting technologies, but they also need to better understand the specific areas of knowledge required to fill these positions. In most cases, infrastructure workers rely on higher levels of knowledge in disciplines that extend far beyond building and construction. These workers rely on this knowledge in order to move goods, serve passengers, and coordinate a range of other activities with a significant majority of those being in support of transportation.

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Nationally, 92.3% of workers in infrastructure (over 14.5 million workers) are transportation workers. Relative to all occupations nationally, the 95 infrastructure occupations, with a high preponderance of transportation workers, score above average in knowledge categories as noted by Brookings, the breadth of which speak to the wide variety of processes and equipment handled by millions of workers in support of transportation. Furthermore, these transportation occupations, which require more specialized knowledge, tend to pay higher wages. Among the 25 occupations with the highest infrastructure knowledge scores, 1.9 million workers across 22 of these occupations earned annual wages higher than national averages, ranging from smaller occupations like traffic technicians to larger occupations like aircraft mechanics44.

Workforce Impacts:
Another significant consideration is the impact that smart and connected transportation technologies will have on the workforce of the future. Automation - be it in vehicles, transactions, manufacturing, analysis, construction, or other areas - will directly impact the types of jobs available in these future economies. According to McKinsey, approximately 50% of the current work activities are technically automatable by adapting currently demonstrated technologies45. As Virginia aspires to leadership in smart and emerging technologies and embrace automation, it will be front and center in the challenges of workforce transitions. These workforce transitions will be necessary as the economy and its supporting workforce are forced to adjust to these new realities. In addition to these challenges, it is also noted that 8-9% of the jobs required in 2030 will be in new occupations46. Where there is challenge, however, there is also opportunity. Virginia’s emerging smart communities’ focus provides an opportunity to continue to diversify and pull its economy away from its current, heavy dependence on the public sector. Currently, 13 of the top 20 employers in the state are public entities like the Department of Defense, or are contractors highly dependent on the public sector. The Commonwealth must continue to strive for economic resilience by diversifying its economic base and tapping into the drivers of the future technology economy. The state has identified five areas to focus on being best in class in support of this opportunity: infrastructure; strategic growth sectors; overall business climate; entrepreneurism and innovation; and talent47. Similarly, the state must also be considerate of the changing demographics confronting the state over the planning horizon.

44 Metropolitan Policy Program at Brookings, Joseph Kan and Adie Tomer, Infrastructure skills: Knowledge, tools, and training to increase opportunity, May 20
46 McKinsey Global Institute, What the future of work will mean for jobs, skills, and wages.
Changing Demographics:
Virginia’s demographics are expected to change in various ways in the upcoming decades. From 2025 to 2045, Virginia’s population is expected to increase from 9,415,616 to 10,528,817, with Northern Virginia experiencing the largest population increases (UVA, 2016). With such growth looming in a space that already experiences debilitating congestion, there are many assumptions that can be made about the effects that 1.2 million people will have on Virginia’s infrastructure.

The number of elderly people in Virginia is expected to double by 2030, with more than 20% of Virginia residents over 65 years of age (UVA, 2016). Virginia can utilize smart community practices and innovations to make life easier and better for those in their later years of life. However, education methods will have to be implemented in order to ensure that this demographic of elderly people will have the means and skills to successfully utilize - and trust - future smart community innovations.

Virginia will continue to see more younger people residing in urban areas rather than suburban and rural areas (UVA, 2016). These urban areas will continue to diversify, leading to new ideas and the acceptance of smart community innovations. Therefore, we should expect to see early implementation of smart innovations in urban areas.

Current Status of Transportation Systems:
Transportation infrastructure is a critical element in the support of an efficient and effective economy. To advance transportation systems, there must be a clear understanding of current challenges and the current state of statewide transportation systems. While technology will play a role in future solution sets, the state will have to overcome current shortfalls and historic deficits in investment as well as the challenges of aging transportation assets. As stewards of the state’s infrastructure, the American Society of Civil Engineers (ASCE) periodically assesses the state’s infrastructure. The latest evaluation (2015) rated the Commonwealth transportation elements48 as follows:

- Bridges – C
- Rail and Transit – C
- Roads – D

Bridges:
Virginia has 20,997 bridges and culverts in its inventory, and their overall health is in decline due to age and lack of funding. Around 56% of Virginia’s structures are approaching the end of their anticipated design life, having been in service for more than 40 years. Approximately 30% of structures are over 50 years old. Virginia’s structures must be inspected routinely; an average of 10,700 condition assessments are carried out annually. In 2013, Virginia’s inventory included 23.2% that were either structurally deficient (meaning that they require maintenance, rehabilitation, or

48 Legend: A=Exceptional B=Good C=Mediocre D=Poor F=failing
replacement) or functionally obsolete (meaning they no longer meet today’s design standards). Of the major Virginia structures on the National Bridge Inventory, about one in every four bridges are structurally deficient or functionally obsolete. These 4,871 structures are in jeopardy as a result of the gap between required and available funding. Available funds are often used to address immediate repair or replacement needs, leaving few remaining funds for preventative maintenance. Additionally, repair to smaller structures is often funded, which decreases the number of bridges requiring attention but leaves a backlog of deferred maintenance on larger, more expensive structures. Statistics indicate an impending spike in the number of replacements which may be required within the next 10 years and perhaps sooner, if needs are not addressed at a faster, higher rate.

**Rail & Transit:**
With 3,200 miles of railways across Virginia and some of the largest port facilities on the East Coast, Virginia ranks as one of the main states where freight carloads terminate, including two large Class I railroads and nine Class III carriers. Amtrak and Virginia Railway Express (VRE) have experienced substantial growth in passenger rail ridership, and use shared tracks for almost all of their routes. Recent reports cite limitations throughout Virginia’s railroad system that prevent the railroads from routing traffic over the primary corridors, with no forecasted high speed rail strategy for transit. While some improvements have been made, Virginia will have to decide how to handle a doubling of rail traffic expected by 2035, including increasing passenger traffic. Realizing the importance of rail to Virginia’s movement of goods and economic vitality, the state introduced its first dedicated source of funding, the Rail Enhancement Fund, for freight and passenger rail improvements in 2005. The Intercity Passenger Rail Operating and Capital Fund was also approved by the General Assembly in 2011. While both funds may represent progress, current funding is not sufficient to meet the increasing demand for rail and passenger service or to complete the much-needed rail infrastructure improvements and upgrades.

**Roadways:**
Roadway conditions are acceptable from a maintenance and safety standpoint, but their lack of capacity has resulted in traffic congestion and gridlock, especially in Washington DC-VA-MD and Hampton Roads regions, negatively impacting commuters, industry, and the economy. The Washington DC-VA-MD metro area is ranked second worst nationally, behind Los Angeles. Based on a recent study, Virginians have spent 28,000 years in total sitting in traffic, at a fuel cost of $5 billion. The average DC-VA-MD commuter experiences 74 hours of travel delay per year, or nearly two full work weeks of sitting in traffic. VDOT reports current needs for condition and/or capacity improvements on most of the interstate systems in Virginia including I-64, I-81, and I-95. Looking toward 2035, similar, significant needs will exist on all interstate and freight corridors. After twenty years of status quo in terms of funding, 2013 legislature took a positive step forward with House Bill 2313 to provide funding and to begin addressing these challenges. However, with a network that has grown by 14% over the last 35 years and with every dollar buying less construction work, more
funding is needed to maintain safe roadways while adding needed capacity, making this a high priority issue for Virginians49.

While these challenges are significant and daunting in light of other fiscal challenges, there are significant opportunities for the Commonwealth in addressing them beyond the natural requirement for investment. It is a fact that the infrastructure industry has not improved productivity significantly over the last 50 years. The Commonwealth, by adopting a platform of innovation, entrepreneurship, and support for emerging technologies, can change this dynamic and create an environment which provides for transportation solutions that change the transportation economics of yesterday and create those of tomorrow. Automation, 3D printing, artificial intelligence, unmanned vehicles, advanced materials, and analytics capabilities are just some of the technologies that have the potential to shape the transportation future of the Commonwealth.

Attraction of Innovation:
The Commonwealth has embraced innovation through various programs like the Center for Innovative Technology accelerator programs such as Mach 37, Smart City Works, the GAP fund, and other programs. As another example, the Virginia Department of Transportation (VDOT) conducts a program where traffic data are gathered from sensors in or along streets and highways and other sources. From this data, estimates of the average number of vehicles that traveled each segment of road and daily vehicle miles traveled for specific groups of facilities and vehicle types are calculated. All traffic data publications that VDOT currently produces are available to the public on their website. The sharing of data with the public is an opportunity to crowdsource solutions to construction traffic, congestion, and routing challenges by an interested public, entrepreneurs, and civil engineering professionals. The Commonwealth would be well served to continue to leverage their innovation investments and networks in support of innovative transportation solutions.

1.5. Virginia Regional Considerations

There are four major regional factors to consider for the Commonwealth:

1. The Virginia portion of metro-Washington DC: This region is one of the state’s fastest growing and is home to the large Washington, DC suburban population. The Washington DC suburbs and exurbs are large employment centers. For example, Tyson’s Corner, Virginia in Fairfax County is a classic “edge city” area that has more office space than downtown Baltimore. The largest municipalities in this region are Arlington and Alexandria, home to many government jobs (the Pentagon is located in Arlington), knowledge industry, government services and contractors, and businesses to support these sectors. The region is home to the headquarters

49 American Society of Civil Engineers 2015 Report Card for Virginia Infrastructure Brochure
of several major Fortune 500 companies including Capital One, Freddie Mac, General Dynamics, Northrop Grumman, Mars Inc., and Hilton Worldwide.

Accordingly, this region has among the highest wages in the nation. Among the top 10 counties with highest median income in the US, five are in the Northern Virginia region: Loudoun County (#1), Fairfax County (#3), Arlington County (#6), Stafford County (#7), and Prince William County (#8).

2. Metro-Richmond: Home of the state capitol of Richmond, this is the second fastest growing region in the state by population. It is bolstered by the large presence of state government employment, several universities (University of Richmond and Virginia Commonwealth University, among others), and a strong presence of national businesses. Metro-Richmond anchors central Virginia and is located equidistant between the Northern Virginia region, the Hampton Roads region, and Lynchburg. While the city of Richmond has grown, so have its suburbs in Henrico and Chesterfield counties, each with populations over 300,000. In addition to being the state seat of government with its subsequent employment, the Richmond region has many private employers present.

The largest is Capital One Bank, which has an operations center in the region and employs over 11,000 residents through its center and branches. Other major employers are the two major health care providers, VCU Health Systems, HCA Virginia Health System, and Bon Secours Health System, which combined employ over 22,000 residents. Other nationally recognized private firms in the region include Amazon, Dominion Resources, and UPS.

3. The Virginia portion of the Hampton Roads metro area contains some of the most populous cities in the state, with Norfolk (home to the largest Naval base in the world), Virginia Beach, Newport News, Hampton, and Chesapeake. Williamsburg is also located in this region and is a major national tourist destination for both its history as well as the nearby amusement parks. The largest employer is the Department of Defense, reflected in the presence of significant Navy facilities and shipyards near Norfolk and Virginia Beach, the Air Force’s Langley Air Force Base, the Army’s Fort Eustis, and many other military instillations. The largest private employer, Huntington Ingalls, is a major ship builder (and the only builder of aircraft carriers), and is reflective of the larger military industrial complex in this region. The Port of Virginia is also located in this region and is a major economic driver for Virginia and the nation. Aside from retailers like Wal-Mart and Food Lion, the region’s major employers tend to be healthcare, government, or hospitality related as well as manufacturing companies such as Stihl, Canon, and Smithfield Packing.

4. The remainder of Virginia: All Virginia counties and cities not in the Washington, Richmond and Norfolk regions. Accordingly, this excludes the most populous areas of Virginia while including
the vast majority of the state’s land. This consists of the large agricultural regions and some medium sized cities such as Lynchburg, and Roanoke. In 2012, the metro-Washington DC area accounted for 41% or $174 billion of Virginia’s economic output. The group of counties comprising the Remainder of Virginia accounted for 23.5% or $99.4 billion, and Norfolk and Richmond contributed 20.1% or $84.6 billion and 15.6% or $65.1 billion, respectively. Per Moody’s analysis, the relative share for each region will remain through consistent through projections till 2040.

Each of these regions have different needs and challenges that a diversified Smart Transportation strategy must address. The Workgroup will interview regional stakeholders and recommend region-specific approaches in the next phase of the transportation study and report.

2. Smart Transportation & Sustainable Mobility Domains

2.1. Overview

The workgroup considered the following key advancements in Smart Transportation, grouped into the following sections: Mobility Technologies; Connectivity technologies; Data Technologies; and Electrification Technologies. The workgroup also assessed the current state of ‘Smart’ in Infrastructure (for Ports & Airports as an example); Strategic Developments in Transportation as a whole, including Mobility as a Service and First-Mile/Last-Mile; and Delivery Models and Best Practices in Governance of Smart Transportation projects. The key domains the team explored were inspired by the twelve focus themes laid out by the US Department of Transportation’s Beyond Traffic Smart City Challenge competition, as shown below.
2.2. Considered Domains

For each of the considered domains assessed, a brief overview of the current state of the technology, implications and value for the Commonwealth of Virginia, and some best practice examples from around the world, are detailed below.

2.2.1. Mobility Technologies

Shared Mobility and Automated Vehicles are becoming common talking points in the media. While advancements are being made daily, the integration of these technologies into both existing and new infrastructure to create safer, more efficient, sustainable, accessible and equitable mobility is a work in progress. There is limited knowledge as to how quickly these technologies will advance, or how they will intersect with each other. Most importantly, it’s difficult to engineer the transition from current state to the integrated future state, and the Commonwealth and other regional jurisdictions must make smart investments into how to promote the most promising technology, while allowing for planned obsolescence.
2.2.1.1. Connected / Autonomous Vehicles

For the past hundred years, innovation within the automotive sector has created safer, cleaner, and more affordable vehicles, but progress has been incremental. The industry now appears close to substantial change, engendered by autonomous, or "self-driving," vehicle technologies. This technology offers the possibility of significant benefits to social welfare: saving lives; reducing crashes, congestion, fuel consumption, and pollution; increasing mobility for the disabled; and ultimately improving land use.

This report is intended as a guide for state and federal policymakers on the many issues that this technology raises. After surveying the advantages and disadvantages of the technology, RAND researchers determined that the benefits of the technology likely outweigh the disadvantages. However, many of the benefits will accrue to parties other than the technology's purchasers. These positive externalities may justify some form of subsidy. The report also explores policy issues, communications, regulation and standards, and liability issues raised by the technology; and concludes with some tentative guidance for policymakers, guided largely by the principle that the technology should be allowed, and perhaps encouraged, when it is superior to the average human driver. This version of the report, RR-443-2, replaces an earlier version that contained an incomplete account of General Motor's policy on its use of OnStar customer data, none of which affected the findings of the report.

Potential Value for Virginia:

The Department of Motor Vehicles Virginia Highway Safety Office keeps statistics on the traffic crashes that occur in the state. These numbers detail the scope of auto collisions and how large a concern they are. Their data includes the most common types of crashes, how many result in injuries, how many are fatal, and more. Unsettling reports for 2015 indicate that steps must be taken now to make the road safer for all those who drive on it each day.

The most concerning number is 753 persons killed as a result of traffic crashes in 2015. This reflects an increase of 7.6% from 2014. Also, in 2015, there were 65,029 individuals who sustained an injury due to a collision, reflecting an increase of 2.6% from the prior year. A contributing factor to these numbers could be the total number of licensed drivers in Virginia. In 2015, there were 6,003,526, an increase of 1.9% from 2014, meaning more risk for potential crashes.

When you consider the averages, the numbers become even more daunting:

- In Virginia, there is a crash every 4.18 minutes
- Of all licensed drivers, one in every 25.8 were involved in a collision
- Traffic crashes resulted in 2.06 fatalities each day
- Traffic crashes also resulted in 178 injured individuals each day
Of the 125,800 total crashes in 2015, 7,591 were alcohol-related, leading to 4,917 injuries and 241 fatalities. This means that 32% of all traffic fatalities resulted from alcohol-related collisions.

Any time a collision occurs, it can result in serious injuries or fatalities. As documented by NHTSA, more than 90% of these incidents are the result of human error or negligence, including drunk driving, speeding, distracted driving, fatigued driving, and more. The injured party may have the right to take legal action to prove negligence and seek the compensation they need to help cover medical expenses, lost income, and any other costs associated with the injury. This is why it is beneficial to consider utilizing automatic vehicles in Virginia. Automated vehicle technology offers several benefits including:

- Fewer vehicle crashes (because of the absence of a driver and subsequent potential for error);
- Increase to the mobility of the young, the elderly, and the disabled;
- Access to personal mobility for individuals who may not be able for afford to purchase a vehicle;
- More efficient traffic flow and a decrease in congestion;
- Reduction in the costs of travel time and congestion, because vehicle occupants could spend travel time engaged in other activities;
- Increased fuel efficiency and facilitation of alternative energy sources;
- Repurposing of parking space, as such vehicles won't need proximate urban parking.

Several Use Cases are detailed below.

1. In campuses and cities around the world, autonomous shuttles are being deployed as innovative, clean, intelligent mobility solutions that help address the first-mile last-mile challenge. Such shuttles provide autonomous, driverless vehicles while also optimizing navigation and safety features. With neither a steering wheel nor pedals, autonomous shuttles use guidance and detection systems that combine various types of advanced technology. Data from Lidar sensors, cameras, GPS, IMU, odometry and other technologies are merged together and interpreted by deep learning programs. Some of the more advanced types of autonomous shuttles have embedded cognitive computing or artificial intelligence that enables real-time efficient decision making. Key providers in this space include Local Motors and Nayva.

2. Starting spring 2016, Uber allowed customers in downtown Pittsburgh to summon self-driving cars from their phones, crossing an important milestone that no automotive or technology company has yet achieved. Google, widely regarded as the leader in the field, has been testing its fleet for several years, and Tesla Motors
offers Autopilot, essentially a souped-up cruise control that drives the car on the highway. Earlier, Ford announced plans for an autonomous ride-sharing service. But none of these companies has yet brought a self-driving car-sharing service to market.

Uber’s Pittsburgh fleet, which are supervised by humans in the driver’s seat for the time being, consists of specially modified Volvo XC90 sport-utility vehicles outfitted with dozens of sensors that use cameras, lasers, radar, and GPS receivers. Volvo Cars has so far delivered a handful of vehicles out of a total of 100 due by the end of the year. The two companies signed a pact earlier this year to spend $300 million to develop a fully autonomous car that will be ready for the road by 2021.

3. The City of Los Angeles has begun designing downtown parking garages that can be repurposed to other uses once autonomous vehicles reduce the demand for parking.

### 2.2.1.2. Electric Vehicles

Climate change and the conditions for the use of fossil resources (e.g. limited availability, price) cause countries to change their climate and energy policies and thus bring about changes to their national societies. Politicians are responding with national emissions limits that unfortunately vary at international level. As a rule, these limits cover direct emissions of CO₂ or other environmentally harmful gases. The global population will increase from 6 billion in 2000 to 10 billion in 2050, and the global vehicles will increase from 700 million to 2.5 billion consequently. If all vehicles are powered by internal combustion engines, gasoline and diesel oil reserves will be depleted quickly, and the emissions will result in greenhouse effect. Energy conservation and environmental protection are growing concerns around the world.

Electric vehicles do not produce direct emissions in the form of CO₂. The introduction of low emissions or emissions-free zones in towns and a changed political framework will speed up the expansion of electromobility. An increasing number of automotive companies are investing in electromobility and are improving this technology. Electric Vehicle (EV) is a road vehicle which involves with electric propulsion. EV can be classified into three types: pure electric vehicles (PEVs, also known as battery electric vehicles or BEVs), hybrid electric vehicles (HEVs), and fuel cell electric vehicles (FCEVs).

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**Potential Value for Virginia:**

Transportation, primarily in the form of gasoline in cars and diesel in trucks, consumes more energy than any other sector such as residential, commercial or industrial. Although the state of Virginia produces massive amounts of coal and natural gas however liquid oil production is very limited – there are just two tiny oil fields (Ben Hur and Rose Hill) in Lee County. Oil production is too small to justify a wide network of wells with pipelines connecting them. Instead, oil is pumped from underground, stored in metal tanks at each well and collected by trucks that drive to each well.

On the other hand, Virginia is a net importer of electricity and even though electricity is produced in only a handful of locations in Virginia, but a complex distribution system of power lines built in the last 80 years carries it to every house in the state.

For years, Dominion Energy has included in its annual Integrated Resource Plan the assumption that electricity demand will continue to grow, so the utility will need to build new power plants. The increased efficiency of appliances and improved insulation of houses has been offset in part by the increased use of electricity per capita due to electric equipment, and Virginia's total population has been steadily increasing. Even if electricity use per capita declines, Dominion Energy has assumed that the increased number of consumers justifies increased investment in new power plants.

Limited oil production, high utilization of energy for transportation, high production of electricity, strong power distribution network in the state and reducing of electricity usage because of efficiency of appliances and improved insulation of houses, all indicate that the state of Virginia is perfect to pursue electric vehicles more. Some advantages of electric vehicles for the state of Virginia are listed below:

- Electric drive motors run more quietly than internal-combustion engines. The noise emissions from electric vehicles is very low. At high speeds, the rolling noise from the tires is the loudest sound.
- Electric vehicles produce no harmful emissions or greenhouse gases while driving. If the high-voltage battery is charged from renewable energy sources, an electric vehicle can be run CO2-free.
- The electric drive motor is very robust and requires little maintenance. It is only subject to minor mechanical wear.
- Electric drive motors have a high degree of efficiency of up to 96% compared with internal-combustion engines that have an efficiency of 35–40%.

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• Electric drive produces some heat as the battery is discharged, but a small fraction of the waste heat produced by internal combustion engines. Electric drive motors have excellent torque and output characteristics. They develop maximum torque from standstill. This allows an electric vehicle to accelerate considerably faster than a vehicle with an internal combustion engine producing the same output.

• The drive train design is simpler because vehicle components like the transmission, clutch, mufflers, particulate filters, fuel tank, starter, alternator and spark plugs are not required.

• When the vehicle is braked, the motor can also be used as an alternator that produces electricity and charges the battery (regenerative braking).

• The high-voltage battery can be charged at home, in a car park and by using any accessible sockets. The blue charging connector on the vehicle and on public charging stations has been standardized across many countries and is used by all manufacturers.

• The energy is only supplied when the user needs it. Compared with conventional vehicles, the electric drive motor never runs when the vehicle stops at a red light. The electric drive motor is highly efficient particularly in lines and bumper-to-bumper traffic.

• Apart from the reduction gearbox on the electric drive motor, the electric vehicle does not require any lubricating oil, nor does it require coolants

Use Case:

Germany is leading to provide and utilize electric vehicles. Germany also produces more automobiles than any other country in Europe and is the third largest in the world. In 2016, the German Bundesrat (the federal council of all 16 German states) voted to ban gasoline- and diesel-powered vehicles by 2030\(^\text{54}\). Germany has set itself the goal of becoming the lead market and provider for electric mobility by 2020\(^\text{55}\) as part of its long-term zero emission mobility vision. Drive electrification reduces dependence on oil, slashes CO2 emissions and allows the vehicles of tomorrow to be fully integrated into new multimodal traffic system models. One million electric vehicles on the road by 2020 – that is the bold aim of Germany’s “National Electromobility Development Plan\(^\text{56}\).” To date, the German Federal Government has invested in the region of EUR 1.5 billion in electric mobility development. Over the same period, the automotive industry has ploughed EUR 17 billion into electric vehicle development. No other automotive nation can boast a comparable range and diversity of vehicles: Seventeen vehicle series launched by German automotive manufacturers were available by 2014 (including BEV, PHEV and REEV models). A further 12 new model series


are already foreseen for 2015, which will allow Germany to further consolidate its lead provider status. The passing of a new “Electromobility Law” in 2014 advantageous to electric vehicle owners provides further impetus to the country’s electric mobility revolution. By putting the appropriate policy measures and R&D funding to implement the necessary changes in place, the German Federal Government is ensuring that the country will play a decisive role in electric mobility.

2.2.1.3. Remotely Piloted Vehicles

Multiple terms are used for a Remotely Piloted Vehicle (RPV) or an Unmanned Aerial Vehicle (UAV), which generally refer to the same concept and are more commonly known as a Drone. An UAV is controlled either by a pilot on the ground or by electronic systems (semi or fully autonomously). The use of an UAV provides great flexibility and mobility for capturing data from areas that are inaccessible or situations that are dangerous or changing. UAVs allow for accurate mapping, surveying, exploration, and tracking. UAVs may be beneficial and cost effective in a wide range of transportation operations and planning applications. These may include incident response, monitor freeway conditions, coordination among a network of traffic signals, traveler information, emergency vehicle guidance, track vehicle movements in an intersection, measurement of typical roadway usage, monitor or parking lot utilization. UAVs improve operational efficiency and provide valuable data that was not economical to obtain previously, or was inaccessible to conventional data gathering methods. There is still significant opportunity and work to be done to realize the use of UAVs to their full potential to develop new applications solve transportation challenges and problems.

Traffic surveillance and monitoring has been one of the main tools for Transportation Managers and Engineers for years and an integral part of traffic management and control strategies. Collecting visual information for large networks can be a challenging procedure. Installing stationary cameras to monitor the extent of a transportation facility has long been a successful practice. UAVs are providing a significant advancement in data collection, both in terms of operational efficiency and reduction in cost to acquire exponentially higher amounts of data. Most UAVs can be on air in a matter of minutes and, with the latest advances in their lightweight materials and equipment, they can cover large distances in very short time intervals, while most UAVs use eco-friendlier energy sources.

Potential Value for Virginia:

The UAV industry requires a large variety of resources for development, testing, and applications. Virginia is uniquely positioned to provide ideal conditions and locations for the land, maritime, and aerial unmanned systems industry. Virginia is pioneering the Cyber-UMS industry by bringing together leaders in both cyber security and UAV industries to ensure that Virginia UAS companies feel secure, as well as develop a whole new industry
that can call Virginia home. Virginia's tech leaders are focused on synchronizing and facilitating a union between technological industries in a way that will simultaneously advance all Unmanned Systems domains such as cyber security, MODSIM, controls, advanced manufacturing, and others.

Some of the key assets in the Commonwealth include:

1. **Virginia’s Center of Excellence for Unmanned Systems**: Launched on May 11, 2017, the Center serves as a "one-stop-shop" for information and assistance related to the unmanned systems landscape in Virginia. Center staff are charged with building on the rich assets and business climate to make Virginia the state for unmanned systems. The Center is responsible for instilling an entrepreneurial culture regarding Autonomous Systems across Virginia, encouraging economic growth across the Commonwealth via Autonomous emergent business activities, and continuing to bolster the Commonwealth’s position as a leader of the Autonomous Systems community.

2. **Virginia Unmanned Systems Commission**: Formed by Executive Order 43, the UMS Commission will bring public and private sector experts together to make recommendations on how to make Virginia the national leader in unmanned systems. "Capitalizing on Virginia's advantages in the unmanned systems industry is key to building a new Virginia economy," said former Governor McAuliffe. The Virginia Unmanned Systems Commission will be a key asset in charting the way forward to grow this industry and create new, good jobs and economic opportunities across the Commonwealth.

Some use cases of UAV services in deployment are:

- Traffic Monitoring
- Logistics Management
- Road construction, photogrammetry and remote sensing
- Indoor/outdoor visual inspections
- Aerial surveys, Topographical surveys
- 3D Models (Point Cloud, Triangle Mesh)
- Thermal Imagery
- Volumetric calculations
- Custom payloads and applications.

2.2.1.4. **Shared Use**

Shared Use mobility refers to a growing list of mobility services as alternatives to car ownership. The most common are:
• Car share (e.g. roundtrip systems such as Zipcap or point-to-point systems such as Car2Go)
• Bike share (e.g. dock systems such as Capitol Bikeshare and Jump Mobility free floating e-bikeshare)
• Ride share which includes both coordinated carpooling by communities such as Reston or ad hoc rideshare such as the “slug lines” used on HOV lanes around the Commonwealth
• On-Demand Transportation: Includes transportation network companies (TNC) such as Uber or Lyft, or microtransit (aka jitney) services such as Bridj or Via to be discussed later in this report.

Potential Value for Virginia:

Shared use mobility supports car free and car-light households, in many cases at less expense than car ownership. A 2010 University of California, Berkeley study found that between 9 and 13 cars are sold or not purchased for each car share vehicle. For autonomous vehicles, most mobility experts support shared systems over single occupancy driverless cars to make the most use of existing infrastructure.

The Commonwealth of Virginia has numerous developments in key urban regions and large campuses, in government and education, where this innovation could deliver substantial savings, improved services, and solve the first-mile last-mile issue in a locality. One further benefit of embracing shared-use infrastructure within the broad multi-modal approaches will be direct benefits to lower economic and social segments of the Commonwealth.

Use Cases include:

Summit New Jersey: In 2016, Summit NJ initiated a public-private partnership program with TNCs to avoid the costs of building a $10 million parking facility at a commuter rail station. Summit Mayor Nora Radest notes the program, expanded in 2017, is the first of its kind in the United States to use ride-sharing technology as a parking solution\(^57\).

California Energy Commission: The California Energy Commission installed charging stations and shared electric vehicles in disadvantaged Bay Area and Sacramento communities most burdened by air pollution, which also tend to be neighborhoods with high concentrations of low-income residents\(^58\).

\(^58\) [http://www.energy.ca.gov/appliances/battery_chargers/](http://www.energy.ca.gov/appliances/battery_chargers/)
2.2.1.5. **Micro-Transit**

Micro-transit refers to small to mid-sized shuttles used to provide trips on short routes which effectively parallel those used by conventional (fixed-route, scheduled headway) mass transit services. However, these services use apps and vehicle navigation to pick up passengers when service is required as a form of on-demand transportation (ODT).

Widely used on campuses and resorts, these services are growing as downtown circulators and feeders to public transit. With advanced technology, service providers can supply on-demand, variable routes. There are several funding methods, from advertising to subsidies from transit agencies. Los Angeles recently launched a microtransit initiative to determine program elements needed to build a successful first-last mile access to transit service. A report prepared by Los Angeles County Metropolitan Transportation Authority (LA Metro) and the Eno Center for Transportation detailing these efforts was released in January 2018 during the 97th Annual Transportation Research Board (TRB) meeting in Washington DC

In the near future, microtransit service with a driver will provide insights on future driverless routes. For AVs, a city may temporarily dedicate a lane with wired, modular rails along a simple route, moving progressively towards more complex, on-demand service.

Microtransit also has strong potential to integrate paratransit services for disabled or otherwise mobility constrained passengers. These are now offered separately from conventional transit at a substantial public cost as well as a great deal of inconvenience for riders (e.g. scheduling required up to 24 hours in advance).

**Use Cases:**

West Sacramento, California and Arlington, Texas have partnered with ride-share shuttle service. Using a mobile app, customers will set pick-up and drop-off locations. Shuttles, guided by optimized routing, will pick up several riders headed in the same direction.

In Tampa, Florida, the **Downtown Tampa Free Ride Service** is a public/private partnership offering free rides in shuttles and Chevy Bolts. The partnership includes the Downtown Business Improvement District, the Downtowner shuttle service, the City of Tampa, Florida Department of Transportation, as well as supporting business and advertisers.

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An initial microtransit provider was Bridj, which has since ceased operations after pilots around the US. New entrants now include Chariot (owned by Ford) and Via (owned by Daimler), demonstrating the commitment of OEMs to new mobility.

2.2.2. Connectivity Technologies

Significant advancements in vehicle connectivity technologies are core to driving progress in Autonomous Vehicles, Drones, and various other Smart Transportation innovations. The Commonwealth has to lead and prioritize investments in the right areas to help develop these innovations. The key components behind vehicles “talking” include - to each other (V2V), to the infrastructure (V2I), to pedestrians (V2P) and even to our homes (V2H). In its larger context, this Vehicle to Everything (V2X) world puts transportation as a critical component in the larger IoT ecosystem. Much work has been done by the Federal Highway Administration (FHWA) on this topic\(^61\) and, locally, the Virginia Tech Transportation Institute\(^62\) is leading in this area.

While these technologies promise to increase safety, promote sustainability and, through new business models, create greater access to and equity around transportation, they also create new data sources giving traffic managers real-time information and a greater ability to plan for the future. And, because many of the V2X systems can be incorporated into existing infrastructure and vehicles through aftermarket devices, the “vision” of connected transportation can be achieved in a shorter time frame. Finally, this connectivity is important to advancing autonomous systems.

These technologies fall squarely in the priorities listed to advance Virginia’s Smart Communities strategy including:

- Ensuring rapid and successful deployment of smart solutions in cities and communities, prioritizing ease of solution replication across communities, interoperability, scalability, and sustainability
- Leveraging higher education research, as well as innovation, commercialization, and associated workforce investments of Virginia universities, community colleges, technical institutes, and entrepreneurial communities
- Fostering economic growth and job development
- Encouraging digital access and equity by deploying technologies in both big cities and rural communities
- Encouraging broader broadband deployment and connectivity as these networks are the foundation for these technologies and the larger smart community ecosystem.

\(^61\) [https://rosap.ntl.bts.gov/view/dot/2425](https://rosap.ntl.bts.gov/view/dot/2425)

\(^62\) [https://www.vtti.vt.edu/](https://www.vtti.vt.edu/)
• Encouraging and helping catalyze private sector investment, innovation, and support for start-ups for smart communities.

2.2.2.1. **Vehicle to Infrastructure (V2I)**

Vehicle-to-Infrastructure communication (V2I) means direct communications between vehicles and roads, traffic lights, parking meters and bridges through sensors embedded into that infrastructure, again with the US DOT providing guidance.63

Use Cases include:

• Traffic light, curve speed, railroad, weather and work zone warnings, vehicle and pedestrian collision avoidance at intersections
• Speed management
• E-tolling
• Transit safety and operations
• Identifying and warning vehicles ahead or in blind spots
• SPAT data to vehicles giving them a countdown to when the light will turn green
• Usage charging and/or charging for oversized and or larger vehicles like semi-tractor trailers proportional to actual use in lieu of annual commercial vehicle taxes that are less exact.

2.2.2.2. **Vehicle to Vehicle (V2V)**

Vehicle-to-Vehicle communications (V2V) means direct communications between vehicles within a certain geographic area. See and. The US DOT has issued standards for V2V Deployment and many automobile companies have started to incorporate these technologies into production platforms, for example: GM has already released the technology in its 2017 Cadillac CTS vehicles.

Use Cases include information shared such as:

• Sharing that vehicles are in specific locations
• Vehicle speed, travel, emissions, braking and acceleration rates
• Road and traffic conditions

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63 [https://www.transportation.gov/briefing-room/fhwa0317](https://www.transportation.gov/briefing-room/fhwa0317)
65 [www.youtube.com/watch?v=OkME1hCRR_Y&sns=em](http://www.youtube.com/watch?v=OkME1hCRR_Y&sns=em)
66 [icsw.nhtsa.gov/safercar/v2v/](http://icsw.nhtsa.gov/safercar/v2v/)
• In-car functions such as blind spot, lane change, forward collision, sudden braking, emergency vehicle and roll-over warnings
• Intersection Movement Assistance which warns an upcoming car that another car in front of it will not be stopping but running a light
• Emergency Electronic Brake notice when the brakes are slammed so the car behind is warned
• ‘Do not pass’ warnings where a driver can’t see around a car or truck ahead and is told there is oncoming traffic
• Truck Platooning
• DOT pilot-projects are underway in New York City, Wyoming and Tampa, FL.

2.2.2.3. Other Connectivity (V2P, V2X, V2H, IN-V)

Vehicle-to-Network communications (V2N) refers to the connection between the vehicle and the internet, which is the backbone of the connected space.

Vehicle-to-Pedestrian communications (V2P) refers to the ability of the vehicle to ‘talk’ to pedestrians, bicyclists and motorcyclists, allowing them to actively communicate using mobile devices to make their movement safer and more expedient.

Vehicle to the Grid (V2G) is gaining traction as electric vehicles (EV) become more prevalent. This integration approach involves integrating the EV into the electric grid as a provider of energy to an electric utility during peak demand, or using the EV battery for different services. This permits usage of the EV as a revenue generator. Other uses include the vehicle’s function as generator during power outages as in Vehicle to the Home (V2H) applications.

Vehicle to Everything (V2X) refers to the vehicle’s communication with anything that can affect the vehicle or the passengers in it and vice versa.

Use case: The Tampa-Hillsborough Expressway Authority is working on a V2X pilot that equips cars, buses, trolleys and roadside units with sensors and pedestrians with phone apps all using Dedicated Short Range Communications to transmit data.

Recently, the VDOT and Fairfax County hosted a joint transportation technologies hackathon at the Refraction incubator in Reston to explore V2V and other technologies, with the winner being Merrifield-based eTransSystems.

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69 https://tti.tamu.edu/2016/08/04/follow-the-leader-two-truck-automated-platoon-test-is-a-winner/
70 https://www.etranssystems.com/
2.2.2.4. Broader Implications of Connectivity Technologies

Congestion and its safety, environmental and sustainability impacts are all integrated to bring out the value proposition behind a connected transportation network.

- **Saving Lives:** 37,461. That is number of fatalities NHTSA reported in 2016 due to car accidents. This is a 5.6% one year increase reflecting $300 billion in estimated societal costs. The US DOT’s Volpe Center visualizes these figures.

While the increase is lower than from 2014-2015, there were increased deaths in all areas: “passenger vehicle occupants, occupants of large trucks, pedestrians, pedalcyclists, motorcyclists, alcohol impaired driving, male/female, and daytime/nighttime” (NHTSA).

Research conducted by UMTRI and the Crash Avoidance Metrics Partnership (CAMP) estimate that connected transportation technologies can prevent up to 80% of all traffic accidents.

- **Advance Mobility and Environmental Quality:** Increased congestion equals billions in travel delays. In its 2016 Urban Congestion Report, which examines the nation’s 52 largest metropolitan areas, the Federal Highway Administration points out that congestion time increased by nearly five minutes in 2016.

While Virginia showed some improvement (with the exception of the Washington, DC area), the report points out the positive effects of intelligent transportation systems. It highlights\(^{71}\) in its V2V guidance that these technologies “shows great promise in helping to avoid crashes, ease traffic congestion and improve the environment.” These technologies can result in greener transportation choices, increasing fuel efficiency by reducing idling and ‘stop and go’ traffic.

- **Equity of Mobility:** Access to affordable, reliable, safe and modern transportation networks is the backbone of communities’ economic development, job growth and quality of life. Real time information about travel conditions can mean the difference between being able to access job opportunities and being an active citizen. Additionally, research is underway to show how these technologies can be used to provide savings in things we buy everyday by cutting transportation cost-savings of goods. It was the benefit of using advanced, connected transportation initiatives to reduce infant mortality that helped drive the city of Columbus, Ohio to win the US DOT Smart Cities Challenge in 2016.

\(^{71}\) [https://www.nhtsa.gov/technology-innovation/vehicle-vehicle-communications](https://www.nhtsa.gov/technology-innovation/vehicle-vehicle-communications)
Transportation 4 America has even opened up a challenge for artists\textsuperscript{72} to team with transportation planners to create comprehensive solutions to transportation challenges that include:

- Generating creative solutions for entrenched transportation projects
- Making streets safer for all users
- Organizing transportation advocates
- Engaging multiple stakeholders for an inclusive process
- Fostering local ownership
- Alleviating the disruptive effects of construction
- Healing wounds and divisions (Transportation 4 America)

\textbf{2.2.2.5. Wireless Communications}

The ability to move data wirelessly with speed and reliability has transformed society. Nowhere is this more evident than in Smart Communities. And nowhere is the impact on safety and reliability more evident than Smart Transportation systems. Whether moving people or goods, by road, rail, sea or air -- today, every part of our transportation infrastructure is supported and enhanced by a web of connected devices and sensors\textsuperscript{73}. These endpoints transmit huge amounts of complex data, at the speed of light, both to the consumers who utilize, and the agencies that maintain, this infrastructure. This has resulted in an undeniable improvement in the efficiency, safety and usability of our local, regional and national transportation systems. However, there are challenges that need to be addressed, including:

- Standards (for wireless networking protocols, etc.)
- Security
- Accessibility - wireless infrastructure supports State or regionally-maintained transport services; however, what about private or not-for-profit initiatives like bike-sharing? Do they have access to the network? Are there special requirements for subgroups of users, such as the disabled?
- Reliability – availability of broadband?
- Scalability - account for population and infrastructure growth
- Public subsidies/availability of funding
- Privacy and data.

\textsuperscript{72} \url{http://t4america.org/maps-tools/creative-placemaking-field-scan/}
\textsuperscript{73} \url{http://tianow.org/videos/trb-lets-pump-brakes-cav-deployment}
2.2.2.6. Security

Modern transportation systems are made safer and more efficient by a web of sensors and other connected devices such as GPS, positive train controls, traffic management systems, payment collection systems, and weather monitoring instruments that share data and execute commands in real time. These sensors and the data that flow to and from them are the new central nervous system of our modern transportation systems and they require reliable and secure network connectivity. Unfortunately, the devices tasked with collecting data (e.g. track sensors, fare turnstiles or fare collection) or executing digital commands (e.g. rail switches, thermostats) may have many of the same security flaws that allow baby monitors to be used to spy on unsuspecting consumers, or security cameras that can be compromised and recruited into massive denial of service attacks.

These devices mostly connect to networks with IP addresses and fall into three main categories:

- **Consumer-type, Internet of Things (IoT) devices, such as cameras and thermostats.** Many types of IoT devices can be easily compromised because their default configurations have easily guessable login and passwords or because they have known security flaws. With regard to security flaws, a large portion of devices have software that cannot be updated or patched and, for models that can, manufacturers may not have well-developed and secure methodologies for communicating updates to transportation authorities.

- **Industrial Control Systems (ICS) or Operational Technology (OT) devices.** This category of devices tends to fall under the umbrella of Transportation Management Systems (TMS) and includes controllers, sensors and actuators that perform a range of functions, including data acquisition, command and control, computing and communications. These devices can run known operating systems (often a Linux variant) or firmware. While these devices are often made by well-known manufacturers, they may or may not be able to be updated and, when they are, manufacturers often lack well-developed methodologies for pushing out updates to transportation authorities.

- **Unauthorized/unknown devices.** It is increasingly common for public- and private-sector organizations to be unaware of a significant number of devices connected to their network. When organizations are unaware of devices connected to their network they cannot be managed or monitored. When organizations do finally implement robust detection capabilities, as the federal government has done through the Continuous Diagnostics and Mitigation program, they may find anywhere from 20%-70% more connected devices (wireless or wired) than predicted. These often include items like wireless access points, gaming devices, unknown HVAC equipment or third-party contractor equipment.
All these devices share a few common characteristics:

a) Since many require an agent (a small piece of software that resides on a device that allows it to be scanned for malware or vulnerabilities) they can be difficult to detect and manage. If an agent becomes non-functional the device cannot connect to a server which has a list of new malware to check for or new patches that need to be run;

b) Even when they are detected, they cannot be managed with traditional security tools and, as discussed above, many cannot be patched or updated; and

c) Because of the sheer volume of devices connecting to networks and the often haphazard way in which these devices are connected, keeping them in their own swim lanes (i.e. properly segmented) is a challenge.

How do undetected, and thus unprotected, devices pose a threat to transportation systems? They can serve as an entry point for attackers to move laterally within the organization’s networks to higher value assets (HVAs). HVAs can include sensitive data (sensitive from a privacy standpoint or from the standpoint of physical security) or assets that are critical to the organization’s continuity of operations. An attack on the latter type of HVA could lead to possible disruption of operations across an organization, and even partial or full system downtime or even outright failure. There has already been an instance in which a transit agency was affected by ransomware that targeted its traditional computers and impacted fare station terminals. There has also been an instance of a U.S. university that was the target of a denial of service attack that exploited its own compromised Internet-connected devices (vending machines) to conduct the attack. The attack slowed the institution’s entire network and restricted access to the majority of internet services.

Protect Connected Transportation Systems Through Detection and Segmentation: A basic tenet of cybersecurity is that you cannot protect what you can’t see. IoT devices typically cannot be detected by traditional, agent-based cybersecurity tools for reasons referenced above (namely that IoT devices cannot run traditional cybersecurity software). To combat the problem of “shadow devices,” organizations must employ a continuous monitoring strategy and that includes IOT and OT devices. The National Institute of Standards and Technology (NIST) defines continuous monitoring as "maintaining ongoing awareness of information security, vulnerabilities, and threats to support organizational risk management decisions." Continuous monitoring and 100 percent visibility across networks is now U.S. Federal government best practice and will soon be realized through several consolidated cybersecurity programs, including the Continuous Diagnostics and Mitigation (CDM) program. It allows organizations to have real time, constant domain

74 http://nvlpubs.nist.gov/nistpubs/Legacy/SP/nistspecialpublication800-137.pdf
awareness - knowledge of a device's presence on the network the instant it connects to the network, versus a periodic scan. This allows organizations to take action against all threats, including the ones most traditional cybersecurity tools miss.

Because patching is impossible for many devices, robust network micro-segmentation is essential to combat the problem of compromised IoT on transportation networks. Devices should be aggressively and automatically segmented, thus helping to prevent infected devices from compromising other assets on an enterprise's networks. Properly detecting then classifying devices on a network permits devices to be grouped into subnets where only similar devices operate. This micro-segmentation makes it possible to monitor devices throughout the time a device is connected (i.e. continuous monitoring) so that anomalous behavior can be detected in real time. If the device is behaving in an unexpected way, this is an indication of compromise and the agency should remove it from service until it can be remediated, either manually or automatically, and in a manner consistent with the manufacturer's specifications.

2.2.2.7. Intelligent Transport Systems

An Intelligent Transportation System (ITS) is an advanced application which, without embodying intelligence as such, aims to provide innovative services relating to different modes of transport and traffic management and enable various users to be better informed and make safer, more coordinated, and 'smarter' use of transport networks.

Although ITS may refer to all modes of transport, the directive of the European Union 2010/40/EU, made on July 7, 2010, defined ITS as systems in which information and communication technologies are applied in the field of road transport, including infrastructure, vehicles and users, and in traffic management and mobility management, as well as for interfaces with other modes of transport. ITS may improve the efficiency of transport in a number of situations, i.e. road transport, traffic management, mobility, etc. Some key components in an ITS are:

- Advanced traveler information systems (ATIS): ATIS include providing real time travel times to motorists to help them choose the fastest route for their journey. This can help to improve overall travel time for all users on the transportation network, by using spare capacity and keeping drivers off already congested routes. ATIS also includes notifying motorists of incidents to allow them to change their route or to reduce driver frustration by proving information about unexpected delays. ATIS can also be used to provide information for public transit service, again, by allowing travelers to make good route and mode choices as well as explaining unexpected delays. Travel time reliability can be more important than
total travel time for some trips and some transportation users and some ATIS include historic reliability information.

Many different technologies are currently in use to determine real time travel time information. Technologies include Bluetooth, Wi-Fi, cell phone data, and GPS. Many jurisdictions use information collected and sold by third parties and then disseminate the information to the travelling public via variable message signs, websites and apps.

- Incident Management: A good incident management system can improve the safety, efficiency and reliability of the transportation network. Key concepts in incident management include incident detection, verification, response and clearing. Even a minor incident such as a breakdown on the shoulder of a freeway can cause a significant impact to congestion due to “rubber necking” as drivers slow to determine the cause of the incident. Secondary incidents, often due to drivers slowing down or watching the incident instead of the road, can exacerbate the impact of an incident. Early incident detection and verification, correct and timely emergency response and clearing of incidents can reduce the impact of an incident.

Incident management planning, specific to the corridor, is key but technology can also play a part in incident detection and response.

- Active Traffic Management: Active traffic management includes various methods to monitor and manage traffic to improve safety and efficiency including:
  - Ramp metering: Using traffic signals to meter traffic entering a freeway to delay the onset of flow brake-down during peak periods. Vehicle detection is used on the freeway to monitor the occupancy and determine the rate vehicles are allowed onto the motorway at each ramp in the freeway system.
  - Variable Speed Limits: Used on freeway systems to advise motorists of safe speed limits due to variable weather, incidents, or changing traffic conditions. This can help reduce incidents and improve traffic flow.
  - Adaptive Signal Control: Requires vehicle detection and communication at traffic signals to a central system that uses algorithms to optimize traffic flow and progression at signalized intersections. Changing signal timings in real time in response to actual traffic conditions can reduce traffic congestion along arterial corridors.
  - Managed Lanes: Managed lanes involve the regulation, warning, guidance and redistribution of traffic (FHWA) to improve traffic flow. This includes HOV (high occupancy vehicle), HOT (high occupancy toll), and dynamic lanes such as lane reversals and hard shoulder running. Many HOV lanes are being converted into HOT
lanes to increase the overall capacity. Managed lanes make better use of the traffic lanes available to increase capacity, improve reliability and reduce congestion.

A number of companies with headquarters or other significant presence in Virginia are involved with these systems including Transurban (Alexandria), KapschTrafficom (McLean), Q-Free (Virginia Beach), and Iteris (Chantilly). During the fall of 2017, Transurban and the 1776 entrepreneurship / incubator / VC based on Crystal City hosted the Smart Highways Challenge where six entrepreneurs came to Northern Virginia to incubate advanced highway technologies.75

Potential Value for Virginia:

ITS solutions provide significant advancements to the Commonwealth in managing its transportation challenges. Some of these challenges include:

- The rate of increase in vehicle miles travelled (VMT) is higher than the increase in roadway capacity. Increasing capacity without building more roadway will continue to be an important tool for controlling congestion.
- The Washington DC metro area, including Northern Virginia, is one of the most heavily congested regions in the country.
- The worst traffic hotspot in the country is along Interstate 95 from the Fairfax County Parkway to Fredericksburg in Northern Virginia. According to data collected by Inrix in 2017, the average traffic jam lasted 33 minutes and was 6 miles long.
- The Hamptons Roads region also has increasing congestion due to the bottlenecks at bridges at tunnels.
- Virginia’s average commute to work time is the seventh highest in the country.
- The cost of congestion is Richmond due to excess fuel and travel time is over $550 million per year, which equates to an average cost per auto commuter of over $700 per year.
- The cost of congestion is Virginia Beach due to excess fuel and travel time is over $1 billion per year, which equates to an average cost per auto commuter of over $950 per year.
- The Virginia state high network is the third largest in the country at over 55,000 miles.
- More than half of all congestion is due to incidents (non-recurring congestion).

Use Cases for ITS are well documented globally, and include the following:

- Adaptive Signal Control has been in use since the 1970’s and is widely used outside of North America. The UK-developed SCOOT system has been widely used in the UK since 1980 and now used in 250 towns and cities worldwide including Seattle and Toronto. The Australian developed SCATS system was also developed in the

75 https://www.1776.vc/transurban-startup-challenge/
1970’s and is now used in over 154 cities in 25 countries including Oakland County, Michigan.

- The Virginia Center for Transportation Innovation and Research conducted a pilot project using Rhythm Engineering InSync on 13 corridors throughout Virginia. The results found a 17% reduction in total crashes, a decrease of 20% in average number of stops, and increase in average speed of 10% and a positive benefit/cost ratio.
- All 50 states have some form of traveler information systems. Since 2001, the telephone number 511 has been assigned as the transportation and traffic information hotline. Iteris, a California based ITS company, provides ATIS systems to 10 states (including Virginia) providing real time traffic, parking and transit data through websites, apps and 511.
- The first managed lane facility in the country was a bus-only lane on I-395 in Washington, D.C./Northern Virginia which opened in 1969. The first High Occupancy Toll (HOT) lanes were installed in Orange County California in 1995. Approximately 40% of all managed lanes in the country are located in California. Currently the state of California has 1483 lane-miles of HOV lanes (817 lane-miles in development) and 221 lane-miles of HOT lanes (1330 lane-miles in development). In the Los Angeles area, it is estimated that on freeways with HOV facilities, the HOV lanes carry approximately 33% of all person trips but use only 20% of the space.

2.2.3. Data Technologies

A fully developed connected vehicle environment will produce vast amounts of information as vehicles and infrastructure send messages to one another. Effective use and management of this data has the potential to transform the transportation industry and transportation in a connected city. “Big data” is a term for a family of techniques and technologies that many businesses are increasingly using to improve and streamline their business practices, and it holds real promise for the management and analysis of connected transportation data.

Big data is an approach to generating knowledge in which a number of advanced techniques are applied to the capture, management, and analysis of very large and diverse volumes of data - data so large, so varied, and analyzed at such speed that it exceeds the capabilities of traditional data management and analysis tools. Big data is often discussed in terms of the 3 Vs: unprecedented volumes of data, with substantial variety in the types of data collected and analyzed at high velocity —to enable real-time decision making. Some organizations have defined a fourth V - veracity - and even a fifth V - value.76

76 ITS JPO - “Big Data’s Implications for Transportation Operations: An Exploration”
The Workgroup has assessed and prioritized various types of relevant data technologies in the Smart Transportation space.

### 2.2.3.1. Artificial Intelligence

Artificial intelligence\(^77\) (AI) is the term on everyone’s lips. But in the transportation industry today, many products and services being labeled as such are in fact reliant on a form of advanced analytics (evolving from conventional algorithms) that enables those features – for example, predictive maintenance in manufacturing.

Theories of AI have existed since 1950. However, AI itself gained wider functional applicability only in the past few decades, with the rise of machine learning and deep learning. This has also been facilitated by advances such as improved algorithms and training methods, greater computing power, and the availability of large amounts of data in the cloud.

Despite these developments, the transportation and automotive industry is still only at the beginning of the AI disruption. State-of-the-art AI applications remain narrow—they can perform better than humans, but only in very specific tasks. And the level and nature of AI technology varies widely; for example, “narrow AI” encompasses classic navigation systems as well as autonomous-driving tasks processing one gigabyte of data per second, or a million times more data than current navigation systems handle. Matching human ability in an even larger number of contexts is still some years out.

Machine Learning (ML) will have a significant impact on the automotive and mobility industry, since it will unlock entirely new products and value pools and not just lead to productivity improvements. Machine Learning applications fall into three distinct categories:

1. Process optimization and increased productivity (often rooted in advanced analytics but enhanced by machine learning)
2. New or enhanced products (mainly enabled by machine learning)
3. Entirely new (vertical) businesses, along customer use cases, making use of these new products

Per Stanford University’s One Hundred Year Study on Artificial Intelligence (AI100)\(^78\), the availability of large-scale data has made transportation an ideal domain for machine learning applications. Since 2006, applications such as MapQuest, Google Maps, and Bing Maps have been widely used by the public for routing trips, using public transportation, receiving real-time information and predictions about traffic conditions, and finding


\(^78\) [http://ai100.stanford.edu/2016-report](http://ai100.stanford.edu/2016-report)
services around a location. Despite these advances, the widespread application of sensing and optimization techniques to city infrastructure has been slower than the application of these techniques to individual vehicles or people. Although individual cities have implemented sensing and optimization applications, as yet there is no standardization of the sensing infrastructure and AI techniques used. Infrastructure costs, differing priorities among cities, and the high coordination costs among the parties involved have slowed adoption, as have public concerns over privacy related to sensing. Still, AI is likely to have an increasing impact on city infrastructure. Accurate predictive models of individuals’ movements, their preferences, and their goals are likely to emerge with the greater availability of data.

Significant work is being carried out on implication of various types of AI in the Transportation by entities such as the Transportation Research Board (http://onlinepubs.trb.org/onlinepubs/circulars/ec113.pdf).

Some significant use cases⁷⁹ are:

- **Real-time delay management**: Urban transit is heavily dependent on external events. So far most urban transit systems fail to communicate on the real impacts of these events on the commuter journey (delays particularly). A new generation of ML-based models can be developed to implement smarter predictive models and personal notifications.

- **Urban transport demand forecast**: Demand forecast is a core requirement to optimize routes, schedules and capacity. The digitalization of transport operations (e-ticketing, mobile, IoT…) generate large sets of data that can be consolidated and enriched to feed ML-based forecast algorithms.

- **Parking management**: ML models for parking places demand forecast can be used to implement services related to real-time routing of drivers and riders, modular pricing systems implementation and multimodal transportation services.

- **Demand forecast for EVs charging stations**: Electrical Vehicles owners and users of EVs sharing services (bikes, scooters, cars) are on the rise and generate new consumption patterns related to both energy demand and parking space demand. Charging stations management requires new ML models to optimize pricing models and demand forecast.

- **Solar power forecast for EVs charging stations**: Solar power generation is becoming a key component of distributed generation. ML models can help anticipate how solar powered charging stations can accommodate EVs energy needs and how they can be integrated into the local distribution grid.

- **Smart Grid Management**: EVs power demand can put some pressure on the local distribution grid. At the same time, some energy stored in EVs could be fed back into

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the power grid (Vehicle-to-Grid / V2G) when vehicles are not in used. ML models can help manage the integration of EVs into smart distributed energy resources systems. The use of EVs as temporary stationary storage units is still at an early stage of development but it is a promising one. It is definitely a mean to sustain the growth of the circular economy through the optimization of renewable energy storage.

- **Autonomy Management (battery charge):** Telemetry systems give the capacity to acquire real-time data on battery levels, driving behavior and vehicle parameters. ML models can in near real-time predict the state of charge (SOC) of EVs batteries according to the anticipated route of the driver.

- **Dispatching / Routing optimization:** Routing and dispatching are complex operations. For an EVs fleet the models are even more complex as the anticipated autonomy of vehicles and the time to charge batteries need to be integrated too. This is a case where deep learning has shown interesting results.

- **Predictive Maintenance:** ML models can be trained to anticipate when a battery should be changed in order to keep good level of performances for EVs. This type of model can be trained for other components of the vehicles through the acquisition of sensors or bus CAN data.

### 2.2.3.2. Data Sources

With the help of digitalization and emerging ICT technologies, more information about private travel activity and public road use can be collected in a cost-effective way that can better inform day-to-day network management, long-term infrastructure planning and road user travel choices. Data sources for transportation include:

- **Conventional Data Sources:** Conventional traffic data sources include road surface traffic sensors, household travel surveys, floating car surveys and traffic cameras, including automatic number plate recognition (ANPR).

- **New Traffic Data Sources:** New traffic data sources include road-side wireless traffic sensor technologies that measure traffic passing fixed points on the road network, and GPS, GSM and Bluetooth data sources, that can potentially provide real-time measures of traffic and road operating conditions across the entire network. As well as these sources, GPS-based HTS can provide more detailed, and potentially more accurate, travel survey responses.

- **Road-side traffic sensors:** Road-side traffic sensors operate via wireless detection of vehicles at highway sites. They essentially provide a less-intrusive alternative to road surface based sensors.
  - Acoustic sensors
  - Microwave radar
  - Lidar and active infrared sensors
  - Video image detection
• RFID tags

• Mobile data sources: Mobile data sources, such as in-vehicle GPS, GSM mobile phone and Bluetooth devices, potentially offer the greatest scope for relatively inexpensive collection of traffic speed, travel delay, traffic volume and OD flows across the networks. Modern mobile phones also have the capability to provide GPS position and report GPS to the network, potentially providing more accurate personal/vehicular movement information.

By combining conventional and new data sources, traffic data collected from multiple sources can be transformed (i.e. aggregated, averaged, scaled, etc.) and reinterpreted to provide meaningful information for traffic monitoring managers, planners and travelers. Furthermore, the timeliness requirements will differ across users: network operations manager requires real-time information about high traffic volume locations and incidents occurring on the network, whereas transport planners’ needs less immediate information about total network use and the factors influencing travel.

Implications of New Data Sources:
Advances in road-side detection technologies offer opportunities for lowering costs in collecting vehicle traffic count type data. GPS, GSM and Bluetooth technologies provide opportunities for collecting more information about when and where vehicles use the road network. When combined, these separate data sources potentially provide a wider range of data suitable for real-time and long-term planning and operational optimization applications. The potential benefits of promoting new data sources include reducing the cost of collecting travel and transport-related data, expanding the range and increasing the accuracy of available transport-related data, and, ultimately, providing better real-time information for network managers and users and better informing long term planning of future infrastructure needs. However, there are a bunch of technical issues (e.g. locational accuracy, network coverage, road user coverage and expansion factors) and commercial and legal issues such as privacy, security, and commercialization opportunities that need to be resolved before this data can be utilized on a large scale.

Examples include the Californian Mobile Millennium project and the US Real-time Data Capture and Management Program. Both have focused on the large-scale data opportunities offered by GSM and GPS-sourced data.

The Californian Mobile Millennium project was developed by the California Center for Innovative Transportation (CCIT), the Nokia Research Center (NRC), and the University of California (UC) at Berkeley and launched in Bay Area in November 2008. The project involved members of the public downloading software for GPS-equipped cell phones, which effectively served as vehicle probes and stored vehicle speed and position.
information every three seconds. These measurements were sent wirelessly to a server for real-time processing. The data was then fed back to users in the form of information about traffic conditions and travel speeds, via smart phones and the world wide web. The project ran for almost two years and attracted more than 2,000 registered users. The data collected through the project was also used by researchers to assess the accuracy and validity of using mobile phone source GPS information, as well as for a range of more complex traffic estimation tests. The project also confirmed the practicality of data fusion techniques, an issue of relevance to government road agencies. However, the project final report notes that fragmentation of the GSM market means that no single provider has sufficient data to cover the entire network comprehensively. Because many of the entities operating in this space are competing vigorously, the challenge for government is to ‘create the proper mechanisms to aggregate data at a global scale’.

2.2.3.3. Data Governance

Data governance can be defined as the execution and enforcement of authority over the management of data assets and the performance of data functions. Data governance’s role is responsible for establishing overall policies, standards, and procedures that are to be followed by the organization. The management of data assets for an organization or state DOT is usually accomplished through a data governance board or council. This role is critical in successfully managing data programs that meet business needs and in supporting a comprehensive data business plan for the organization. According to the Data Governance Framework set by the Data Governance Institute, it describes who can take what actions with what information and when, under what circumstances, using what methods, including:

- Rules (policies, requirements, standards, accountabilities, and controls) and the rules of engagement to make those rules. Due to the increasingly larger amount of new data sources such as video camera, sensors, GPS and GSM data, standardized data format across transportation system must be achieved to share data, integrate data and manage data. Meanwhile, accessibility with privacy control, security protection are also vital for data flow in the system in order to make the full usage of data. Policies such as data ownership focuses on the protection of the data and authorize access to various data applications in their business area.

For any DOT, different divisions may own their data for specific applications supporting their business area, such as planning, traffic operations, and engineering. Custodians and owners outside of the IT department are responsible for ensuring that sufficient controls are established within their area of responsibility to ensure the accuracy and completeness of data and that data comes from the appropriate source for the intended use. In private sector
companies, any group, other than the IT department, does not typically own data. To have a well-functioning data governance structure, there must be open channels of communication between the providers of data and information and the users of the data. Outreach programs from the data providers to the data user community are an effective way to maintain this relationship.

![The DGI Data Governance Framework](source.png)

**Figure 3 The DGI Data Governance Framework**

- People and organizational bodies involved in making and enforcing those rules. The processes that these people follow to govern data, while creating value, managing cost and complexity, and ensuring compliance.

The benefits of implementing a data governance framework include improved quality of data collected and reported, which in turn, has a positive impact on decision-making. Leveraging a well-defined data governance model helps to ensure successful sharing of responsibilities with respect to data management functions. A data governance board or council may be established to serve in the oversight role for managing the data governance activities of an organization.

As an example, the WSDOT has a Data Council and a Data Stewardship Council to help support data governance at WSDOT. WSDOT also further defines two categories of Data Stewardship: Business Stewardship and Technical Stewardship. The Business Stewards are executive, managerial, and operational stewards, while the Technical Stewards include the more traditional roles of system architects and database administrators.
The WSDOT model started with a smaller goal of gaining support at the executive level for a data policy. This eventually led to the support for the development of a data catalog which was followed with the development of a Data Stewardship program. This proved to be an effective method for beginning implementation of a data governance framework. The role of the Data Stewardship Council is to address data issues across the Department. An additional Data Council also was established to set standards for such components as data architecture, data modeling, and data stewardship. The Department successfully encourages the use of data standards, by linking the funding of various programs, when possible, to the use of those standards within the organization. This is an effective means for gaining compliance with the data management policies and procedures for the Department.

2.2.3.4. Data Management

Data management can be defined as the development, execution and oversight of architectures, policies, practices, and procedures to manage the information life-cycle needs of an enterprise in an effective manner as it pertains to data collection, storage, security, data inventory, analysis, quality control, reporting, and visualization. It makes possible for data integration and sharing with internal and external stakeholders.

Data Sharing and Integration

Open data is a trend for most government agencies to provide better information services to public. Sharing data between agencies provides benefits not only in terms of reducing costs associated with having multiple agencies collect the same data but also in terms of resources dedicated to maintaining duplicate data systems. It will also reduce the risks of providing different responses to the same question when a single source of data is used for reporting and decision-making in a specific business area.

Government agency or organizations may utilize formal data sharing agreements with external partners and agencies. The Maryland Motor Vehicle Administration (MVA), for instance, uses Memorandums of Understanding (MOU) with all organizations that it shares data with. Some of the types of data that the MVA obtains from external sources include the following:

- National Driver Register data;
- Social Security data;
- Commercial Driver’s License data; and
- Insurance data.

Transportation data collected over years can also help researchers in universities, or business who provide transport services. It is valuable asset which can be utilized by
various group of people to develop better transportation services. Some sample questions we need to consider regarding data sharing:

- Who may need what data?
- What data can be made available to public, and what should only open to certain group of people?
- How to integrate different format of data? How to make data available to potential users? How to address data security and privacy concerns?
- Should the user be charged for using data? How to define the price schema?

With development of connected vehicle technology, more traffic related data become available from nontraditional traffic management authority, like car makers, fleet owners, even telecommunication carriers. In most cases, V2I or V2V data are owned by different agencies or vendors. On one hand, these data is a good supplement to official traffic management system, and government agency may like to incorporate those data into. On the other hand, traffic management authority may want to share information with connected car service platform, so that drivers of connected car may get more traffic information too. Therefore, data sharing could be a two-way sharing.

Data Quality Management

Data quality refers to how well a set of data reflects what it represents in real world. A set of data is considered in high quality if the data can represent a scenario accurately and completely in a consistent manner when we need to use it for making decisions in real life.

Data completeness and accuracy are two important measures of data quality. Completeness means that data should cover all aspects of a scenario. For example, to understand daily commute demand of a city, we need data on road traffic, public transit system, and taxi information as well. Those data are collected by and stored in different systems.

Data accuracy refers to degree of erroneous in a set of data. Loops or cameras for road traffic data collection may become defected, or generate bad data due to extreme weather. Data collected from these types of devices needs to be validated and cleaned to ensure accuracy and satisfies to needs of traffic analysis needs.

Another measure to data quality is data consistency. With the growth of data collected from various devices or systems, we may find that same attribute(s) of an entity may have different values. Or data reflecting the same attribute(s) of an entity changes over time while it should remain the same. For example, some traffic management systems use RFID signals from vehicles on streets as input to detect traffic volume. If an RFID reader detected
a vehicle at an intersection, but a traffic camera at that intersection may send back data showing no car there, it is very possible we have a mal-functioning camera.

Timeliness is also a measurement of data quality in some application, especially for applications requiring quick responses. In a real time traffic control system, how quickly an accident on a busy road can be detected will determine how severe a traffic jam will be due to that accident. With the stream technology in big data, now some systems can automatic detect accidents within a minute.

Data quality management is not a one-time task. It must be done in an iterative way from the creation of data to its obsoleteness. Therefore, it should be considered from the very beginning of data collection for traffic management systems.

Key techniques of data quality control include cleansing, validation, process and fusion. Access control to a data collection, especially who may modify what data at what time, also may have great impact on data consistency, accuracy and availability.

With the advance of IOT technology, we are finding more ways to monitor the status of a transport system. For example, besides loop and radar on a road side, cameras are now used on traffic monitors. Getting high quality video images from a CCTV camera will dramatically increase the amount (and quality) of data we can get, compared to a standard camera system which may not provide enough information during evening or bad weather situation.

With the growth of connected car technology, it is possible to detect localized weather information by collecting data from connected cars. If the backend monitoring system detects most cars driving in a remote area have their windshield wipers on, it is highly possible there is rain in that area, even when weather forecast center cannot cover that area. This is a good example of how new technology will improve data completeness of traffic operation systems. Similar to this, data collected by sharing car/bicycle service providers may also be used to decipher the demands to first or last mile services, or needs to optimize public transit services to meet needs which may change with the growing economy in an urban area. We need to look into new technologies and business models for ways to improve data quality in this smart mobility era.

The data layer offers a foundation for smarter transportation services. To build and maintain a special data set (GIS) in high quality will also be essential for any meaningful smart transportation systems.
Data System Management

Data system management focuses on the management of a data repository. Most legacy transportation applications use a traditional relational database system as a data repository backbone. This domain has become matured with decades’ development.

With the advance of ICT, we now produce approximately 2.5 exabytes - that’s 2.5 billion gigabytes (GB) - of data every day. More sensors generate data on traffic status much faster than five or ten years ago. Not only do we produce data in numbers or character strings, we also capture images from CCTV or in other formats. How to process, store and retrieve big volume data efficiently, how to store and retrieve data of pictures, files, or what from web, will be typical, big data challenges to the next generation of transportation information systems.

Cloud technology offers answers to many of these questions. Public cloud infrastructure providers, like Amazon or Microsoft, offer quick and easy data storage services. The cost may be also lower than to build a private cloud from scratch. But there are two concerns about using public cloud: 1) how to migrate legacy application data to a public cloud; 2) how to enforce data security, especially for sensitive data. Hybrid cloud architecture makes it possible to build information system on top of both public and private cloud. For example, legacy data and sensitive data will remain on a private cloud, data from new sources or non-sensitive data can be stored on a public cloud.

Data Security Management

Data security management refers to rules and processes to protect digital data from destructive actions and unauthorized access. When an information system stores personal related data, such as name, phone or contact information, car registration and license plate information, etc., privacy protection is also a focus in data security management.

Data protection can be done via two paths: hardware-based and software-based. The hardware-based protection uses control on users log in/out and different sets of privileges to prevent unauthorized person from physically accessing a system. Now some systems use biometric technology to prevent malicious access. Software-based data protection uses data encryption schema to prevent unwanted data disclosure.

As mentioned above, with the advance of technologies and business innovations, there are not only more data being generated in faster pace, but also more (and new) business players involved in transportation domain. Most likely the future transportation information systems will be built to include high volume high speed data in various format which resides on a cloud based distributed system. There are new challenges to data security and privacy management.
Below are the top ten new data security and privacy challenges listed by Cloud Security Alliance:

1. Secure computations in distributed programming frameworks
2. Security best practices for non-relational data stores
3. Secure data storage and transactions logs
4. End-point input validation/filtering
5. Real-time security/compliance monitoring
6. Scalable and compostable privacy-preserving data mining and analytics
7. Cryptographically-enforced access control and secure communication Granular access control
8. Granular audits
9. Data provenance

Data Analysis

Data analysis refers to a process of cleaning, transforming, and modeling data with a goal to detect and understand some situation in the real world, such as highway traffic status and trend prediction, or commute pattern in a region, or transportation demand in new city development area, etc. Without data analysis and modeling, data remains as numbers or records in a storage device, not meaningful information, and we cannot use them in real world transportation operation, or to improve transportation services. All of existing transportation information systems contain various data analysis and modeling components. It is these components that bring business intelligence built within an application to life.

Addressing different subjects or issues of transport will require different sets of data, different algorithms, simulation models or strategies to analyze data. There are commercial transportation analysis tools on the market.

There are two general areas of transportation needs across Virginia State: urban vs rural. In urban areas, like where adjacent to D.C. or the Richmond city area, limited natural resources and growing mobility demands are current challenges. However, urban areas are also better equipped with digital infrastructure and stronger financial capability (compared to rural areas). Cities focus on innovation (both tech and business model) to provide better pub transit services, support first/last mile transport demands, while continuing to improve road traffic safety and efficiency. For rural areas, road traffic safety and efficiency should continue to be the primary focus.

In urban areas, one important trend is the move toward a sharing economy. Businesses like Uber or Airbnb provide new ways for travelers or residents to experience a city. This type of
'sharing-based' business is now highly visible. The data these companies collect in the course of their operation is an important supplement to data collected from traditional transit modes (i.e. taxi, bus, airport, etc.). The shared bicycle has become more popular in metro areas to help address the last/first mile connection. With the development of self-driving vehicles, it has become possible to use a self-driving vehicle instead public transit services, or short-term car rental services.

One of the challenges to city authority is how to collaborate with business sector on use of new data resources. Must we collect all data from its owners for analytics, or can we build some kind of cloud-based analytics platform with contracted connection to private business?

For rural areas, traffic efficiency and safety will still be a focus. As we move into the IOT era, not only does the amount of raw data grow dramatically, but data is being generated at a much faster rate. It becomes possible for transportation operators and participants to know what is happening more accurately and with shorter delay. However, the bad news is that data process and analysis modules in most existing transportation applications were not designed to handle data at such high volume and speed level. Data analysis usually occurs after raw data is processed and stored into a database system. A solution is to use stream technology to move part of the processed data and analytics work into memory before storing the data on the storage system. This will save time writing to, and reading from, a hard disk, therefore allowing applications to generate meaningful information more efficiently.

With the advance of telecommunication technology, the smart phone and other mobile devices have become essential to people’s daily life. The use of mobile devices provides a new way to understand how citizens move around a city or region. Transportation professionals and information engineers have been collaborating on the development of new data models as they analyze mobile device data. One example is a regional government in the Netherlands that pilots a traffic management solution that collects and analyzes data from car and road sensors in near real time, providing authorities with critical information needed to resolve traffic issues quickly. This regional authority in the Netherlands is working with several technology companies to capture and analyze near real-time vehicle and road-sensor information to provide traffic authorities with the information they need to respond to and alleviate traffic problems more quickly. A sophisticated analytics engine monitors and analyzes incoming data to flag traffic events and notify traffic authorities. Commuters equipped with a smartphone app can be alerted to incidents in near-real time, allowing them to find alternate routes around accidents and traffic jams. Near-real-time analysis and early warning about almost any road event is expected to help reduce congestion and improve traffic flow on the region’s roadways.
2.2.3.5. Blockchain

Per a recent blog post by KSM Transport Advisors\(^{80}\), the transportation industry has always been a critical link within the supply chain, and it has a significant role to play as blockchain technology advances. The industry could also reap several benefits, including timely status updates, faster freight payments, and improved cargo security. Additionally, the data generated through blockchain technology could drive greater data analysis, which is valuable in today’s data-driven supply chain.

Blockchain can also help transportation providers mitigate risk and could lead to more contract transparency and a more direct transportation process. Early adopters of the technology are seeing benefits from blockchain’s transparency in reducing fraud for high-value goods such as diamonds and pharmaceutical drugs and to improve safety on sensitive shipments, such as food. There is little doubt that Blockchain has the potential to change the way transportation carriers interact and transact with each other. Support of this enterprise solution, which documents transactions that are important to the safe and efficient moving of freight, is gaining traction, and the number of retailers, manufacturers, and carriers embracing blockchain and its benefits is growing.

Increased demand for security and transparency within the supply chain is driving interest in the ability to have a continually updated, unchangeable ledger of economic transactions on a peer-to-peer network. Blockchain still encompasses the various familiar transactions in the supply chain, but it adds a level of protection as each transaction is validated and recorded on a shared electronic ledger. As a result, one party on the network can modify or delete any record without consensus from the others. This creates a permanent, digital history as products move from the point of origin to the final mile.


Numerous government and private sector alliances and trade groups are now focused on developing platforms to mature key use cases and develop clear proof points. In January 2018, IBM and A.P. Moller-Maersk announced\(^{81}\) the creation of an industry-wide trading platform that can speed up trade and save billions of dollars. The global shipping industry has seen little innovation since the container was invented in the 1950s, and cross-border trade still leaves an enormous trail of paperwork and bureaucracy.

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Success of the platform, which will be made available to the ocean shipping industry around mid-2018, depends on whether Maersk and IBM can convince shippers, freight forwarders, ocean carriers, ports and customs authorities to sign up.

“Customs and port authorities in the United States, Singapore, the Netherlands and China’s Guangdong province have shown interest in using the platform and some other shipping companies are also interested,” said Maersk’s Chief Commercial Officer Vincent Clerc said in an interview. Maersk, which handles one in seven containers shipped globally, sold off its energy business in 2017 to focus entirely on transportation and logistics.

The Commonwealth of Virginia and the Center of Innovative Technology have already announced investment to aid in the commercialization of Blockchain technologies. Much more can be done, in conjunction with key Transportation & Logistics stakeholders to ensure that the Commonwealth remains are the forefront of this capability.

### 2.2.4. Electrification Technologies

With the promise of considerably lower operating costs combined with real positive impacts to the environment, interest in plug-in electric vehicles (PEVs) is growing at a significant rate. With the introduction of fully electric vehicles, as opposed to hybrid electric vehicles that utilize both electricity and gas or diesel, the availability of infrastructure to support a growing fleet of PEVs is under significant growth pressure.

Both EVs and hybrids have been around for more than a century, with the former having been built well back in the 19th Century and the latter invented by Ferdinand Porsche in 1900. The expectations for EVs have been established by over a century of the fossil fuel powered vehicles that then prevailed. The proliferation of fueling stations, the ability to fuel a vehicle in minutes, travel multiple hundreds of miles between fueling stops, supported by a mature petroleum production and distribution network, have set the bar very high in terms of requirements for PEVs.

The availability of charging stations, capacity and charging rate of vehicle batteries, and capacity within the power generation and distribution infrastructure are all opportunities for innovation within the transportation industry. Understanding the impact of PEVs on both the communities and the infrastructure will help smart communities adapt.

#### 2.2.4.1. Vehicle-oriented Electrification

According to Bloomberg, after taking more than 20 years to sell the first million EVs, the second million were sold in only 18 months, and the next million in less than one year. Momentum is growing in the passenger EV space.
However, as stated earlier, fossil fuel burning vehicles have set the standard for expectations of EVs. While there is optimism for reaching a level of service for passenger vehicles and light-duty trucks, there are still considerable technical hurdles to overcome in order to meet the sustained power storage and infrastructure required by medium and heavy duty commercial vehicles.

To do this, innovations will be required for infrastructure as well as batteries and storage that will be discussed in later sections of this paper. However, there are enablers available now to support the growth of PEVs in Virginia.

Policy support: With PEVs being a relative small percentage of the active vehicles on the road, public policy support will be critical to fostering growth. Public policy can create incentives for adoption that can take multiple formats, from helping consumers reduce purchase and operating costs through rebates, tax incentives, toll exemptions and preferred parking, to providing manufacturers and researchers with favorable tax and regulatory environments to accelerate technical innovation and reduce manufacturing risks and costs.

Internationally, more drastic policies such as bans on the sale of fossil fuel cars and vans by 2040 in France and the U.K, or 2030 in India are driving significant innovation, in those countries, and Virginia is poised to benefit from the pace of such innovations.

2.2.4.2. Infrastructure-oriented Electrification

When considering the demands of PEVs on the electrical infrastructure, the prevailing thought is that large scale electrical generation and distribution infrastructure is not the primary obstacle to growth. The challenges and opportunities for our power infrastructure generally focus on the local grid.

One of the ‘facts-of-life’ associated with PEVs are the natural spikes in electricity demand for charging. These spikes happen generally early in the work day (8-11am) for commercial / work-place charging stations, and in the early evening (6-9pm) for residential charging. The local power infrastructure is not designed to meet the level demand required when multiple PEVs are attempting to charge simultaneously.

There are several techniques to managing this, all involving building intelligence into a smart energy infrastructure. One method is called “valley filling”, where PEVs are scheduled to charge during non-peak demand times, and PEV owners are incented with less costly charging rates during these off-peak times. This pricing strategy of higher cost during high demand, and lower cost for low demand is called dynamic pricing. Valley filling is often the first step in a broader energy management solution called managed charging or intelligent charging. Managed charging involves communication to the vehicle, or to the vehicle via
the charging station, to inform the PEV owner of the best time and, when paired with
dynamic pricing, least cost to charge. This extends the concept of valley filling by, for
example, incenting charging during times of high renewable energy production, such as
mid-day for solar power.

There is an emerging technology that further supports the local power grid called vehicle
to grid (V2G), where a PEV can discharge power back to the grid during peak demand times,
and charge during off-peak demand times. This capability adds stability to the local power
grid, by “flattening” the spikes and filling a much needed gap in local power storage. There
are also potential opportunities for PEV owners. With dynamic energy pricing in place, a
PEV owner can provide power to the grid when demand is high (i.e. PEV owner is paid by
the utility a higher price) and requesting power when demand is low (i.e. PEV owner pays a
lower price) yields a net cost reduction in to the PEV owner.

Intrinsic to all of these solutions are the integration of a smart technologies within the grid,
our vehicles, and the chargers in our homes, offices and communities.

2.2.4.3. Battery, Storage & Charging Technologies

The single largest expense in a PEV is the battery. The battery is also place where there are
the largest opportunities for innovation. These opportunities are can be broken down into
the following categories:

- **Charge capacity or Energy Density**: Energy density of a battery is measured in the
  number of watt-hours per kilogram of weight (W-hr./kg). In real terms for the
  consumers, this translates into the potential mileage of a PEV. A higher W-hr./kg rating
  will generally allow more miles to be driven on a single charge. The most promising
  battery technology that is poised to enter large scale production are lithium-ion
  (lithium) batteries. Lithium batteries offer a balance of cost and energy density. How
can a PEV compete against internal combustion engines (ICE) in terms of energy
density?

- **Charging rate**: This is indicated by the amount of time required to charge the battery.
  This is typically dictated by the charging environment. In the home, level 1 and level 2
  chargers are used. Level 1 chargers use a standard AC outlet and can take up to 30 hours
to fully charge a car. Level 2 chargers are professionally installed 240 volt outlets,
similar to what might be required by large appliances, and can lower charge times to
around 5-6 hours. Commercial charging stations can offer what is called fast chargers.
These offer about 5x the charging rate of the level 2 chargers, and can charge up to 80%
capacity in about 30mins. Can PEV “refueling” times be lowered to a point comparable
to their fossil fuel burning counterparts?
• **Price:** The standard by which PEV batteries are measured for price is cost per kilowatt-hour ($/kWh). According to McKinsey, with increased research focused in this area, and increases in economies of scale, lithium batteries costs have been continuously dropping from a high of around $1000/kWh in 2010 to $227/kWh in 2016, with Tesla claiming their current costs are $190/kWh. This is an area of substantial opportunity, with multiple analysts forecasting the magic number to drive significant growth being a sub $100/kWh battery, and that this goal is attainable within the next several years. Can both the purchase and operating cost of PEVs be brought down the levels comparable to ICE vehicles?

• **Service life:** Over the course of their service life a battery will go through many charge/discharge cycles, and with the current battery technologies, as the number of charge/discharge cycles increase, the capacity of the battery will diminish. Most manufacturers offer a warranty on their battery, but only commit to some percentage of capacity over the warranty period. For example, Nissan warrantees their Leaf battery for eight years and 70% of original capacity. As batteries are the most expensive single component of a PEV, what can be done to extend their service life, or lower the cost impact of replacement?

• **Safety:** Understanding what happens to a battery in the event of an accident or a failure. While lithium batteries are the most promising power source from the perspective of energy density, cost, and near-term mass production, lithium ion batteries have an issue with excessive heat in the event of a failure. A failing lithium cell will generate significant heat, which in turn can cause neighboring cells to fail. The heat generated can cause flammable materials near the cells to catch fire. Examples have been captured on a small scale with electric scooters, and on a large scale on Boeing 787 auxiliary power units. While there is significant fire hazard from an accident in an ICE vehicle, what can be done to lessen the potential risks to passengers in a PEV accident?

• **Recycling:** With an expected service life of 8-10 years and explosive growth in the usage of PEVs, there will be a significant and growing need to determine what happens to PEV batteries at the end of their service life. Because of the complexity of the chemical processes and the variety being deployed by manufacturers, standards for recycling of Lithium ion batteries are significantly more complex than that of older technologies such as lead-acid batteries. Significant research is being conducted in order to address this issue and with several years before the necessity of a solution becomes pressing, analysts are confident the issue will be addressed in time. What can be done in advance by a smart community to prepare for these deployed batteries to minimize potentially harmful environmental impacts?
Charging Stations: Two of the biggest concerns from consumers with regard to PEVs are related to charging stations. The primary concern is the availability of locations, followed closely by the time required to charge. Often cited is the ability to make a trip beyond the distance capable of being made under a single charge. Will there be a charging station nearby when my battery is running low? How long will it take to get a reasonable charge? Technology is beginning to address both the range and charging time issues. While still not comparable to ICE vehicles, the gap is closing with higher energy density batteries and fast-charging stations being continuously deployed. A significant issue in the past is beginning to be addressed in the form of standards for charging plugs. With the integration of the SAE J1772 plug standard by many of the major PEV manufacturers, anxiety about pulling up to a charging station and not having a plug that will fit your car is lowering.

The charging technology innovation that is common for cellphones, and has potential for serving the PEV industry, is called induction charging. Induction charging allows a PEV to park on top of an induction pad, and the induction coil’s magnetic field can charge the car with no cables or plugs. Building parking places with induction charging pads is not a trivial expense, and the major technical drawbacks of induction charging are the charging speed and efficiency.

2.2.5. Infrastructure Components

2.2.5.1. High Speed Rail, Maglev & Hyperloop

High Speed Rail (HSR) systems allow trains to travel on a new, dedicated guideway with speeds in excess of 160 mph or on existing lines with speeds in excess of 120 mph. Due to the high speeds, the new lines are usually grade separated with large turning radii and are typically powered by overhead electric lines. Often there are challenges upgrading existing network to carry higher speed trains due to infrastructure required and many lines are therefore new construction. High speed rail lines are often used for passenger service, but can also be used for freight trains.

The Acela Express and the Northeast Regional (reaching 150 mph 125 mph respectively on a relatively short section of track between Baltimore and Philadelphia run along the Northeast Corridor from Washington, DC to Boston) are currently the only nominally high-speed lines in the USA, that lags far beyond HSR systems in Europe and Asia, some dating from as far back as 1964, that routinely operate above 200 mph for extended distances.

The California High Speed Rail was approved in 2008 to provide service between LA and San Francisco. Construction of the first phase began in 2015 and is planned to partially open in 2025 with the complete first phase open in 2029. The system is designed for passenger rail with speeds up to 220 mph. Additional expansion is in the planning stage. The systems is
designed on a new, dedicated, grade separated guideway using steel wheel on steel rail construction and will be electric powered.

The Southeast High Speed Rail (SEHSR) is a proposed system running from Washington, DC to Florida. This includes the Richmond to Raleigh segment and the Washington, DC to Richmond segment which are both in the environmental review and preliminary engineering stages. This corridor is envisaged to be a shared passenger and freight rail system and is not planned to be electrified. Some of the alignment is planned to be along existing rail lines which include some at grade rail crossings and speeds will be limited. Virginia does not allow the creation of new at-grade rail crossings and therefore newly constructed segments will be grade separated. Top speeds along the alignment will be up to 110mph and the travel time between Richmond and Raleigh will be cut in half from 4 hours to 2 hours.

**Maglev** (Magnetic levitation) uses electromagnets located in the train guideway to levitate the train and to produce propulsion. Maglev cannot operate on conventional rail tracks and requires a dedicated guideway. Due to the lack of friction between the train and the tracks, better acceleration, deceleration and speeds are possible and noise is reduced. The cost of construction is high, but due to the simpler construction, operation and maintenance costs can be lower than High Speed Rail. Energy consumption can also be lower than conventional rail. However, due to the prohibitively high cost of construction, currently the only operating systems are in China, Japan and South Korea, which operate at speeds similar to High Speed Rail; however, Maglev test tracks have exceeded 375 mph.

**Northeast Maglev** (TNEM) is an American company, working closely with the Central Japan Railway Company (JR Central) to bring the revolutionary superconducting maglev technology to the Northeast Corridor, the most congested transportation region in the country. They are leading a proposal to build a 39.8-mile (64.1 km) maglev train system between Baltimore, MD and Washington DC. It is the first segment of the planned Washington-New York Northeast Maglev project.

This proposal is based on Section 1218 of the "Transportation Equity Act for the 21st Century" created a National Magnetic Levitation Transportation Technology Deployment Program. The program is administered by the Federal Railroad Administration (FRA), a unit of the U.S. Department of Transportation. The objective of the program is to demonstrate high-speed maglev technology in commercial service through a project of about 40 miles in length, so that it can be considered later in the century for implementation in a longer distance intercity corridor application. Section 1218 envisioned $1 billion in federal funding for a single demonstration system. FRA selected seven projects for further study in May 1999, and they received $55 million in further funding to develop their proposals. Of these seven, Baltimore-Washington and Pittsburgh advanced to next stage as semi-finalists in
April 2001. Over the last few years, energy has been renewed for the Baltimore - Washington D.C. project, when Maryland Governor Larry Hogan visited Japan to ride an advanced prototype maglev train which traveled at 311 miles per hour (500 kph) and some $28 million of U.S. funding was tapped to study the project.

In 1999, Old Dominion University in Norfolk VA agreed to work with American Maglev of Atlanta to construct an on-campus student transportation link of less than one mile - using a smart train / dumb track design in which most sensors, magnets, and computation were located on the train rather than the track. While projected to cost less to build per mile than existing systems, the ODU maglev was never operational. After far exceeding its projected $14 million budget, a groundbreaking was held in 2001, the project was completed in 2002; and the technology failed: the vehicle lost its "float" and came to a full friction stop on top of the rail, damaging much of the system. American Maglev and ODU dissolved their relationship and the project became an internal university research project. In October 2006, the research team performed an unscheduled test of the car that went smoothly. In February 2009, the team retested the sled and was successful despite power outages on campus. ODU subsequently partnered with a Massachusetts-based company to test another maglev train. MagneMotion Inc.\(^2\) was expected to bring its prototype maglev vehicle, about the size of a van, to the campus to test in 2010. MagneMotion was subsequently bought by Rockwell Automation and this project was discontinued.

The concept for Hyperloop was developed by SpaceX and Tesla and involves travel in pods in a sealed low-pressure tube to reduce air resistance. The pods would levitate, similar to Maglev technology, but the magnets are located on the pods and not on the guideway. Passenger comfort would dictate maximum acceleration and deceleration. Virgin Hyperloop One is a California based company currently developing Hyperloop technology with the goal of having a system in place by 2021. They estimate speeds in excess of 670 mph.

Hyperloop technology involves pods carrying passengers through a tube at high speeds topping over 700 mph. Similar to a pneumatic tube, Hyperloop proposes the propulsion of the pod by magnetic acceleration through a low-pressure environment, cushioning the pod through high speeds. Due to the pressure buildup in the front of the pod due to air displacement, the pod would also house an air compressor in the front to channel and move the air to the rear. Elon Musk, the author of the white paper that outlines the concept, also suggests the entire system could be powered by solar panels atop the tube structure. The design of Hyperloop allows it to be most economical for moderate distances. At distances less than 900 miles, aircrafts become less feasible as most of the time is spent ascending and descending. Here is where the Hyperloop concept shines, with proposed routes from Toronto to Montreal, Chicago to Toronto, New York to Boston, Orlando to

Miami, Seattle to San Francisco and many more. Since the publication of the white paper, several companies have been founded to pursue the Hyperloop concept including Virgin Hyperloop One, Hyperloop Transportation Technologies, TransPod, and others.

Value of High Speed Rail, Maglev & Hyperloop for Virginia
Developing high speed rail, including Maglev and Hyperloop variations, is becoming a priority for many US States due to the increasing price of aviation fuel as well as increasingly congested freeways and increased demand for intercity mobility. High speed rail also offers a safer, more efficient mode of travel producing less greenhouse gases than other modes. There are many advantages to implementing high speed rail.

- As roadway congestion continues to increase, providing good alternative modes becomes more important to maintain connectivity. The connectivity provided by high speed rail will help Virginia to continue to grow and be economically competitive.
- High speed rail fosters economic development by encouraging high density transit oriented development (TOD) near stations.
- High speed rail provides fast, convenient, comfortable, reliable travel with fast boarding times, no lost baggage, with direct downtown to downtown connections.
- Travel by high speed rail means increased productivity for business travelers who can work while travelling, have more room, can use laptops and cell phones.
- Most passenger trains in Virginia operate at speeds less than 50mph and none are authorized to operate at speeds greater than 79mph and therefore new infrastructure is required to accommodate high speed rail in Virginia.
- The same trains that travel at 125mph north of Washington D.C. pass through Virginia, but at much lower speeds. Investing in high speed rail would mean that Virginia could take better advantage of these already high speed routes.
- It is estimated that high speed rail in Virginia will increase passenger train service by 85%, reliability by 20% and reduce travel time by 25%.
- Passenger rail travelers would have saved 793,900 hours of travel time if high speed passenger rail existed in Virginia.

2.2.5.2. Smart Rail & Transit

The digitalization of rail has quickened possibilities, new entrants to the market are not respecting traditional timelines and operators are beginning to enjoy these shortened time-scales. Start-ups are shaking-up what has been considered an at times conservative industry, while larger companies are adapting and consolidating in response. If they don’t, they risk going out of business.
Industrial Internet of Things (IIoT) has been one of the main driving technologies behind innovations in Smart Rail, including improved cargo management and autonomous vehicles. Rail has employed IIoT for a while, though trains operating at such high speeds through tunnels and extreme weather conditions have presented challenges when it comes to deploying IIoT systems. Fortunately, advances in networking have made smart trains a reality.

Legacy infrastructure is gradually being replaced by train management systems in which trains become interconnected communication hubs, transmitting data among themselves and to network control centers and receiving instructions from control centers. Machine-to-machine communication, with some help from the cloud, enables operators to use equipment, tracks and stations more efficiently while dramatically reducing safety risks.

Safety is, of course, a primary element of IoT applications and solutions when it comes to train management. One safety use case is on-board train location and detection systems that enable trains to be “aware” of the positions of other trains. This reduces the risk of collisions while allowing trains to operate safely in close proximity to one another. Speed monitoring and control is another important safety application. Systems have been developed that can display train velocity for drivers and report speeds back to central control systems. On-board monitoring systems are interconnected with outdoor signaling systems that can regulate train speeds, or even remotely command trains to stop based on track conditions, the positions of switches, the presence of other trains on the track and other factors.

Umberto Malesci, CEO of Fluidmesh Networks, wrote in a LinkedIn post that there are three major systems within railroads that will significantly benefit from automation and the IoT: signaling, interlocking and level crossings control.

Signaling systems control the movement of a train by remotely adjusting train speed and braking. More traditional signaling systems are based on radio-frequency identification along the train track, but wireless train to ground signaling is becoming more common in both railroad and metro systems, according to Malesci. He said most of the new European high-speed railroads are equipped with European Train Control System level 2, a signaling standard that requires constant radio communication between the train and the group.

Interlocking avoids conflicting movements on the tracks at junctions and crossings by using red and green light signals. The interlocking system works in conjunction with the signaling system to prevent a train from getting a signal to proceed if the route is proven to be unsafe.

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The IoT can further improve the system’s level of automation and its integration with the signaling system.

Level crossings control is the third system that impacts safety on railroads. According to the European Railway Agency, 619 accidents occurred at level crossings in 2010, causing 359 fatalities in the European Union that year; 2009 stats show 831 level crossings-related accidents caused 405 fatalities that year. Accidents related to level crossings represent 30% of all railway fatalities in the EU. IoT can help decrease those statistics by deploying cameras and sensors for increased safety.

According to a recent report by Cisco\(^85\), almost $30 billion will be spent in the next 15 years on IoT projects in the railway industry. While the Rail industry has accomplished a lot with Asset Management, Predictive Maintenance, and IoT related technologies, there are still tremendous opportunities for regional transit, rail companies, and industrial rail operations across the Commonwealth to advance to Smart Rail, using new operational, engineering and information technology advancements.

### 2.2.5.3. Smart Ports

As the only port facility on the East Coast currently able to handle the supersize Panamax ships now able to travel through the Panama Canal (with others requiring significant dredging and/or bridge replacement or raising) as well as the value of the intermodal Inland Port in Front Royal, the value of Smart Ports is exceptionally high in Virginia.

According to Port Technology International, there are many definitions to the word ‘smart’ in the context of the global port and terminal network. Some industry experts believe that being smart relates more to the mind-set of a given port or terminal, where policy decisions and smart use of resources takes precedence over technology and innovations.

The effectiveness of the smart port environment may lie in the technology and smart practices’ ability to be able to work together to effectively share information, both for the benefit of ports and for its customers. A recent Technical Paper from Miguel Montesinos of Pro Develop recently articulated how information sharing is a must when citizens and business partners require information to reinforce a relation with a particular port, as was the case at the Port of Cartegena\(^86\).

The Port of Hamburg has implemented into its operational DNA a ‘smartPORT’ logistics strategy. Jens Meier, CEO of the Port of Hamburg Authority, recently explained how the aim of this strategy\(^87\) was to allow the Port of Hamburg to develop intelligent solutions for traffic

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\(^{86}\) [https://www.porttechnology.org/technical_papers/smartport_port_information_in_your_hand](https://www.porttechnology.org/technical_papers/smartport_port_information_in_your_hand)

\(^{87}\) [https://www.porttechnology.org/technical_papers/the_port_of_hamburg_smartport](https://www.porttechnology.org/technical_papers/the_port_of_hamburg_smartport)
and trade flows in order to optimize the flow of information and efficiently manage trade flows at the port. “In the end, there is more than one tool needed to achieve the goal in becoming a smart port. In order to optimize traffic flows and the flow of goods, we introduced a cloud-based information and communications platform called SPL (smartPORT logistics).

“More efficient traffic management is made possible by interlinking the information and communication systems. This is how we keep the current traffic situation in the entire port area under control and are able to plan proactively.”

In the end, the most important KPIs in the operations of Ports and Terminals remain the same as before: the actual TEU throughput, the CHE utilization rate, turnaround time, time spent in a truck (by the driver) and kilometers driven by the truck. Smart Ports remain focused in using the latest thinking and innovations to drive these KPIs lower.

Another major discussion in Port Operations is around the automation of container terminals. Currently there are about thirty container terminals globally that are referred to as “automated terminals”. In these terminals, the degree of automation ranges from unmanned yard cranes to unmanned horizontal transportation, and both. The majority of the roughly 2,000 container terminals are however running with manned equipment. While the TraPac Terminal at Port of Los Angeles and the Middle Harbor Terminal in Long Beach are held up as leaders in this space in the US, there are a number of semi-automated terminals, including at the Port of Virginia.

Finally, in the space of long-term planning and economic development, Ports are also now getting more into closed-loop planning and 30-year optimization and development Master Plans. Understanding and incorporating new developments and technologies fundamentally change with the use cases of Ports a decade or more into the future. Planning for these changes is becoming very central to many Port leaders in the world, and remains a key aspect for the Commonwealth to consider.

2.2.5.4. Smart Airports

Per a recent study by strategyr.com, the global market for Smart Airports in terms of annual spending is projected to exceed $19 billion by 2024, driven by surging passenger traffic, growing investments in airport modernization, and increasing investments in disruptive technologies that help improve the efficiency and effectiveness of airport operations. Growing airport competition and the resulting need to alleviate passenger experience through connected, intelligent, digitized, and personalized solutions are the key drivers of growth. Future growth in the market will also be driven by escalating interest in

88 http://www.strategyr.com/MarketResearch/Smart_Airports_Intelligent_Airports_Market_Trends.asp
automation technologies to ease the burden on airport infrastructure and the workforce. The rising demand for smart technologies will enable real-time information sharing and collaboration. Smart airport solutions being adopted by airports around the world can range from smart gates, beacon technology, mobile devices to navigate the airports and face recognition systems, to air traffic management, baggage and check in management, IP-based security monitoring, communications, ticketing, and information systems, freight operations information systems, air traffic management and airways analytics.

The four key challenges facing airports today are all driving their push to become smarter. These challenges are:

1. Growth: The need to find new paths to increased revenue, combined with the need to plan to accommodate ever increasing passenger and goods, as well as aircraft
2. Experience: The increasing demand to provide consistent value-add passenger and business experience, adding new capabilities and services, increasing airport and aerotropolis attractiveness, delivering a true transportation hub capability; and becoming an economic driver for the local community
3. Efficiency: Continually improving operational efficiency with increased integration and stakeholder engagement

With many airports evolving into 21st century commuter stations⁸⁹, they now go beyond their basic function of getting passengers from point A to point B, looking to provide a very positive first impression of the city they serve while offering customers new experiences as they transit through. Singapore’s Changi Airport, for example, with its rooftop swimming pool, orchid and sunflower garden and free 24-hour cinema is one airport working hard to make a good impression and, in doing so, are a part of a trend where airports are not a source of stress, but rather an extension of the entire holiday experience. The consumer-aviation website Skytrax has published its latest annual World Airport Awards and for the fifth consecutive year, Singapore Changi International Airport took home the crown as the world’s best airport.

Unsurprisingly, there are no US airports in the 2017 Top 15 airports listing by Skytrax. While Washington Dulles International Airport (IAD) does appear in the Top 10 airports in the country, as assessed by Time Magazine⁹⁰, we still have a ways to go to incorporate the latest Smart Airport innovations.

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2.2.5.5. Sustainable Infrastructure / Structural Health Monitoring

Per CRC Research, infrastructure is the set of structural elements that supports the day-to-day function, and influences the direction of human society. Sustainable infrastructure refers to the designing, building, and operating of these structural elements in ways that do not diminish the social, economic and ecological processes required to maintain human equity, diversity, and the functionality of natural systems.

Infrastructure is critical to sustainable community development, our future well-being and the day-to-day lives of individual citizens. The infrastructure we are building today will shape tomorrow’s communities.

In 2002, the Town of Mont-Saint-Hilaire, Canada, put in motion the development of a multi-functional suburb\textsuperscript{91} focused around a new heavy-rail commuter station providing service to downtown Montreal. Called \textit{Village de la Gare}\textsuperscript{92}, the village uses transit-oriented principles to put in place high-density development that:

1. provides 1,000 residential units within walking distance to the station to be built over ten years, of which 400 are already constructed;
2. reduces the need for automotive transport in favour of walking and bicycle paths;
3. creates a multi-functional district - residential, commercial and institutional - within close proximity of the commuter station;
4. allocates approximately a 14 per cent of the overall site to green space, including retention of natural characteristics such as stands of trees and interesting vistas; and,
5. provides easy “walk-to” station commuting to Montreal. All residential units are within 750 metres of the station.

Beginning in 2002, the development, which will be phased in over ten years requires modifications to the town plan of Mont-Saint-Hilaire especially with respect to the distribution of zoning density and location, and will feature “old fashioned” building designs to better blend with the older sectors of the town and the rural nature of the surrounding area. The new commuter station is an extension of an existing heavy-rail commuter line to the south of Montreal, and was put in as an integral part of the development. Data to date suggest a significant drop in automotive usage, and a 30 to 40 per cent increase in the value of condominiums located near the commuter station. Design of the development has single family houses near the periphery of the community with a gradual transition from high to low density moving from the commuter station to the already existing community. Key to the development was a conscious effort to put together a win-win situation to support Mont-Saint-Hilaire as an environmentally sustainable and

\textsuperscript{91} www.ville.mont-saint-hilaire.qc.ca
\textsuperscript{92} www.levillagedelagare.com
scenic community, to increase commuter traffic, and to provide reasonable returns to developers.

Another holistic concept is the Toronto New Mobility HUB project, that aims to fill in gaps with a network of hubs across Toronto, which conveniently link multiple modes of sustainable transportation. The Exhibition Place New Mobility HUB is the first site of the project, located where GO Train service between downtown and the suburbs and three local Toronto transit lines converge. Launched in April 2006 by the partnership Moving the Economy (MTE), this hub added short and long-term bicycle storage, a BikeShare station, Autoshare car sharing, a taxi hotline, wireless hotspot, and bicycle and transit route maps.

In Canada’s 13 largest cities, over 75% of transportation-related greenhouse gas emissions are due to personal transportation, and 97% of this is from private automobiles (National Round Table on the Environment and the Economy, 1998). Since 80% of buildings standing today were built in the last 50 years (Kunstler, 1993) when the private automobile became the dominant mode of transportation in developed countries, only a few areas of some cities were designed in a way that facilitates transit, cycling, and walking for utilitarian transportation. Invariably, municipal and regional transit systems have problem areas with infrequent service, long distances between the nearest service and peoples’ destinations, municipal boundaries requiring a second fare payment, lack of schedule and route information, or uncomfortable waiting areas. The goal of the New Mobility HUB project is to close these gaps and lower barriers to sustainable transportation by making it simple and convenient to combine regional transit, municipal transit, cycling, taxi, and shared cars in a single trip.

The final piece of this puzzle is Structural Health Monitoring (SHM)93. Qualitative and non-continuous methods have long been used to evaluate structures for their capacity to serve their intended purpose. Since the beginning of the 19th century, railroad wheel-tappers have used the sound of a hammer striking the train wheel to evaluate if damage was present. In rotating machinery, vibration monitoring has been used for decades as a performance evaluation technique. Applying this concept to heavy civil infrastructure ranging from bridges, roads to tunnels have not been common. Non-destructive testing, visual inspections and periodic manual assessments are traditionally favored. But, given the recent advancements in sensing, data gathering, reliability of analytics, and improved statistical modeling, we are entering a new era of being able to deploy Continuous SHM solutions to usher in a new era of managing the maintenance effectiveness, increasing the life, and lowering the lifetime costs of civil infrastructure. One well know use case is the the Wind and Structural Health Monitoring System (WASHMS) is a sophisticated bridge monitoring system, costing US$1.3 million, used by the Hong Kong Highways Department to ensure road user comfort and safety of the Tsing Ma, Ting Kau,

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93 https://en.wikipedia.org/wiki/Structural_health_monitoring
Kap Shui Mun and Stonecutters bridges. The sensory system consists of approximately 900 sensors and their relevant interfacing units. With more than 350 sensors on the Tsing Ma bridge, 350 on Ting Kau and 200 on Kap Shui Mun, the structural behaviour of the bridges is measured 24 hours a day, seven days a week. The sensors include accelerometers, strain gauges, displacement transducers, level sensing stations, anemometers, temperature sensors and dynamic weight-in-motion sensors. They measure everything from tarmac temperature and strains in structural members to wind speed and the deflection and rotation of the kilometres of cables and any movement of the bridge decks and towers. These sensors are the early warning system for the bridges, providing the essential information that help the Highways Department to accurately monitor the general health conditions of the bridges. While the focus is primarily on external effects affecting bridge performance, new techniques are now being tested worldwide on internal stresses, durability, and wear on the structure itself.

2.2.6. Strategic Tends
2.2.6.1. Mobility as a Service (MaaS)

The critical development, in response to the changes cited previously, is the concept of Mobility-as-a-Service (MaaS) which began in Europe and has now spread worldwide. The key premise of MaaS is seamless access to as many different modes as possible, from journey planning, to electronic / mobile payments and fare media, to both real time and predictive information enroute. A key element of MaaS involves the collection, sharing, and analysis of “big data” through the Internet of Things (IoT) including maintaining appropriate security and protection of privacy across the entire operational and value chain.

Automakers (aka vehicle original equipment manufacturers or “OEMs”) are already responding to this shift and by and large have accepted and begun to act on the transition to MaaS. This is reflected through partnerships including Ford and Lyft and, very recently, GM and Uber. Moreover, OEMs themselves are diversifying their own MaaS businesses including car sharing enterprises launched by GM (Maven), BMW (ReachNow) and Daimler (Car2Go).

Daimler has also ventured into the journey planning arena with the acquisition of mode-agnostic journey planning with the creation of Moovel Group (formerly US-founded Ridescout) and a consortium Daimler, BMW and Audi have acquired mapping company HERE. New technologies are also helping municipalities evaluate potential demand for microtransit.

Noting the situation with TNCs and transit ridership cited in the previous section, a new area of focus for both government and industry is microtransit, also called on-demand
transit (ODT) or Jitney service which represents something of a hybrid between taxi-like services and conventional fixed route / schedule mass transit. Here again OEMs are key early deployers of these types of services including Daimler’s Via and Ford’s Chariot.

Increased use of public-private partnerships (PPP or P3), especially in the US where it has not been common except in Virginia, is also a key consideration. While toll roads have been a favorite target for P3 for some years in the Commonwealth and elsewhere, state and local governments are also beginning to consider other mobility projects. Los Angeles Metro, the third largest US transit agency, has just announced a P3 project focused on microtransit and is currently soliciting interested partners. Kentucky has also just announced the Commonwealth Infrastructure Fund in partnership with its largest banks.

2.2.6.2. Mobility & Behavior Change

Fundamentally the attitude and approach of the traveling public, driven by increasingly connected younger generations, is shifting perceptibly from the idea of vehicles being products that consumers purchase and retain for many years to the idea that mobility is a much more fluid concept, with each trip essentially researched, negotiated, and ideally procured in real time based on immediate conditions (weather, traveling companions, price, comfort, time, whether the person will be buying or carrying anything, etc.).

Correspondingly, rather than being loyal to any one mode always cycling, walking, driving, using taxi / TNC services or taking transit -mobility customers want access to multiple modes. Rather than individual “tickets” based on timetables trips, using one or more modes will become part of a seamless journey planned door-to-door in real time.

As a result, car ownership is on the decline, with many Virginia high school students not opting to get drivers' licenses as soon as they turn 16 and the majority of undergraduate and even graduate students not owning cars. Even when entering the workforce, many young professionals eschew vehicle ownership and even take pride in being “car free.”

Transit usage will also have to change as a result of customer demands, with Philadelphia’s SEPTA agency reporting in July that transportation network companies (e.g. TNC, Uber, Lyft) were already impacting ridership. A number of transit properties are undertaking new ways to engage and communicate with riders with some success, particularly Seattle King County Metro which is increasing transit ridership against national trends.
2.2.6.3. First Mile / Last Mile

Per David King’s excellent synopsis on this issue, the First Mile / Last Mile problem is drawn originally from the telecommunications sector, and then in supply chain management (goods movement). For telecommunications, First Mile / Last Mile is the final leg (or first leg) to the consumer. With physical infrastructure, it is expensive to match high capacity hubs to individual units. In the 1970s and 1980s, as cable TV was being deployed across the US, cable companies had to individually wire each and every household. This was a tremendous but necessary cost, and the cable companies were able to amortize the expenses over many years. Rarely did an individual household pay the full cost of running cable, instead paying a small installation fee and their monthly subscription.

The First Mile / Last Mile issue was then was used by logistics companies (FedEx, UPS, etc.) to describe their end point deliveries from centralized warehouses. These trips are complex chains to optimize, and ultimately the goal is to lower the cost as much as possible to lower the overall cost of shipping a parcel from Point A to any other Point. For both telecommunications and logistics, the First Mile / Last Mile issue has had large literatures of public and private research.

In recent years, the First Mile / Last Mile issue has been used to also describe passenger travel in the context of getting to / from bus and rail stops. While there are some similarities between telecommunications, goods movement and passenger travel, First Mile / Last Mile for transit isn’t well understood.

For addressing the First Mile / Last Mile issue for transportation and transit, there is very limited research on what defines success, and there are lots of private firms now competing for scarce public dollars to subsidize favored technologies and modes. There are many transit agencies and cities starting to look to Uber, Lyft, Juno, etc. to provide short trips to and from transit stops (mostly rail from what I can tell). These shared rode / taxi trips might be subsidized and will hopefully enhance existing transit service. Beyond these pilots, here are some issues to be considered:

- **Elasticity of demand with regard to fares**: Transit ridership is sensitive to fares. As fares go up, demand for transit goes down. For many reasons, it has not been possible to isolate a reliable point estimate of elasticity, but -0.3 is typical (i.e. a 1% increase in fares reduces demand by 0.3%). Will people pay additional taxi fares, even if subsidized, to take transit they are paying a separate fare for?

- **Disutility of transfers**: We know that transit riders prefer to avoid transfers when possible, but many are willing to use one transfer. Transfers have to be easy, and with long headways (up to 20 minutes), it is not clear that transfers between First Mile / Last

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94 https://transportist.org/2016/10/06/what-do-we-know-about-the-first-mile-last-mile-problem-for-transit/
Mile can be reliable enough to encourage use. Getting to the station is one problem. Waiting at the station is another.

Overall, the First Mile / Last Mile is a plausible idea with substantial pilot projects in place. But the long-term benefits and implications are unclear. The Commonwealth will have to evaluate specific pilot projects in terms of value (or ‘bang for the buck’), not just to address core economics as they relate to transit ridership, or public transport in general, but also to address broader socio-economic, public health, and jobs related public policy.

### 2.2.6.4. Transportation, Land Development & Sustainable Growth

In the 1950s, urban transportation studies in Detroit, Chicago, and Philadelphia recognized the connection between land use and transportation. This period coincided with the commercialization of large-scale computers, and transportation planning was one of the first applications. The first widely used set of computerized transportation models for forecasting travel on the basis of land use inputs was developed for the Federal Highway Administration in the 1960s, followed by some of the pioneering land use models. After a long gap in federal funding, the new Transportation Model Improvement Program is developing the next generation of models based on an entirely new approach to evaluating travel. The Transportation Research Board\(^\text{95}\) has led a number of studies assessing the correlation between Transportation and Land Development. Some of the key issues to be considered include:

a. Role of ‘Transit First’ Policies  
b. Transit-Oriented Development  
c. Transportation Access to Greenfield & Brownfield Development  
d. Multimodal Corridor Preservation Planning  
e. Impact of Pricing on Land Use  
f. Parking Development and Land Use  
g. Urban Development Models  
h. Transportation and Place Making  
i. Smart Growth Policies

### 2.2.6.5. Adaptation for Climate Change

It is a well-known fact that the Transportation Sector is one of the key sources of Green House Gases (GHGs). Reducing GHGs, especially CO2 emissions, has become a key priority for governments and private stakeholders all across the Transportation Sector. Transportation produces roughly 23% of the global CO2 emissions from fuel combustion.

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More alarmingly, transportation is the fastest growing consumer of fossil fuels and the fastest growing source of CO2 emissions. Besides being affected by climate changes, transportation systems also contribute to changes in the climate through emissions. In 2010, the U.S. transportation sector accounted for 27% of total U.S. greenhouse gas emissions, with cars and trucks accounting for 65% of that total. Petroleum accounts for 93% of the nation’s transportation energy use. This means that policies and behavioral changes aimed at reducing greenhouse gas emissions will have significant implications for the various components of the transportation sector.

Climate trends affect the design of transport infrastructure, which is expensive and designed for long life (typically 50 to 100 years). The estimated value of U.S. transportation facilities in 2010 was $4.1 trillion. As climatic conditions shift, portions of this infrastructure will increasingly be subject to climatic stresses that will reduce the reliability and capacity of transportation systems. Transportation systems are also vulnerable to interruptions in fuel and electricity supply, as well as communications disruptions which are also subject to climatic stresses. For example, power outages resulting from Hurricane Katrina shut down three major petroleum pipelines for two days, and the systems operated at reduced capacities for two weeks. Climate change will affect transportation systems directly, through infrastructure damage, and indirectly through changes in trade flows, agriculture, energy use, and settlement patterns. If, for instance, corn cultivation shifts northward in response to rising temperatures, U.S. agricultural products may flow to markets from different origins by different routes. If policy measures and technological changes reduce greenhouse gas emissions by affecting fuel types, there will likely be significant impacts on the transportation of energy supplies (such as pipelines and coal trains) and on the cost of transportation to freight and passenger users.

Per a recent report by the World Bank, trips are distributed across the range of available modes (referred to as the modal split), depending on the competitiveness of the alternatives for any given trip maker. Every motorized trip emits GHG emissions and the amount of emission depends largely on the amount and GHG intensity of the fuel used, or the efficiency of the vehicle fleet and the energy intensity of the fuel used. Finally, driver behavior impacts the fuel use; after certain threshold speeds, fuel consumption becomes significantly higher.

While this complex and distributed nature in which GHG emissions are generated makes transport a particularly hard sector in which to dramatically reduce emissions, there are several strategy options to reduce the carbon foot-print of the transport sector:

• Changing the distribution of activities in space: If a city can influence the distribution of activities in space (for example, by changing land-use patterns, densities, and urban design) for any given level of economic activity, it can have an impact on the total level of transport activity. Better land-use planning and compact city development can lead to fewer or shorter motorized trips and a larger share for public transport of motorized trips.

• Supporting low-carbon transport modes: A city can also influence the way transport activity is realized in terms of choice of modes.

Adaptation strategies\(^\text{98}\) can be employed to reduce the impact of climate change related events and the resulting consequences. Consideration of adaptation strategies in the transportation sector is especially important in the following five areas:

• **Transportation and land-use planning:** Deciding what infrastructure to build and where to build it, as well as planning for vulnerable areas of the community and impacts on specific population groups.

• **Vulnerability and risk assessment:** Identifying existing vulnerable facilities and systems, together with the expected consequences.

• **New infrastructure design:** Adapting new infrastructure designs that anticipate changing environmental and operational conditions.

• **Asset management:** Adapting existing infrastructure and operations that respond to current and anticipated conditions, including changed maintenance practices and retrofits.

• **Emergency response:** Anticipating expected disruptions from extreme weather events, and developing emergency response capability.

Adaptation takes place at multiple levels, from individual households and private businesses to federal, state, and local governments. The impacts associated with climate change are not new, since flooding, storm surge, and extreme heat have long been challenges. What is new is the changing frequency, intensity, and location/geography of impacts and hazards.

### 2.2.6.6. Smart Logistics & Goods Movement

Goods movement is a term used to describe the way goods are transported by truck, train, ship, and plane. Not only is goods movement vital to the health of the economy, it impacts the health of its citizens. And one of the most important criteria for successful implementation of goods movement and logistics projects is active participation by cities and municipalities. This is true even though private companies (e.g. logistics companies, industrial companies, etc.) implement many urban logistics projects. Governments can

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facilitate implementation of these projects by creating appropriate conditions and support\textsuperscript{99}.

Over the years, the entire field of supply chain management, which includes logistics, has changed and emerged as the function that can make or break an organization’s economic survival, including the government’s. While people generally visualize the movement of goods by airplanes and trucks when they think of logistics, the reality is that logistics affects all aspects of the supply chain. Everything from the management of multi-modal transportation networks, inventories, packaging, and billing is impacted by efficient and successful logistics planning.

2.2.7. Delivery Models & Best Practices in Governance

2.2.7.1. Project developers, investor-sponsors, and interested stakeholders

Launching big transportation projects and programs is combination of art and science, but more science is deserved than is typically applied to large transportation projects and programs in North America. In their famous 2013 report “Infrastructure Productivity: How to Save a Trillion Dollars”\textsuperscript{100}, McKinsey identified the numerous ways, at all stages of project conception and delivery, savings are to be had. Projects often cost in the order of billions of dollars and yet project optimization work done at the very front end that costs hundreds of thousands of dollars, sometimes millions, can yield improvements in benefits resulted of a hundred percent. In “Upping the Value”\textsuperscript{101}, it is explained how many projects could achieve improvements in a hundred percent or more in benefits on a billion dollar project would yield a billion dollars in benefits! In the transportation space, these kinds of possible gains are quite realistic. The key is setting up projects so that the right kind of investigations and decisions take place so that these benefits are realized.

At the very early stage of project development, while state and local authorities are often the source for project ideas and plans, they should not be the only source. Similar to successful start-up ecosystems, infrastructure projects should be ideally sourced from a diverse and creative base of competing ideas and freely flowing knowledge. It sounds simple but in the world of infrastructure it can be a very difficult thing to actually realize.

Once a project has been ideated, setting up governance and controls that constantly pressure all project participants to maximize value is critical and very important. The United Kingdom (among other leading jurisdictions) have developed practices known as project sponsorship that clearly define roles and interests of various parties involved in

\textsuperscript{99} \url{http://www.businessofgovernment.org/blog/strategies-font-color-redcut-costsfont-and-improve-performance-smart-logistics-intro-cutting-c-0}
\textsuperscript{100} \url{https://www.mckinsey.com/industries/capital-projects-and-infrastructure/our-insights/infrastructure-productivity}
\textsuperscript{101} \url{https://www.hatch.com/en/About-Us/Publications/Blogs/2017/04/Big-projects-upping-value}
projects, in the interest of driving best-possible outcomes. The investing parties (often governments) assign sponsors to track and ensure projects are doing as they were intended to do (or better). Delivery agents are responsible for delivery, and are held accountable by sponsors. Essentially buyers (investors) holding sellers (delivery agents such as constructors and operators) accountable by assigning agents acting on the buyer’s behalf (sponsors).

Martin Buck’s paper102 outlining the various elements of the Elizabeth Line is an excellent resource indicating how a large project should be considered, overseen and sponsored.

Outside input from stakeholders - often seen as time consuming and unproductive - can make projects better. Typically, the authority for this input comes through political means and can lead to highly inefficient and sometimes very problematic outcomes. For example, despite a lot of very good transit projects being built in Toronto, a one stop subway extension costing $3 billion has been advanced for purely political reasons and the result is a loss of trust by the public and decision-makers across the spectrum of leadership in the region.

The goal is to engage with stakeholders in ways that are productive and can add value to the project. Good examples are property owners alongside a rail project, or special interest groups who can be adversaries or champions for a project. Good project governance which balances input, realizes good sponsorship and delivery, and ultimately leads to great outcomes is required.

2.2.7.2. Application of P3 Models

The application of P3 models has become a predictable and appreciated practice in many jurisdictions ranging from Australia, the UK, Canada, and increasingly now, some parts of the United States including Virginia. There are different approaches to P3s but essentially, they are contracting models for bringing together complex projects and ensuring a private partner (or consortia of partners) delivers.

The key is to make the analysis and consideration of application of P3 a standard part of any project development. While a P3 approach may be determined not to be desirable, a P3 approach must be considered before P3 delivery is discarded. For a light rail, metro, regional rail, or other project, procurement models that bundle and transfer more delivery innovation and risk to a private sector partner should be looked at. The upside is greater schedule and budget certainty, and higher quality. P3s are not silver bullets however – they

take work and the right expertise. Differing jurisdictions have developed their own models of public-private partnerships and the field continues to evolve and develop slightly adjusted models of P3 applicable and customized to different types of projects. This customization represents innovation, and often to good result.

Bringing in more alternative sources of finance can bring about different ideas and better align incentives to bring about creative solutions that lead to project optimization. The Canadian Infrastructure Bank, for example, is potentially setting up for a “first loss” investment that will enable more projects to be brought forward through unsolicited proposals. This should “crowd in” private sector investment. The Canadian Infrastructure Bank is in its infancy and it remains to be seen how the experiment will work but the theory is certainly attractive. Advisor Michael Lindsay wrote about thoughts on the Canadian Infrastructure Bank. 103

Another area where highly customized public private partnerships are appropriate is in the development of transit oriented development and development integrated with transit stations. By mixing interests of transportation agencies, several very good outcomes can be realized.

2.3. Evaluation & Prioritization (Process Used, Summary Results)

The workgroup conducted online surveys, conference calls and in-person meetings, with a select group of knowledgeable Smart Transportation leaders, local and regional Transportation thought leaders, and Commonwealth transportation leaders. The selection criteria for prioritization included (1) concrete benefits for the Commonwealth, (2) proven technologies that can be deployed now, (3) fundamental change agents, and (4) path to economic development and jobs for the Commonwealth.

The workgroup also aligned their prioritization to align to the goals and visions outlined in the Commonwealth of Virginia Office of Intermodal Planning and Investment’s VTrans 2040 Report104.

• **Goal A** – Economic Competitiveness and Prosperity: Invest in a transportation system that supports a robust, diverse, and competitive economy.
  o **Problems to Address:**
    • Vehicle miles traveled in severe congestion
    • Number and severity of freight bottlenecks
    • System reliability on key corridors for all modes

• **Goal B** – Accessible and Connected Places: Increase the opportunities for people and businesses to efficiently access jobs, services, activity centers, and distribution hubs.
  o **Problems to Address:**
    ▪ Average peak-period travel times in metropolitan areas
    ▪ Combined housing and transportation costs for Virginians.

• **Goal C** – Safety for All Users: provide a safe transportation system for passengers and goods on all travel modes.
  o **Problems to Address:**
    ▪ Motorized fatalities and severe injuries.
    ▪ Non-motorized fatalities and severe injuries.

• **Goal D** – Proactive System Management: maintain the transportation system in good condition and leverage technology to optimize existing and new infrastructure.
  o **Problems to Address:**
    ▪ Bridge condition
    ▪ Pavement condition
    ▪ Transit vehicles condition

• **Goal E** – Healthy and Sustainable Communities: Support a variety of community types promoting local economies and healthy multi-modal lifestyles that minimize vehicle travel, while preserving agricultural, natural, historic and cultural resources
  o **Problems to Address:**
    ▪ Per capita vehicle miles traveled
    ▪ Transportation related NOX, VOC, PM and CO emissions

2.4. Prioritized Domains

Based on the deliberations, the following four areas have been prioritized for investment and focus for the Commonwealth:

I. First Mile & Last Mile - Connected / Autonomous Vehicles

From enabling access to jobs and improving public health, to creating value in each of the four regions in the Commonwealth, to driving economic prosperity, and to engaging local communities and businesses, finding solutions for the First Mile / Last Mile problem is going to be key for the Commonwealth. The Workgroup combined connected / autonomous vehicle offerings here, to position this set of innovations as a key potential solution to tackle this gap.

There are numerous pilot projects across the world, including here in the Commonwealth, that touch upon various aspects of these issues. The workgroup recommends ideation sessions with all relevant stakeholders and key subject matter experts to develop a comprehensive mapping of technologies, Commonwealth's needs, ecosystem and market conditions. A subsequent prioritization will help development of a concrete short-term and long-term investment and policy action plans.
II. Security – Vehicle Connectivity, IOT & IIOT

The power to transform transportation system usage is data, so its integrity is vital. Therefore, it stands to reason that security is an essential element in any connected transportation technology adopted. It is no simple feat; however, to secure reliable data transmission between all the vehicles, infrastructure, devices, sensors and networks that underlie and will power the Smart Transportation Infrastructure of the future. Security encompasses what in common terms is called Cyber Security, but in reality extends to everything – hardware and software – that forms the connectivity tissue of the framework that produces, ingests, normalizes, analyzes, and presents data for decision support in the Transportation Sector.

Securing this framework is of paramount importance, and the Worgroup has placed special focus on this area. It is recommended that a Transportation Task Force be formed with active collaboration under the Center for Innovative Technology, working with parallel initiatives such as Mach 37, Smart City Works, NIST/DHS, and the Smart Cities Council to develop a common framework of engagement.

III. Smart & Sustainable Infrastructure Solutions

Every four years, the American Society of Civil Engineers’ Report Card for America’s Infrastructure depicts the condition and performance of American infrastructure in the familiar form of a school report card—assigning letter grades based on the physical condition and needed investments for improvement. Per the latest assessment by ASCE (2015), Virginia’s infrastructure is aging and affects the quality of life and safety of its citizens, as well as its economic well-being.

Using publicly available data, the Virginia Section of the American Society of Civil Engineers (ASCE) graded the condition of the state’s infrastructure assets, identifying the need for critical improvements and funding. Grades were assigned in 13 primary category based on the reported condition of existing assets, expected service life, current functionality and level of service, future growth needs, and anticipated level of funding required to maintain Virginia’s infrastructure.

While significant traditional investment is required to upgrade the Commonwealth’s infrastructure, various intermediate steps can be taken to extend the life and usage of existing infrastructure. The workgroup recommends developing a comprehensive plan to catalog critical key transportation infrastructure across the Commonwealth, both those under direct Commonwealth control, as well as those maintained by Port, Airport, Intermodal, Transit and other Federal Authorities, and Private Enterprises including Rail Companies, and P3s, and create a platform for bringing in monitoring, optimization, modeling and predictive capabilities.

IV. Data Management & Governance

105 https://www.infrastructurereportcard.org/
The common thread for becoming ‘Smarter’ in Transportation is data. The world’s most valuable resource is no longer oil, but data. As devices from watches to cars connect to the internet, the volume is increasing: some estimate that a self-driving car will generate 100 gigabytes per second. Meanwhile, artificial-intelligence (AI) techniques such as machine learning extract more value from data. Algorithms can predict when a customer is ready to buy, a jet-engine needs servicing or a person is at risk of a disease. Industrial giants such as IBM, GE and Siemens now sell themselves as data firms.

This abundance of data changes the nature of competition, planning, operations and decision making. While data management and governance issues have been part of policy discussions and standards creation since the advent of computerized systems, the recent massive changes in what is now termed as ‘big data’ is necessitating a radical re-think. Working groups and inter-operability teams from International Organizations such as ISO, UIC; Federal entities such as NICT, USDOT, FHWA; Regional and State agencies, including those in the Commonwealth; and from transportation industry organizations such as ITSA, APTO and all working on these issues.

The recommendation is for a formal engagement mechanism that brings together the relevant Commonwealth’s departments and other related transportation entities with Virginia private enterprises to drive, the development and subsequent piloting and deployment of data governance standards in all aspects for future Smart Transportation projects. This is especially important, as there will not be one set of standards that will prevail, but a series of innovations that will force a constant re-imagining as we move forward. The Commonwealth must be able to invest in the right areas to foster growth, while being able to future-proof as best as possible.

2.5. Recommendations

Establishing Smart Transportation plans into the fabric for sustainable growth for the Commonwealth of Virginia, will require concrete actions that are visible, measurable, action oriented, community-driven, and sustained over time. New approaches, materials, and technologies to ensure our transportation infrastructure is more resilient – to more quickly recover from significant weather and other hazard events – and sustainable – improving the “triple bottom line” with clear economic, social, and environmental benefits are needed.

Basing our thought process with the guiding principles of (1) Authenticity vs Flash, (2) Benefit to the Community, (3) Future-Proofable, (4) Clear Economic Impact, (5) Sustainability, and (5) Executability, the Transportation Workgroup recommends the following actions:

1. Create a Smart Transportation Coordinating Body that works under Commonwealth’s direction and is empowered to drive actions in the four prioritized transportation domains. This cross-
organization body will closely engage with key stakeholders in state, federal and local government, and key private enterprises, community groups and NGOs, to enhance engagement and project execution.

2. Develop a series of Innovation Mechanisms (including grants, pilots, maker spaces, research lab engagement, start-up hubs, technology vehicles, investment packages, and P3 platforms) to foster a creativity environment across the four regional zones in the Commonwealth.

3. Establish a Commonwealth-wide Community Engagement Program for Smart Transportation that is set up with a sustainable mechanism (with digital and physical platforms) with key Commonwealth Education, Civic and NGO entities to bring in collaborative, sustained participation from various community groups, for them to formally be part of the decision making process on investment, job creation, and sustainability issues in their communities.

4. Create a Operating Leadership Council under the Commonwealth, potentially under DOT, to focus on key policy & procurement opportunities to increase effectiveness, streamline the project permitting process across transportation infrastructure sectors, with safeguards to protect the natural environment, to provide greater clarity to regulatory requirements, bring priority projects to reality more quickly, and secure cost savings. This Council should:
   a. Authorize programs to improve specific categories of deficient transportation infrastructure and support that commitment by fully funding them in an expedient, prioritized manner.
   b. Identify a pipeline of transportation infrastructure projects attractive to private sector investment and public-private partnership.
   c. Improve land use planning at the local level to consider the function of existing and new infrastructure, the balance between the built and natural environments, and population trends in communities of all sizes, now and into the future.
   d. Create incentives for local governments, regional transportation and transit agencies, and the private sector to invest in maintenance, and to improve the efficiency and performance of existing transportation infrastructure.
   e. Help develop tools to ensure that projects most in need of investment and maintenance are prioritized, to leverage limited funding wisely.

Smart investment will only be possible with leadership, planning, and a clear vision for our nation’s infrastructure. Leaders from all levels of government, business, labor, and nonprofit organizations must come together to ensure all investments are spent wisely, prioritizing projects with critical benefits to the economy, public safety, and quality of life, while also planning for the costs of building, operating, and maintaining the infrastructure for its entire lifespan.

2.6. Areas for Future Work

2.6.1. Capacity Building

Capacity building to deliver a 21st century transportation system is a significant component of any state-wide effort and will require efforts and collaboration from a number of obvious and not-so obvious sectors: state and local public officials and agencies, but also private sector
partners and academia, not-for-profits, business, and community groups. The business of building a new system is big business – the best corporate minds and leadership are critical to this endeavor because there is planning, investing, and implementation and delivery decisions to get right. Much can go wrong and should enough go wrong, entire programs can be derailed.

It also important to remember that not only traditional and obvious sectors will need to undergo capacity building. Other industries related to beneficiaries and impacted by new transportation system development also need to be involved. This includes property development, and whatever the major employment sectors are who will benefit from improved transportation (usually office-intensive industries, which in Virginia may be government contractors, defense, etc.)

Toronto, a city-region that has grown by 100,000 people every year for decades and now boasts approximately 7 million people, was admired and praised for its public transport system as a result of an intensive planning and build cycle that lasted through the 1950s, 1960s and into the 70s. Then the city didn’t plan or build much of anything for approximately 30 years: the “City that works” was no longer, as regional governance didn’t exist or work, the transportation system was overcrowded and insufficient, and development growth patterns had been allowed to spread out in inefficient, land consumptive, and car-commuting intensive ways. Starting with a planning framework developed in the second half of the first decade of this century, with one of the largest infrastructure build programs underway anywhere, Toronto will start realizing the benefits of significant investments early next decade.

London, UK, is another case study: largely a backwater of transportation system investment negligence by the 1980s and early 1990s, London has refurbished its tube and bus system, realized immense growth, and has delivered significant new projects like Jubilee line, the Docklands Light Rail network, Crossrail, Thameslink, and Overground projects, all linked by an integrated fare system. The bus and cycle networks have even received extensive updates. It took an intensive and long process to bring together the business community, multiple levels of government, and other stakeholders to build institutions and effort of capability – resulting in legacy projects and systems that have helped support London’s re-ascendance as a leading global city-region.

2.6.2. Public Education & Engagement

Recently, WAYMO joined with the National Safety Council, the Foundation for Senior Living, Mothers Against Drunk Driving, the Foundation for Blind Children and the East Valley Partnership to create a dialogue around public acceptance of new transportation technologies. The issue of educating the public about connected and autonomous vehicles, vehicle to infrastructure communications and new mobility options such as mobility on demand and mobility as a service has been gaining steam especially as these new forms of transportation
and the concept of smart cities/communities merge although these discussions and debates go back a number of years.

According to a recent study by ABI Research, smart cities and the technological and societal changes that come with them should be driven at the state and local level. Citizens not only need to understand the technologies, how they operate and what they can mean for them in their daily lives, but how the societal impacts that will come from widespread adoption of those technologies.

These efforts can take many forms including:

- Educational efforts for students from K - college and community and technical schools in the area of smart communities and new transportation models
  
  a. Begin training early and make computer programming available as early as elementary school
  b. Work with technical training schools to begin offering classes on the different technologies being used in vehicles
  c. Offer free adult education classes
  d. Work with universities to start a Cyber Security Track Degree Programs.

- Seek research dollars and grants for Virginia’s educational institutions to provide studies in all of the associated initiatives
- Conduct community outreach efforts and both identify and bring together stakeholders
- Work to redefine the workforce needed to advance smart communities, new transportation modes and associated disciplines as well as retrain the existing workforce for new opportunities
  
  a. What is the anticipated impact of the proposed technology on the existing workforce, bus drivers, taxi drivers, truck drivers, mechanics, technicians and others?
  b. What are the new jobs that are expected to be created as a result of the proposed technology?
  c. What IT positions will be needed?
  d. There will be a need for technicians that are experienced and know how to properly test, calibrate, and repair sensitive sensors in the field and on vehicles
  e. Cybersecurity and privacy professionals will be needed
  f. What are the social and economic implications of new technologies to the workforce?

- What new funding sources will be needed as more connected, autonomous and electric vehicles come onto the roads which will continue to put downward pressure on revenues coming from gas taxes, parking fees and moving violations?
- Transportation departments, as an integral part of the smart communities’ ecosystem, will need appropriate funding and continuing educational initiatives to buy, maintain and manage increasingly complex technologies.
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Appendix H
ESTABLISHING AN EXECUTIVE WORK GROUP TO ADVANCE SMART COMMUNITIES IN VIRGINIA

Importance of the Initiative

Technology is rapidly changing many aspects of our everyday lives. The development of “smart” cities and communities presents an opportunity for the Commonwealth to work with federal, state, and local efforts to implement innovative policies to build the New Virginia Economy, spurring continued economic development in high-growth industry sectors, enhancing citizen services, and attracting capital investment. Leveraging on the extensive work done by the Commonwealth to establish a leadership position in innovation, cyber, autonomous systems, healthcare, public safety, and transportation, Virginia is well positioned to align these assets to support the development of “smart” cities and communities.

Therefore, I am directing the Secretary of Technology to convene a work group to develop a strategy to position Virginia as a leader in Smart Communities. The strategy shall include but not be limited to best practices, processes, technologies, and policies to enable communities of all types in accessing networking and information technologies and services that underpin the development of Smart Communities. The work group shall renew the National Institute of Standards and Technology Global City Teams Challenge SuperClusters, including issues of:

- City Platform/Dashboard
- Data governance and exchange
- Energy, Water, Waste Management
- Healthcare
- Public Safety
- Public WiFi/Broadband
- Transportation
Establishment of the Executive Leadership Team

I hereby direct the establishment of an Executive Work Group to develop a strategy to equip Virginia communities with the support, tools, and resources they need to become Smart Communities in the Commonwealth of Virginia. This work group shall be led by the Secretary of Technology. In addition, the work group shall be comprised of designated leadership from the following entities:

- Secretary of Transportation
- Secretary of Public Safety and Homeland Security
- Secretary of Commerce and Trade
- Secretary of Health and Human Resources
- The Center for Innovative Technology
- Other private and non-profit sector organizations as determined by the Secretary of Technology

Key Objectives

The work group shall formulate a strategy that leverages existing assets and programs to enhance collaboration across functional areas to:

- Develop a replicable model for Virginia Smart Communities
- Identify partners and resources
- Align smart systems and devices from diverse sectors such as transportation, energy, manufacturing, and healthcare—in fundamentally new ways to enable communities to improve services, promote economic growth, and enhance the quality of life
- Establish Virginia as a global leader for the development of "smart communities"

The work group shall make an initial report of its findings and recommendations to the Governor by October 15, 2017.

Staffing

Staff assistance for the work group shall be provided by the Center for Innovative Technology.

Effective Date

This Executive Directive shall be effective upon its signing and shall remain in force and effect unless amended or rescinded by further executive order or directive.
Given under my hand and under the Seal of the Commonwealth of Virginia, this 2nd day of August, 2017.

__________________________________
Terence R. McAuliffe, Governor

Attest:

__________________________________
Kelly Thomasson, Secretary of the Commonwealth
Appendix B
VASC Working Group Leads and Contributors

The Working Group is led by Esther Lee, Secretary of Commerce and Trade, Commonwealth of Virginia.

The Working Group is supported by the following individuals at the Business-Higher Education Forum (BHEF) and the Center for Innovative Technology (CIT).

- Janet Chen, Director, BHEF
- Debbie Hughes, Vice President of Higher Education and Workforce, BHEF
- David Ihrie, Chief Technology Officer, CIT
- Caroline Luxhoj, Broadband Program Administrator, CIT

Many people contributed to the overall idea generation and discussion for this report, and there was extensive interaction and exchange of ideas among the Working Group’s various Committees. In addition to these overall contributions, each Committee would like to recognize the following individuals who made additional substantive contributions to the overall report.

The Working Group’s Committees include the following leads and contributors.

1. City Platform/Dashboard & Data Governance
   Lead: David Ihrie, Chief Technology Officer, CIT
   Contributors:
   - Sam Ansari, President & CEO, Accure
   - Hardik Bhatt, Leader, Smart Cities and Mobility Verticals, Amazon Web Services
   - Arlyn Burgess, Associate Director for Operations and Strategic Initiatives, University of Virginia
   - Chase Cunningham, Chief Technology Officer & Co-Founder, CynjaTech
   - Emma Dockery, Vice President, Abernathy Industrial, Inc.
   - Don DuRousseau, Director, Research Technology Services, George Washington University
   - Alan Ford, Director, Government Systems Pre-Sales, Teradata, Inc.
   - James Hayes, Vice President, Global Government Affairs, Tenable
   - Josh Levi, Vice President of Policy, Northern Virginia Technology Council
   - Moe Nikbakhshian, Director, Enterprise Risk Management and Big Data Initiatives, George Washington University
   - Kevin Pomfret, Partner, Williams Mullen
   - Jeffrey Reed, Willis G. Worcester Professor, Bradley Department of Electrical and Computer Engineering, Virginia Tech
   - Sokwoo Rhee, Associate Director of the Cyber-Physical Systems Innovation, National Institute of Standards and Technology
   - Nancy Ross, Internet of Things Line of Business Leader, The MITRE Corporation
   - Carter Schoenberg, President & CEO, Hemisphere Cyber Risk Management, LLC
   - Albert Seubers, Director Global Strategy IT in Cities, Atos
Robert Stolle, Senior Vice President, Operations, CIT
Chris Sullivan, Sales Director, State Government & Civilian Federal Accounts, Teradata, Inc.
Cindy Wiley, Government Solutions, Teradata, Inc.
Keith Wine, Director, State & Local, Public Sector, Grant Thornton

2. Energy, Water, and Waste Management
Lead: Julie Manzari, Energy Technology Strategy Consultant, Dominion Energy, Inc.
Contributors:
- Jonathan Goodall, Associate Professor, University of Virginia, School of Engineering & Applied Science
- Kyle Spencer, Deputy Resilience Officer, The City of Norfolk
- Marcus Quigley, Chief Executive Officer, OptiRTC, Inc.
- Debbie Manzari, Program Manager - Streamsweper, The Center for Natural Capital
- David Koogler, Vice President of Member Services & External Affairs, Rappahannock Electric Cooperative
- Bimal Sareen, Co-Founder, CyberForce LLC
- Jennifer B. Sebastian, Regulatory Consultant Principal, Appalachian Power
- Kumud Lata, IT Systems Architect, Dominion Energy, Inc.
- Tom Simchak, Senior Policy Analyst, Environment, Energy & Transportation Division, National Governors Association
- Kathleen Staples, Power Delivery Renewable Energy Program Manager, Dominion Energy, Inc.
- Sam Musa, Adjunct Associate Professor, University of Maryland University College

3. Healthcare, Public Health, and Human Services
Lead: Margie Zuk, Senior Principal Cybersecurity Engineer, The MITRE Corporation
Contributors:
- Don DuRousseau, Director, Research Technology Services, George Washington University Virginia Science and Technology Campus
- Megan Frisk, AAS Science & Technology Policy Fellow
- Keith Crandall, Director, Professor of Biology, George Washington University School of Medicine and Biological Sciences
- Adelaide O’Brien, Research Director, Governmental Digital Transformation Strategies, IDC Government Insights
- Penny Chase, Senior Principal Scientist, The MITRE Corporation

4. Public Safety
Lead: Jon Selby, Director, Commonwealth of Virginia

5. Public Wireless/Broadband
Leads: Jeffrey Reed, Willis G. Worcester Professor, Bradley Department of Electrical and Computer Engineering, Virginia Tech; Caroline Luxhoj, Broadband Program Administrator, CIT
Contributors:
- Yvonne Harris, Vice Provost for Research and Scholarship, James Madison University
- Steve Koenig, Senior Director of Market Research, Consumer Technology Association
- Jennifer Taylor, Vice President, U.S. Jobs, Consumer Technology Association
- Debbie Bryan, Associate City Attorney, Virginia Beach City Attorney's Office
- Tho Nguyen, Managing Director & Senior Research Program Officer, University of Virginia
6. Transportation

Lead: George Thomas, Founder, New Urban Informatics & Global Director, Smart Infrastructure, Hatch Ltd.

Contributors:
- Rob Cary, Chief Deputy Commissioner, Virginia Department of Transportation
- David Pickeral Advisor, NextGen Mobility, P3 & Smart Cities
- Gregory Sauter, Founder, Smart City Works
- Katherine Gronberg, Vice President, Government Affairs, ForeScout Technologies
- Keith Wine, Director, Global Public Sector, Grant Thornton LLP
- Laura Fu, Principal, New Urban Informatics
- Lisa Nisenson, Lead, New Mobility Group at Alta Planning + Design & Co-Founder, GreaterPlaces
- Michael Sutherland, Director, Urban Systems, Hatch Ltd.
- Mike Mollenhauer, Director, Center for Technology Deployment at Virginia Polytechnic Institute
- Regina Hopper, Senior Vice President, Global Public Policy, GRIDSMA RT Technologies
- Rick Dwyer, Deputy Executive Director, Hampton Roads Military and Federal Facilities Alliance

The Working Group’s Policy Committee includes the following individuals.

- Hardik Bhatt, Leader, Smart Cities and Mobility Verticals, Amazon Web Services
- Timothy Blute, Director, NGA Future, National Governors Association
- Jeffrey Booth, Department of Homeland Security Science & Technology First Responders Group, Director of the Information, Applications and Standards Division
- Alison Brooks, Research Director, Smart Cities Public Safety Strategies, IDC Government Insights
- Vardahn Chaudhry, Digital Cities Consultant, Accenture
- Ruthbea Clarke, Research Director, Smart Cities Strategies, IDC Government Insights
- Christine Early, Senior Account Executive – Mid Atlantic US, IDC Government Insights
- David Forscey, Policy Analyst, Homeland Security & Public Safety Division, National Governors Association
- Megan Frisk, American Association for the Advancement of Science (AAAS) Science & Technology Policy Fellow
- Sue Gander, Division Director, Environment, Energy & Transportation Division, National Governors Association
- Erwin Gianchandani, Deputy Assistant Director, Directorate for Computer and Information Science and Engineering, National Science Foundation
- David Heyman, Founder, Smart City Works
- Ryan Locicero, AAAS Science and Technology Policy Fellow, National Science Foundation
• Rafi Martina, Senior Policy Advisor, Office of Senator Mark Warner
• Michelle Noch, Program Manager, U.S. Department of Transportation
• Adelaide O’Brien, Research Director, Government Digital Transformation Strategies, IDC Government Insights
• Ryan O'Toole, Director of Market Development, 1776
• Jeffrey Reed, Willis G. Worcester Professor, Bradley Department of Electrical and Computer Engineering, Virginia Tech
• Sokwoo Rhee, Associate Director of the Cyber-Physical Systems Innovation, National Institute of Standards and Technology
• Rana Sen, Managing Director, Deloitte Consulting
• Egan Smith, Managing Director of the Intelligent Transportation Systems Joint Program Office, U.S. Department of Transportation
• Mark Zannoni, Research Director, Smart Cities & Transportation, IDC Government Insights
Appendix C
VASC Working Group Kick-Off Meeting Agenda

Monday, September 18, 2017
Virginia Tech Executive Research Center
900 North Glebe Road
Arlington, VA 22203

12:00 PM Networking Lunch
12:20 PM Work Group Introductions
12:40 PM Welcome and Framing of the Work Group
   - Karen Jackson, Secretary of Technology, Commonwealth of Virginia
1:00 PM Defining the Federal Smart Communities Landscape
   Agency leads present priorities, investments, and plans for the future around smart communities
   - Jeffrey Booth, Department of Homeland Security Science & Technology First Responders Group,
     Director of the Information, Applications and Standards Division
   - Erwin Gianchandani, Ph.D., Deputy Assistant Director, Directorate for Computer and Information
     Science and Engineering, National Science Foundation
   - Sokwoo Rhee, Ph.D., Associate Director of the Cyber-Physical Systems Program, National Institute of
     Standards and Technology
   - Egan Smith, Managing Director of the Intelligent Transportation Systems Joint Program Office, U.S.
     Department of Transportation
2:15 PM Breakout into Committees
   The Work Group will break into subgroups for a focused discussion on the topic that best aligns with their area
   of expertise.
   1. City Platform/Dashboard & Data Governance
      Lead: David Ihrie, CIT
   2. Energy, Water, and Waste Management
      Lead: Julie Manzari, Dominion Energy
   3. Healthcare
      Lead: Margie Zuk, MITRE
   4. Public Safety
      Lead: Jon Selby, Commonwealth of Virginia
   5. Public Wireless/Broadband
      Lead: Jeff Reed, Virginia Tech
   6. Transportation
      Lead: George Thomas, New Urban Informatics
3:15 PM DHS-Virginia R&D Announcement
   - The Honorable Terry McAuliffe, Governor, Commonwealth of Virginia
   - Mr. William Bryan, Under Secretary for Science and Technology, Department of Homeland Security
3:45 PM Committee Report Outs – five minutes per group on key takeaways from discussion
4:15 PM Next Steps
   - Karen Jackson, Secretary of Technology, Commonwealth of Virginia
4:30 PM Meeting Adjourns
Appendix D
Virginia Smart Communities Working Group
In August 2017, Governor Terry McAuliffe signed Executive Directive Number 13 directing the Secretary of Technology to establish an executive work group that would develop best practices, policies, processes, and technologies to equip Virginia’s communities with the resources, support, and tools to become smart communities.

The key objectives of the work group would be to develop a strategy that builds on Virginia’s existing assets and programs to:

- Align smart systems and devices from diverse sectors in fundamentally new ways to enable communities to improve services, promote economic growth, and enhance the quality of life;
- Develop a replicable model for Virginia Smart Communities;
- Identify partners and resources; and
- Establish Virginia as a global leader for development of smart communities.

With support from the Business-Higher Education Forum (BHEF) and the Center for Innovative Technology (CIT), the Governor’s Virginia Smart Communities Working Group will convene public and private sector experts to develop a strategy and propose recommendations for ways that Virginia can align, engage, and invest around smart communities across the state and establish itself as a global leader in smart communities.

To kick-off the working group, this meeting will break the group into six Committees that align with the National Institute of Standards and Technology Global City Teams Challenge SuperClusters. SuperClusters are multi-city, multi-stakeholder collaborations organized around common project objectives and shared solutions and that produce blueprints/playbooks to be used by cities and communities around the world as the foundation to build their own smart city strategies. The six Committees will address issues including:

1. **City Platform/Dashboard & Data Governance.** These two SuperClusters seek to discover the common set of things all cities measure and understand how to standardize that list, so that all cities can apply the data to address their unique challenges regardless of the size, governance or location of the municipality. They also aim to address the challenge of building a standard governance and exchange model for IoT data and a plan for governments to successfully customize and deploy it. (Blueprint)
2. **Energy, Water, and Waste Management.** This SuperCluster’s purpose is to address leading sustainability issues in cities for Energy, Water and Waste by bringing cities and counties together in the United States and around the world with academia and technology partners to demonstrate real world-class examples and best practices. ([Blueprint](#))

3. **Healthcare.** This SuperCluster is still in development. Its purpose is to address the use of the latest mobile and digital technologies to make advances in healthcare systems while also driving the growth of intelligent and connected medical devices.

4. **Public Safety.** This SuperCluster is a public-private partnership to identify technologies, processes and strategies to enhance public safety and resilience within smart connected communities, and improve the preparedness, response and recovery of modern society from the complex challenges, hazards and risks that threaten local and regional stability. ([Blueprint](#))

5. **Public Wireless/Broadband.** This SuperCluster is focused on the development of best practices for the deployment of high-speed, public wireless systems. ([Blueprint](#))

6. **Transportation.** This SuperCluster was formed and is managed by forward looking municipalities interested in preparing their infrastructure for new technologies that look set to provide better, more equitable services at lower cost. ([Blueprint](#))

**Smart Cities Initiative**

The Smart Cities Initiative, launched in 2015, is an emerging community of civic leaders, data scientists, technologists, and companies joining forces to build “Smart Cities” – communities that are building an infrastructure to continuously improve the collection, aggregation, and use of data to improve the life of their residents – by harnessing the growing data revolution, low-cost sensors, and research collaborations, and doing so securely to protect safety and privacy.

Through the Smart Cities Initiative, over $160 million in federal research support is being invested with more than 25 new technology collaborations to help local communities tackle key challenges such as reducing traffic congestion, fighting crime, fostering economic growth, managing the effects of a changing climate, and improving the delivery of city services. The National Science Foundation (NSF), National Institute of Standards and Technology (NIST), Environmental Protection Agency (EPA), and the Departments of Homeland Security (DHS), Transportation (DOT), Energy (DOE), and Commerce (DOC) have committed $35 million in new grants (e.g., scaling next-generation Internet applications and cyber-physical systems), over $50 million in new investments, and $70 million in new spending in support of building a research infrastructure and unlocking new solutions in safety, energy, climate preparedness, transportation, health, and more related to smart cities and communities. As part of this investment:

- NIST has taken a leadership role in developing performance standards and measurement tools, with the goal of fostering innovation that is developed, deployed, and evaluated to create standards-based Smart City technologies.
- The Networking and Information Technology Research and Development (NITRD) Program release of a framework to help coordinate Federal agency investments and outside collaborations will guide foundational research and accelerate the transition into scalable and replicable Smart City approaches.
- DHS is investing more than $50 million over five years focused on emergency response technologies.
- DOT has provided over $40 million in new funding for innovation in transportation for Smart Cities, building on a broad base of existing research and outreach to spur the development of next-generation transportation systems.
Smart Communities in Virginia
Virginia has launched a number of signature initiatives around Smart Communities, the most prominent of which are the following demonstration projects:

- 22 CityLink and the Gramercy District, a $500-million, 2.5-million-sq-ft, ‘smart city’, integrating connected health, intelligent buildings, smart retail, and improved safety into a single experience in Loudoun County.
- Smart City Works, the first business “actuator” focused on helping startups and mature companies transition new ideas or inventions into viable growing businesses that deliver high-impact solutions to make cities smarter, safer, and more resilient.

Many initiatives and collaborative activities are occurring across the Commonwealth. For example:

- In 2015, the Intelligent Community Forum named Arlington County as one of the three U.S. finalists for the world’s most intelligent communities;
- Virginia Tech is assisting Rosslyn to develop smart city protocols for the County;
- Virginia Tech is also partnering with Arlington County and Vornado/Charles E. Smith to implement and share data from rooftop sensor devices deployed in Crystal City;
- Park Roanoke is piloting smart meters in its parking;
- Roanoke and Richmond are participating in the Department of Energy’s Better Communities Alliance;
- NIST’s Global City Teams Challenge established multi-team super-clusters with Newport News as a lead city;
- NIST developed and announced Replicable Smart City Technologies grants, with Newport News as a lead city, focused on the development and deployment of interoperable technologies to address important public concerns regarding air pollution, flood prediction, rapid emergency response, and improved citizen services;
- MetroLab Network, with new support from the Annie E. Casey Foundation, launched a lab focused on the intersection of big data and human services in Arlington County, with Virginia Tech-National Capital Region as a member;
- Startup incubator, 1776, launched the Urban Innovation Council, a coalition of cities, startups, and corporate stakeholders dedicated to overcoming challenges to building smarter cities through entrepreneurship, with Arlington County as an initial member.

Organizations Supporting the Working Group
The Business-Higher Education Forum (BHEF) is the nation’s oldest membership organization of Fortune 500 CEOs, college and university presidents, and other leaders dedicated to the creation of a highly skilled future workforce. BHEF members collaborate and form strategic partnerships to build new undergraduate pathways; improve alignment between higher education and the workforce; and produce a diverse, highly skilled talent pool to meet demand in emerging fields.

CIT, a nonprofit corporation, has been Virginia’s primary driver of innovation and entrepreneurship since 1985. CIT accelerates the next generation of technology and technology companies through commercialization, capital formation, market development and revenue generation services. To facilitate national innovation leadership and accelerate the rate of technology adoption, CIT creates partnerships between innovative technology start-up companies and advanced technology consumers. CIT’s CAGE Code is 1UP71. To learn more, please visit www.cit.org.
Appendix E
# Virginia Smart Communities Working Group

**December 15th, 2017**  
**9:30 AM – 3:00 PM**  
**Hall of the States**  
**Room 233/235**  
**444 North Capitol Street, NW**  
**Washington, DC 20001**

<table>
<thead>
<tr>
<th>Time</th>
<th>Agenda</th>
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<tbody>
<tr>
<td>9:30 a.m. – 10:00 a.m.</td>
<td><strong>Check-In</strong></td>
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<tr>
<td>10:00 a.m. – 10:15 a.m.</td>
<td><strong>Welcome and Overview of VASC Working Group</strong></td>
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<td>Debbie Hughes, Vice President, Higher Education &amp; Workforce, BHEF</td>
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<td>David Ihrie, Chief Technology Officer, Center for Innovative Technology</td>
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<td>10:15 a.m. – 10:30 a.m.</td>
<td><strong>NGA’s Smarter States, Smarter Communities Initiative</strong></td>
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<td>Timothy Blute, Program Director, Homeland Security &amp; Public Safety Division, NGA</td>
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<td>Sue Gander, Director, Environment, Energy &amp; Transportation Division, NGA</td>
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<td>10:30 a.m. – 11:00 a.m.</td>
<td><strong>Federal Perspectives for Smart Communities</strong></td>
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<td>5-min presentations of agency updates and priorities</td>
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<td>Katherine Bates, Manager of Outreach, BroadbandUSA, National Telecommunications Information Administration</td>
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<td>Sokwoo Rhee, Ph.D., Associate Director of the Cyber-Physical Systems Program, National Institute of Standards &amp; Technology</td>
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<td>Scott Tousley, Deputy Director, Cybersecurity Division, Homeland Security Advanced Research Projects Agency, Department of Homeland Security</td>
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<td>Chad Parker, Assistant Administrator, Telecommunication Programs, USDA Rural Development</td>
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<td>Merrill Smith, Program Manager, Office of Electricity Delivery &amp; Energy Reliability, Department of Energy</td>
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<td>11:00 a.m. – 11:30 a.m.</td>
<td><strong>State Perspectives on Smart Communities</strong></td>
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<td>Kirk Lonbom, CISO and Acting Secretary, Department of Innovation &amp; Technology, Illinois</td>
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<td>11:30 a.m. – 12:00 p.m.</td>
<td>Break</td>
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<td>12:00 p.m. – 1:00 p.m.</td>
<td><strong>Integrating Federal &amp; State Activities</strong>&lt;br&gt;Attendees will engage in a facilitated discussion exploring how federal, state, and local officials can integrate smart community initiatives. &lt;br&gt;Moderator: <strong>Hardik Bhatt</strong>, Smart Cities &amp; Mobility Vertical Lead, AWS</td>
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<td>2:30 p.m. – 2:45 p.m.</td>
<td><strong>Reconvene &amp; Report Outs</strong>&lt;br&gt;Each committee will share key takeaways.</td>
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<td>2:45 p.m. – 3:00 p.m.</td>
<td><strong>Wrap-Up and Next Steps</strong>&lt;br&gt;<strong>Debbie Hughes</strong>, Vice President, Higher Education &amp; Workforce, BHEF &lt;br&gt;<strong>David Ihrie</strong>, Chief Technology Officer, Center for Innovative Technology</td>
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<td>3:00 p.m.</td>
<td><strong>Close</strong></td>
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**Therese Empie**, Strategy Advisor, Executive Office of Governor Rick Snyder, Michigan  
**Billy Hylton**, Digital Services Director, Department of Information Technology, North Carolina
VIRGINIA Smart Communities

Contribution by

Albert H Seubers

Director Global Strategy IT in Cities for Atos
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About this document

We read about Smart City programs and their success; yet there is still uncertainty about whether these programs are the right way for cities to go. In the paper, we explore the Data-Driven City as the way forward.

As a digital services company, Atos’ duty is to contribute what we are good at: designing, implementing and operating secure, stable and flexible technology solutions that support cities and citizens in realizing a Data-Driven City. Everyone in Atos is also, of course, a citizen. We can consider and discuss what we can contribute to a healthy, prosperous and safe city, wherever we live.

In this document, you will read about our MyCity vision, the key components of a Data-Driven City, the enablers for making this a reality, and relevant projects we have completed for clients in cities across Europe. As the paper will show, we, citizens, rely on data more and more, even where joining up data could impact our privacy on one-hand and on the other hand we need to trust data to be available at all times, like from IoT sensors.
Introduction

In an era of technological advance and political devolution, in return for greater autonomy, more will be expected from cities and local services in terms of value for money and innovation.

In today’s hyper-connected world, public services are on a journey of transformation towards greater efficiency with higher levels of citizen engagement across multiple channels, all available via smartphones, tablets, wearable devices, interactive digital signage and social media networks. These technologies make it easier to connect everything we do in our daily lives in the city: traveling, working, socializing, visiting attractions and making discoveries. Through technology, all these aspects of our lives are being transformed.

While we might not be able to predict exactly what the future will look like, one thing is very clear: digital technologies will power tomorrow’s cities. As the volumes of data generated through these technologies continue to grow, Atos’ vision is to harness that data for citizens, city services and partners to co-create healthy, prosperous and inclusive cities.

The purpose of this paper is to outline Atos’ vision for MyCity as a Data-Driven City and how it can help cities, citizens and private sector partners to bring community sense back, or in today’s words create Smart Communities. MyCity covers all aspects of city life; data is everywhere and it is the connecting element between citizens and optimal city services. A clear strategy for cities in their Secured Digital Journey is what we want to help define and realize.
A digital vision

Cities are responsible, on average, for over 80% of a nation’s Gross Domestic Product. Cities and their inhabitants have an important role to play in a world facing major environmental, economic and security challenges.

For us all to participate in addressing those challenges, we need to understand how our choices impact our communities, our nations and, ultimately, our planet. Then we need to adjust our daily lives and routines accordingly. In the digital age, data is a vital resource to support individual and collective decision-making. Atos’ vision is the Data-Driven City, in which data is used to help citizens make informed choices, to improve city life, and to target city services more effectively day to day.

In the Data-Driven City, data is securely shared by individuals and held by city administrations to help citizens understand the impact of their daily choices on their city and make positive adjustments accordingly. It is used by the city to enhance the quality of services to citizens at lower cost. Real-time data is captured and analyzed to inform the way traffic, transport, air quality and so on are managed. A Data-Driven City fosters a sense of community and cooperation to create higher quality of life and attract new residents and investors.

To break down data silos across the whole city and maximize the value of data, our vision is to implement Urban Data Management with tight controls to maintain public trust and individual privacy. This joins up data from different sources and systems and in different formats and enables analytics to be applied across these newly created datasets.

Yet Data-Driven Cities are not out-of-the-box solutions that can be bought and sold: they are co-created by citizens, public bodies and the private sector. In the Data-Driven City, the city is the enabling partner in an ecosystem of collaborating partners and citizens. This ecosystem uses a multi-sided approach, sharing and using data for the benefit of all participants. In the new Economy of Data, data is the new currency that can fund the improvement of city services. Alternative business models make it possible to deliver innovative public services with minimal up-front investment and risk.

In future, public services will be fueled by more devolved political authority, with innovation, new markets and new collaborations between the public and private sector. Atos is committed to working alongside city leaders and other partners to help create and support sustainable, secure and prosperous environments for citizens, communities, businesses and city authorities to thrive.

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Trusted partner for your Digital Journey
A digital revolution
It is the citizen who will shape the digital transformation of city services.

We are living in times of unprecedented change and opportunity; in elections and through new movements and communities across the world, the voice of the citizen is being heard and changing the climate politically. Cities, and we as citizens, have the power and opportunity to effect positive change. This is an amazing opportunity to shape local government culture and services. Digital technologies are vital to this, and future-thinking cities will need to design the digital journey for the citizen (or, even better, with the citizen), as well as developing the relationships between citizens and public bodies.

As citizens, we expect the same level of online interaction with our city services as we have with commercial companies. We are willing to share our data with retailers in exchange for a small discount or free delivery. We are intrigued by wearable technologies that promise to help us stay healthy and in shape. These tools and networks generate huge volumes of data and enable us to use and consume public services differently.

Building a sense of community
Traditionally, delivery of many city services may have been driven primarily on what time and budgets were available. Now, city administrations are starting to build 360° views of their residents. In this way, they can make cost savings while delivering more personalized, optimized services. There is potential to enhance citizens’ experiences through predictive real-time services based on data gathered via the Internet of Things.

Citizens want to live in their city of choice: one that provides them with a safe and clean environment, with affordable housing, good-quality education and health services and economic opportunity. We want to live in a city that is managed efficiently and in a transparent way that engenders trust, a city where we can connect and move around using different channels and modes of transport that suit our needs at any moment. As citizens, we can participate in shaping our cities of choice by adjusting our daily routines based on information provided to us, for example to make informed decisions on how and when we travel, or how we can save on energy to reduce our own costs while helping to lower the carbon footprint of our city. Through these choices and connections, we can build a sense of community that empowers citizens to take more responsibility for their city and the environment in which they live.
A Smart City: our future?

High-quality connectivity is what we need to support our fast-developing digital lifestyles: but is that what makes a city smart?

In recent years, a plethora of new digital services have become available in cities and a broad spectrum of Smart City projects are underway. While most of these are small-scale, some have formed investment partnerships to deliver city-wide projects. All, however, take a single issue as their focus, such as parking, streetlighting or waste collection.

Holistic approach

City administrations are on their way to breaking down the silos between different departments to create a more integrated 360° view of each of their residents. Yet to maximize the value of data, when cities are breaking down silos on one hand, they shouldn’t re-instate silos on the other by creating parallel Smart City projects that cover only one aspect of city life. We don’t just need a Smart City to improve services and quality of life; we need a Data-Driven City. We can adapt our lifestyle using information from all available data resources, from the Internet of Things to contracted city service partners. Issues such as parking, lighting and so on are connected and need to be addressed in a more holistic way with citizens at the heart of the solution.

In times of austerity it may seem impossible to create lifestyle changes among citizens when there is no budget to do so. Alternative business models make it possible to deliver innovative public services with minimal up-front investment and risk. While big budgets may be available from technology companies to showcase their products by delivering Smart City projects, the city should retain control and develop its own city strategy that is smart, not a smart city strategy.

We citizens do not need a Smart City; we want to live in a city that is managed in a smart way.
A Smart City is data-driven

With citizens at the heart, data connects city services and connects the city to its citizens.

For services, such as traffic management and waste management, service providers need to collect data to optimize the services they deliver. Data, however, is also of value to the city. So, data captured by service providers should also be made available to the city in a way that the city can use.

Today’s Smart City projects are based on capturing data for use in promoting services to the public and informing the public about events. These projects are creating new mini-silos of data. In contrast, Urban Data Management captures data from Smart City projects and service contracts together with data that cities already hold.

Urban Data Management joins up data from different sources, of different types and formats and provides a platform for analytics to be applied across these new datasets. In all cases, however, the city has control over who has access to which combinations of data to ensure privacy regulations are met, to publish transparently on which urban data is used, and to ensure that benefits are delivered for all participants in this new ecosystem.

The guaranteed availability, security and integrity of data is essential to ensure that services can be built on top. Data, like any utility in a city (such as water or electricity), will need to be secured and protected. To protect the privacy of citizens and personal data, cities need to monitor closely who is accessing data and for what purpose.
Influencing the City

A combination of social, environmental and economic factors is driving the need for the Data-Driven City.

Almost every article we read about Smart Cities tells us the number of people who will be living in a city in 10 to 15 years from now. However, urbanization is not only about rising populations and their impacts on infrastructure. There are several other developments influencing our cities today.

Globalization has one of the biggest impacts on daily city life. Different cultures in city communities are raising demand for new services in multiple languages. Ageing populations and the rise of long-term conditions are other key factors. To live safely and independently for as long as they can, citizens need more personalized support, from household services to medical or personal services. Today’s safety is under a constant threat physically or virtually. With the rise of more connected objects and the increase of digitalization the cyber threat is growing.

At the same time, a multitude of forces have driven our adoption of new digital tools and channels. The explosion in the use of social media, cloud and mobile technologies combined with changing citizen expectations are driving the digital transformation of public services. Ongoing austerity and rising demand for services requires public bodies to do things differently, not just more efficiently. Many citizens expect their local government to provide the same type of modern, automated, personalized online experience that they have in other aspects of their lives.

The combination of factors from globalization and economic development, together with demographic changes, new legislation and technological developments all emphasize the value of using data to connect the citizen to the city.
A multi-sided approach

In the Data-Driven City, the city is the enabling partner in an ecosystem of collaborating partners who can exchange data for the benefit of citizens and all participants.

Within the ecosystem of partners in a city, some are contracted city services providers, and others are commercial service providers. These partners can form relationships and agreements using a multi-sided approach based on connections between the citizen, the city and all service providers. In this multi-sided model:

- citizens can choose and pay for commercial services that are offered to them based on their profile and data shared about them
- providers of these commercial services pay for having access and using the data
- contracted city services partners provide and use data as part of the contracted services, lowering their costs and the cost to the city, for the benefit of the city, the citizen and the providers.

There is also an opportunity for cities to support citizens’ own sharing economy whereby citizens share skills or needs via a digital platform so that either the city can provide the services needed, or citizens themselves can exchange goods and services, further developing a sense of community.

A new ecosystem

All data between these parties is shared in a transparent way and with consent of the citizen.

Data is shared via the Urban Data Management Platform. If service providers who are not contracted by the city access data published on the Urban Data Management Platform, they need to apply for access and agree on payment terms.

One important development for cities is that procurement is changing. Today, cities publish specifications of services they require and select the provider that makes the offer that best fits the requirements at the best price. In a multi-sided market, service providers are selected based on the best fit with the existing ecosystem of partners. Services provided by the city can be replaced where appropriate, enabling citizens to choose which services and service providers to use. What’s important for cities is the role they play as the enabler of this multi-sided model. While the city is responsible for monitoring its own Data-Driven model, it cannot and should not be in control of the relationships between citizens and service providers other than by maintaining regulations, laws and contracted agreements.
The economy of Data

While the technologies needed for the Data-Driven City are available, many cities lack the budget and time needed to implement them. Here is where the Economy of Data can help.

The Economy of Data brings together citizens and city, with a multi-sided model built on data that is made available and shared through contracts, through apps and smart devices, and through services that are delivered based on shared data.

Payment for the systems to support this Economy of Data can be through added value or hard currency. In other words, contracted service providers to the city can grant access to data captured while delivering services (traffic management, collecting waste, public transport and so on).

Enhancing services

The city can open up access to the data they hold where and when needed, with individual data only shared with the active consent from the relevant person. Citizens who sign up for services from the city or contracted service providers will share their data (based on profiles) to enhance the quality or personalization of services. Service providers will pay for accessing the data. This is a big change to the current Open Data mindset that some cities still have. If data is published for free, then it may appear that there is no value in it for the city. Cities with Open Data programs today may be increasingly convinced that attempts to create value out of it have failed.

To create the Data-Driven City, the city must start making changes at various levels. Today’s service contracts, for example, are unlikely to contain a paragraph on data. Take waste collection as an example. A contract on waste collection is focused on routes per day and in some cases about the weight of waste collected. This data is provided in periodical reports. Whereas the data from sensors in bins is used only to optimize the waste collection process, that data is not shared. Repurposing the data
on the completion level of bins can provide new services to citizens or support more severe enforcement on littering.

Today, paying for accessing data is based on transactions or volumes; in the near future, this will be based on Blockchain technology. Blockchain will ensure better quality of the data, as responsibility will be much more distributed than it is today. It can be seen as a decentralized ledger system for managing and controlling the sharing of data. It helps to ensure the quality and origin of data as well as the fees that apply for accessing data according to predefined economic rules.
Value of a Data-Driven City

As well as improving the quality of services, the Data-Driven City will deliver longer-term economic and social value.

The Data-Driven City will make information available for citizens to make more informed choices and for the city to improve the quality of services to citizens at lower costs. Real-time data will be shared through smartphone apps, digital signage and other channels to inform citizens on traffic, air quality and so on throughout the day.

Through Urban Data Management, a city can support the use of joined-up data from different sources to provide accurate information to citizens. Out of this, a new economy can emerge, with:

- providers exchanging innovative models for delivering city services
- technology companies developing data exchange technologies (APIs) and data analytical models or algorithms to use in sensors
- local entrepreneurs finding opportunities to create information-based services for citizens, commuters and visitors.

Data as the new currency

In the Data-Driven City, data is the new currency that can be shared and used to finance city services and deliver value to citizens and providers. A Data-Driven city will create the conditions for start-ups and scale-ups to generate new city solutions. Start-ups bring innovation that will distinguish the Data-Driven City from others, driving up economic growth (because large corporates tend to want to collaborate with start-ups), and branding the city as an incubator of new services that can be exchanged for others. A Data-Driven City will invite more interest in research and development in all aspects of the city, again increasing its attraction for investors. The economy will benefit, with new job opportunities for the unskilled and skilled workforces.

Furthermore, services that work in one city will also work in other cities, so as a direct result of Urban Data Management standards, exchanging of these information-based service technologies (such as APIs, algorithms and apps) is possible, further developing the economy and creating new jobs.

Creating ‘social value’ in a Data-Driven city is a key enabler for success. For example, Digital Social Value, redefined by technology and based on real-time data, focuses on enabling, enhancing and offering greater choices and connections to the city’s population. New and innovative services should also include solutions targeted at the less digitally experienced or digitally able citizens.
Safe city

Data is an enabler to create early warning indicators that help keep citizens safe and secure.

Using more responsive, capable, real-time technologies, local police can respond to alerts and incidents more quickly and enhance citizens’ feelings of safety. Furthermore, the digital transformation of policing means that intelligence can be extracted and delivered to officers wherever and whenever they need it.

Timely sharing of appropriate information within the police service and across city departments means that citizens’ issues can be dealt with more rapidly, repeat work can be reduced and incidents that do not require a police response can be redirected earlier. With smart use of data, police services can react more swiftly to crime, creating a more predictive, proactive and pre-emptive police service.

Ensuring citizens’ safety is about more than policing and fighting crime. Traffic safety is just as important, such as identifying potentially risky situations, enforcing regulations such as speed limits, and giving warning signs to drivers by making streetlights blink or change color when needed.

Next-generation services

Connected buildings can send early alerts before smoke or fire detection systems raise the alarm for fire services. The micro-grid inside a connected building understands when electrical systems or appliances show an abnormal consumption pattern and can send early alerts. Just imagine the fire brigade pulling up to a building before a call to 911 has been made.

Next-generation 911 systems will respond not only to phone-calls or alarms from smoke and fire detectors; calls will be made through Internet of Things connected systems, social media and so on. Communication from the dispatch center to members of the public and police, fire and ambulance services will be done through multiple channels to ensure that all relevant parties are reached quickly. A citizen’s alert can also be triggered through use of a light-emitting diode (LED) streetlight system.
Clean city
Creating and maintaining clean spaces requires not only city services but also the participation of citizens. What keeps a city clean?

A clean city means a healthy environment, with good air quality and no littering, among other things. Air quality is highly impacted by traffic and, in some case, by household heating systems.

Energy transition is an important element in creating a cleaner and healthier city. This means reducing levels of pollution from carbon-based energy sources and changing to renewable sources where possible. Energy transition requires not only the availability and accessibility of new energy sources, but also a change in the mindset of citizens to use alternative energy sources and reduce energy use. Communities of citizens already exist in many cities to invest in renewable energy systems and to buy energy collectively. In parallel, smart-meters that provide real-time feedback on energy consumption help citizens to understand the impacts of their consumption levels. Companies make use of connected building technologies with micro-grids and a range of technologies to reduce overall energy consumption in buildings. Often, these are designed for cost reduction only; but whatever the reason, they contribute to creating a cleaner city.

Reducing pollution
With air quality already under threat in some places, this means reducing travel (especially at peak times) and switching to more sustainable forms of mobility. Cities tend to change their own vehicles to be more electrified or hybrid and public transport is also becoming greener. For example, London’s buses are increasingly hybrid. To reduce pollution from traffic in cities, a trans-modal shift is happening with easier access to alternative modes of transport such as shared bikes, shared cars, bus, metro and so on.

Visible pollution is also the result of litter. If the city operates a good waste management service, enforcement on littering should be intensified. A sense of community is needed to share feelings of pride and success on keeping the city clean, which in turn prompts more positive action. Many Smart City projects today are about waste collection. Sensors that indicate a bin is full create data that enables waste collection services to optimize routes and reduce mileage. However, these services need an incentive to do so that is agreed as part of the contract. Greater benefits can be realized if the trucks only drive at times when they have the least impact on traffic levels. This makes the contract beneficial for both the city and the contracted partner. Using the data on whether bins are full or not creates a whole new element of servicing the public. If people can check at their front door whether the bin is full before taking a bag to it, this enhances the feeling of customer service while also preventing people leaving rubbish next to full bins. If citizens have this information, there can be tighter enforcement and penalties for those who do leave their rubbish in the street next to a full bin.
Connected City

Connected city administrations will be available 24x7 for many services, with citizens able to digitally interact seamlessly with local public service providers.

Across the range of local authority services, from bin collection to adult social care, it is critical that cities provide the digital framework for an ecosystem of services and tools that enable communities to match needs with skills. The city is the enabler of this data-sharing ecosystem.

Transforming relationships with citizens

Now is the time for cities to digitally transform their relationships and services for citizens. There are three compelling reasons for this:

1. **The financial imperatives are as unarguable as the opportunity.**
   How to deliver more for less is a challenge for local governments. To deliver value for money and meet the demands of growing and ageing populations, public services must leverage innovation and collaboration from all sectors and take advantage of more devolved responsibility to become more agile.

2. **Citizens’ expectations are changing.**
   Most cities have moved on from written postal forms to call centers and websites. Yet with populations becoming more digitally mature, people want self-service, speed and convenience, with proactive online local government services delivered to them any time and anywhere.

3. **Hyper-connectivity is evolving.**
   With the convergence of device, connectivity and social media, citizens are becoming more digitally connected. The data they generate will enable local authorities to gain actionable intelligence about behaviors and preferences that has never been available before, establishing a virtuous circle of data-informed continuous improvement. Not only are citizens increasingly connected, so are the objects and devices around us. The growing number of Internet of Things (IoT) platforms connect traffic lights, waste bins, parking spaces and so on to generate data.

In the connected city, authorities can harness the ever-growing volumes of data to further improve services to citizens, visitors and workers. For example, connected bins will provide data to:

- optimize the routes of waste trucks and therefore save of fuel, reduce emissions and so on
- enable trucks to drive at different times to reduce the impact on traffic situations
- enable residents to check whether a bin is full or not before they drop their waste
- support enforcement on littering because citizens are more empowered to keep their neighborhood clean.
The retail sector has started to capitalize on this kind of digital transformation, influencing the infrastructure and appearance of our city centers with fewer shops as more and more shopping is done online. Rob van Gijzel (former Mayor of Eindhoven) once stated: “the city center is no longer the place to shop and buy; we as a city must ensure the city center is the place people want to be”. As a result, city centers should be safe and clean and offer a multitude of opportunities to meet and enjoy time – including the opportunity when shopping to feel, taste and select goods. A vision in the near future is to be able to select and buy goods in a shop, and then have them delivered to anywhere at any time. This will be thanks to connecting technologies between the product and the consumer’s smartphone.
Mobile City

Mobility in cities is under severe strain. Citizens can play a major role in addressing the problems – given access to the right data at home and on the move.

The pressure on mobility in cities is due to a combination of factors including an increase in deliveries of goods purchased online and changing retail strategies. It is not cost-effective for retailers to store goods in expensive retail space, so deliveries happen more frequently; and as delivery services extend their services, there is constant pressure on traffic and mobility in cities.

In addition to these changes, it is we, the citizen, who also play a major role. Overall, motorists choose to use their cars and park where it is easiest and most convenient for them instead of using alternative transport and parking options.

There are many Smart City projects already underway to reduce numbers of cars, optimize traffic flows, enhance parking capacity and offer alternative modes of transport such as bikes and car shares. All these projects serve the greater good, yet there is more that can be done to change day-to-day choices. Data captured on current traffic situations, parking availability and options for alternative transport modes should be presented in a single view to enable us to make decisions on our travel plans in real time. Of course, only a proportion of the population can decide not to travel or change their travel times – yet if there are 10% fewer cars are on the roads, congestion will be reduced to nearly zero.

Real time traffic information

Information based on real-time monitoring of traffic flow, traffic incidents, planned roadwork and external factors such as the weather means that citizens can take different decisions even after their journey has started. This information should include predictions on the impact of incidents and updates for drivers on alternative routes and modes of traffic to prevent congestion. Switching to an alternative mode of transport must be easy and comfortable, for example a single access card to pay for national rail, local rail, parking, shared bike use and so on, using either a bank or credit card or a city or transport card. Added-value services around the change in transport will encourage people positively to change their plans, such as valet parking, discounts on combination tickets for park & ride – even a parcel drop-off service or deposit boxes at the park & ride.

Providing a complete overview of traffic-related data in one single application for drivers to use while driving is not easy to achieve given the complexity of data sources involved. Information therefore needs to be provided based on personal profile, location and time of day, all in a format that is supported by the device that is in use.
Improving parking
‘Smart’ parking solutions are part of many Smart City projects. The idea is to reduce miles driven to find a parking space as part of a complete overview of traffic information. To encourage drivers to use a different mode of transport, it sometimes makes more sense to remove parking options so that drivers will change their routine and park elsewhere. Changing to maximum duration of parking with a limited number of minutes for each vehicle allows for delivery and pick-ups to support the local economy. The ‘smart’ in parking comes with sharing information on availability, access to parking and making enforcement more targeted based on the available data. Abuse of designated areas, parking in delivery zones and so on has a big impact on traffic and quality of life. An even smarter approach to parking would be to dynamically allocate space for parking.

Reducing congestion is often best achieved by completely removing parking options, encouraging drivers to use park & ride or offering them other modes of good-quality transport. In Singapore, clean, low-cost public transport is always available, giving citizens options that are just as appealing as their own private transport.

Keeping a city mobile directly impacts air quality, so energy transition in transport is also important. Electronic vehicles do not reduce congestion, but they do reduce environmental pollution. These require more charging stations to be available across cities which could also function as parking spaces. From a grid perspective, it is interesting to combine charging and generation by use of solar for instance. The management of a charging grid and public charging stations must ensure easy access for all drivers using e-vehicles and all types of cars, bikes, scooters and so on.

With many new developments being tested, such as autonomous vehicles (either in designated lanes or as part of daily traffic), all planned investments planned in parking and road upgrade programs need to be reconsidered. Current infrastructures will one day become obsolete. If we expect autonomous vehicles to operate personal or group mobility services, why would a city invest in parking?

But let’s not forget today’s challenges, a mobile city providing easy access to affordable transportation, with a simple payment system that covers all transportation modes, will help create more job opportunities.
Caring City

Demand for social care in cities is rising. Joining up data can promote healthy lifestyles to reduce pressure on services, as well as help target social care resources most effectively.

Increasing demand for social care is not only a result of ageing: high-density populations and infrastructures mean that stress levels are rising in cities, causing all kinds of issues.

While cities can’t enforce healthy lifestyles, they can promote them by providing citizens with positive opportunities. From a design perspective, more open and preferably green space is needed to help provide clean air and time to relax.

The City of Copenhagen is a very good example of these design principles. Within 15 minutes, every resident can reach a park or waterfront on foot or by bicycle. The City of Houston has a very well designed riverside park where cycling, running and other types of sports are possible. Attracting people to sports in parks is done in some cities in partnership with sponsors such as Nike providing a running track equipped with a high-tech video wall that enables athletes to compete against their avatar. These green spaces not only support healthy living and a cleaner environment, they can also create opportunities to deal with other challenges cities are facing like storm water management.

Personalizing health and social care

Ageing also has an impact. As we grow older, we want to live independently for as long as possible, creating an increasing demand for home and health support. This is in the interests of city services for whom the costs of elderly and retirement homes are high. Home support services are provided by commercial companies, sometimes contracted by the city and sometimes directly by residents. Currently, the services delivered tend to be shaped by the availability and schedule of the provider. Instead, access to biometric data can help personalize services much more effectively for individual citizens. Wearable technologies can capture such data, with highly secure connected bracelets providing real-time data on vital functions to a care provider’s dashboard. And there are other uses for such data. It can, for example, help city planners to identify traffic situations that are particularly challenging for elderly or disabled people by analyzing heartbeat and blood pressure captured. A wearable device could even trigger the lights at a pedestrian crossing to allow the wearer some more time to cross the street.

Delivering targeted and timely social care in a city means breaking down silos of data held in different systems. Combining data from social services with police records and education service systems can trigger alerts about vulnerable or potentially vulnerable individuals and families who need help. Of course, privacy needs to be taken very seriously. The results of the analysis must be presented in a way that protects data and privacy, with training for city workers who receive the alerts.
While healthcare is not a city service, changes in cure and recovery programs are impacting the city. Patients, where appropriate, recover more quickly in their own environment than in hospital. Connectivity is a key enabler for this. New or redesigned housing should accommodate easy and secure connectivity at all times; the next step is to provide connectivity in public spaces. While free wifi is already a topic of discussion in cities across the world, it does not have the capacity to support the secure connection of patients.
Secure City

As we see in the news every day, cyber-crime is on the rise. Citizens need to be able to trust city services to ensure the security, integrity and availability of data at all times.

With the growth in sensor networks, connected buildings, connected vehicles and data connections between city departments and service providers in cities and also free City WiFi, cyber security is critical.

Wealth located in cities will attract cyber-criminals; cities’ strategic political importance and media focus will attract disruptive actions by protesters, nation states, hacktivists and terrorist groups. Many of them have aspirations to cause practical damage through cyber activity. This aspiration is less about the IT equipment itself and more about disrupting the processes it controls (such as stopping trains running, flood-barriers or water supplies). A ‘global city’ role brings an intensity of focus and magnifies the potential impact of any vulnerability. When Atos builds the infrastructure for an Olympic Games, we do so in full recognition that for the 17-day period of the Games, it will be one of the world’s top cyber security targets.

The security challenge is far broader than simply addressing one issue such as securing data, securing mobile devices or securing cloud computing environments. A cyber security strategy that addresses these interrelated issues in an integrated way is essential. Achieving a cyber security posture across all key areas is vital for a city’s future growth, innovation and competitive advantage. It is also vital for fully exploiting the business and economic opportunities provided by Urban Data Management in an open, secure and prosperous environment.

A safe city is one that can rely on a secure ICT infrastructure that can continuously develop, evolve and transform.

Security in the cloud

Government Cloud initiatives have started in many places to address the most common challenges to deliver a logical infrastructure that supports and enables change. As the ‘move to the cloud’ accelerates, there is a pressing need to ensure that cyber security capabilities, monitoring and response are included in the cloud services.

National and state governments have already started to initiate journeys to cloud services. Cities can benefit from these initiatives by accessing these services within legal government frameworks at low cost. Cities can benefit from these initiatives as these provide an easy accessible starting point for creating the Data Driven City. Good references on this are Texas, Western Australia, United Kingdom and The Netherlands.
While cloud adoption in the public sector might still lag behind commercial companies, the six organizations above are front-runners willing to share their experiences. For cities, cloud is everywhere as more and more contracted service providers run their operations in the cloud. It is vital that cities select a Hybrid Cloud Orchestration partner who can securely integrate cloud services from different providers and ensure that data is stored and shared according to security and privacy regulations.
The Data-Driven City

The technologies needed to realize the vision of a Data-Driven city exist. What is needed is collaboration and cooperation across an ecosystem of public and private partners and citizens to realize the vision.

To implement the infrastructure for enabling a Data-Driven City, there are six key components:

1. A single platform to ensure all data connections can be monitored with controlled access to data; this is called the Urban Data Management Platform.
2. High security standards and tools applied to cyber security, data access and applications that use data.
3. Data science skills and tools to minimize any risks of joining up data.
4. Active consent for the use of personal data from individuals, with opting out, or applying the right to be forgotten.
5. Data analytics in real time and constantly monitored as part of Urban Data Management.
6. Transparency to ensure the support and understanding of citizens, with Governments trusted to safeguard and explain what data is used and for what purpose.

Crucially, to create a Data-Driven City, city leaders need partners who understand public sector responsibilities and are committed to the same values of trust and transparency. Above all, vision and leadership from mayors, councilors, political leaders and private sector industry representatives need to be aligned to engage with citizens and to design, build, improve and evolve the digital world that citizens will expect.

A Data Driven City creates economic opportunity for companies, start up, scale up etc that will use data provided to create new business services. The city is the enabler for this and allows for innovation. Innovation means also to allow to fail fast, then iterate and re-create.
Urban Data Management

Urban Data Management depends on designing, building and operating a highly secured data platform for storing and accessing all data captured in the city for the benefit of citizens, businesses and city services.

Urban Data Management is by nature supported by cloud, due to the vast amounts of data and the flexible demand for compute power needed to support data analytics and to manage data from multiple sources in a secure way.

A city needs to provide Urban Data Management, at best provided as a Service in an ecosystem of partners. In this the city could also be county, state or nation. The opportunities are endless to create or recreate services based on data to strengthen the local economy in cities. Exchanging city solutions, like New York is now promoting through their Marketplace.city initiative, will help increase number of interesting solutions or services for cities.

Results of data analytics can be published and accessed through mobile apps, dashboards etc. In some case the analytics result will mean real time alerts have to be shared and pushed to smartphones. There are other communication options for reaching groups of people; for example, LED streetlight systems through a machine-to-machine interface can send signals such as blink, change color and so on, to alert people on the streets. Cities as enabler for this can determine the rules on safety to be applied by all members of the ecosystem of partners in the Economy of Data.
The first step: Readiness workshop

As many Smart City projects today are single-issue-focused and siloed, the risk is that cities may not have an overview of the links between multiple Smart City projects. This calls for a City Strategy that is future-driven, future-proof and smart.

Implementing Urban Data Management and starting up an Economy of Data may seem out of reach for many cities. Yet most cities may already be part of this without fully recognizing it.

To help cities understand what their role is and how prepared they are for it, a Readiness Workshop to explore the impacts and opportunities of a data-driven future would be a good first step.

A readiness workshop is non-technical and structured around three steps:

1. Understand the possibilities and implications of Urban Data Management and key technology enablers such as cloud, network operation, data analytics and cyber security
2. Assess opportunities for quick wins from a holistic view based on the eight key topics described earlier.
3. Explore innovation accelerators and use cases for proving value of a Data-Driven strategy, including solutions and opportunities to attract interest from companies to design, develop and implement as partners in the ecosystem.
The output of the workshop will be a vision for the future, underpinned with greater awareness of the changes needed to realize this vision, and an overview of initiatives to deliver quick wins.

Currently cities are planning projects years ahead as approval and budgets need to be secured before publication and involvement of businesses for detailed planning, design and realization. In relation to data-driven services, a different, more agile approach is needed. Iterative development and testing of data-driven innovations that help to change the daily routines of citizens should be tested in real-life with real citizens and reiterated until the right design and technology is reached.

These are exciting times for cities to harness the power of technology to improve the city environment and create spaces and economies that attract investment and new opportunities. On this journey towards a more data-driven digital future, the focus of a city should always be on the needs of the citizens it serves. Driving innovation in this way often demands new ways of thinking and ideas, which is exactly what a Readiness workshop aims to provide.

Dr David S Ricketts from, TECH the Technology and Entrepreneurship Center at Harvard organizes this type of workshops, called Innovation Accelerator.
Appendix G
State of Illinois
Enterprise Memorandum
Of Understanding (E-MOU)
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HHS Enterprise Memorandum of Understanding (E-MOU)

WHEREAS, thirteen State agencies (the “Partners” or “Original Partners”) currently have responsibility for the administration of the State’s healthcare and human services programs and are members of the Illinois Health and Human Services Leadership Transformation Committee: these thirteen State agencies are the Department of Human Services, the Department of Aging, the Department of Healthcare and Family Services, the Department of Commerce and Economic Development, the Department of Employment Security, the Department of Public Health, the Department of Children and Family Services, the Department of Corrections, the Department of Juvenile Justice, the Department of Veterans Affairs, the Department of Central Management Services (for technology services), the Department of Innovation and Technology, and the Illinois State Board of Education;

WHEREAS, the Partners desire to securely exchange data as permitted or required by applicable law in order to increase the efficiency and effectiveness of programs they operate for the benefit of the citizens of the State of Illinois;

WHEREAS, this Enterprise Memorandum of Understanding (“E-MOU”) does not preempt or contradict in any manner any statutory duties or authority required of or granted to, respectively, Partners; rather, the Partners enter into this E-MOU to enable their participation in the Data Exchange Service, as defined and set forth below;

WHEREAS, once the Partners enter into this E-MOU, they hope that other governmental entities desire to participate in the Data Exchange Service in the future, and each new entity shall be known as a “Partner”;

NOW, THEREFORE, for and in consideration of the mutual covenants contained herein, the Partners mutually agree to the provisions set forth in this E-MOU.

ARTICLE I
INTRODUCTION

The purpose of this E-MOU is to allow for interoperability of data between the Partners. Interoperability is a national effort of technology and programmatic coordination. Interoperability refers to the ability of two or more systems or components to exchange information and to use the information for the benefit of the State and its clients.

ARTICLE II
DEFINITIONS

For the purposes of this E-MOU, the following terms shall have the meaning ascribed to them below.

a. Applicable Law shall mean all applicable federal and state laws and regulations.
b. **Authorization** shall have the meaning and include the requirements set forth at 45 CFR §164.508 and any similar Applicable Laws with additional requirements. Authorization shall be confirmed by execution of the Uniform Authorization to Exchange Information form or some other written authorization that meets the requirements of Applicable Law that applies to the Partner providing the data.

c. **Breach** shall mean all known incidents that result in the unauthorized access, use, or disclosure of data protected by federal or state laws.

d. **Changes** shall mean Developmental Changes (as used in Appendix 3 and defined in Appendix 3, Section 1.A) and Compliance Changes (as used in Appendix 4 and defined in Appendix 3, Section 1.B). Changes shall be managed in accordance with Appendix 3 of this E-MOU.

e. **Data** shall mean any information about an Individual, including but not limited to information that can be used to distinguish one person from another person and/or that is confidential under Applicable Law, and disclosed by one Partner to another Partner under this Agreement.

f. **Data Exchange Service** shall mean hardware, software programs, protocols, etc. that serves to securely and safely share Data between Partners. Requirements for Data Exchange Services are defined in Appendix 5 of this E-MOU.

g. **Data Request** shall mean a request for Data made by one Partner to another and defined by an approved E-MOU Specification.

h. **Data Transmittal** shall mean an electronic exchange of Data between Partners using agreed upon Specifications.

i. **Digital Credentials** shall mean a mechanism, such as a public-key infrastructure, that enables Partners to electronically prove their identity and their authority to conduct data transmittal with other Partners.

j. **Discloser** shall mean a Partner that discloses Data to another Partner through a transmittal in any format.

k. **Dispute or Disputed Matter** shall mean any controversy, dispute, or disagreement arising out of or relating to this E-MOU.

l. **Effective Date** shall mean the date of execution of this E-MOU by two or more Partners.

m. **Emergent Specifications** shall mean new technical specifications that existing and/or potential Partners are considering to implement to test the feasibility of the emerging technology, to identify whether the Specifications reflect an appropriate capability for the Partners, and assess whether the Specifications are sufficient to add as a production capability available to the Partners.

n. **Individual** shall mean a client or person whose data is maintained by a Partner
and subject to exchange with participating agencies.

o. **Information Technology Service Provider or ITSP** shall mean a company or other organization that will support one or more Partners by providing them with operational, technical, cloud, or information technology services.

p. **Notice or Notification** shall mean a written communication sent to the appropriate Partner’s representative in accordance with the other policies and procedures attached to this E-MOU.

q. **Operational Measures or Operational Data** shall mean information pertaining to the volume and performance of Data Transmittals pursuant to this E-MOU; such as activity counts, performance measures, uptime metrics, error rates, connection metrics and other indicators of activity. This aggregated data does not contain any individually identifiable data or protected content.

r. **Partner** shall mean any “public agency” as defined in Section 2 of the Intergovernmental Cooperation Act (5 ILCS §220/2), that is a signatory to this E-MOU, and any ITSP working specifically for the Partner.

s. **Partner Access and Disclosure Policies** shall mean those policies and procedures of a Partner that govern a User’s ability to access, exchange, and transmit Data using the Partner’s System, including privacy and security policies.

t. **Personally Identifiable Information (PII)** is information which can be used to distinguish or trace an individual's identity, such as their name, social security number, biometric records, etc. alone or when combined with other personal or identifying information which is linked or linkable to a specific individual, such as date and place of birth, mother’s maiden name, etc.

u. **Production Data** shall mean Data created by a Partner in accordance with the Validation Plan and used by the Partner for Production purposes in a Production environment. Production data may contain PII or other data that is subject to State or Federal data protection requirements.

v. **Recipient** shall mean the Partner(s), users, vendors, and any other person or entity that receive(s) or has access to the Data through a Data Transmittal from a Discloser pursuant to this E-MOU.

w. **Specifications of Service or Service Specification or Specifications** shall mean the specifications established by Applicable Law or adopted by the Operational Committee that prescribe the Data content, technical, and security requirements needed to enable the Partners to Transmit Data. Specifications may include, but are not limited to, specific standards, services, and policies applicable to Data Transmittal pursuant to this E-MOU. The specification requirements are attached hereto as Appendix 5, and may be amended in accordance with Appendix 3 and 5.

x. **System** shall mean the software, portal, platform, or other electronic medium
controlled by a Partner through which the Partner conducts its Data Transmittal related activities. For purposes of this definition, it shall not matter whether the Partner controls the software, portal, platform, or medium through ownership, lease, license, or otherwise.

y. Test Data shall mean Data created by a Partner in accordance with the Validation Plan and used by the Partner for Testing purposes in a Testing environment. Test Data in a Test environment shall not contain Production Data, unless the data has been obfuscated to ensure there is no PII data present or agreed on by all E-MOU Partners. In the case of such exceptions, all production level data security protocols must be adhered to.

z. Testing shall mean the tests and demonstrations of a Partner’s System and processes used for interoperable Data Transmittal to assess conformity with the Emergent Specifications, Specifications and Validation Plan.

aa. Transmit, Transmittal or Transmitting shall mean, in varying tenses, to send Data electronically using the Specifications.

bb. User shall mean any employee of a Partner or individual or entity who has been authorized to access the Data through the respective Partner’s System in accordance with Applicable Law.

c. Validation Plan shall mean the framework for Testing and demonstrations for Partner seeking to use a Data Exchange Service. The Validation Plan is attached hereto as part of Appendix 6, and must be in compliance with Appendix 3 and Appendix 5.

ARTICLE III

RESPONSIBILITIES OF THE OPERATIONAL COMMITTEE

The Operational Committee is an advisory group reporting to the Secretary of the Department of Innovation and Technology. It will support secure Data Transmittal and develop the Specifications, including Emergent Specifications, with which the Partners shall comply in Data Transmittal pursuant to this E-MOU. The Committee is comprised of one representative from each of the Original Partners and is chaired by the State’s Chief Data Officer (representing the Department of Innovation and Technology). The Committee will elect a Vice-Chair and a Secretary; additionally, one member of the Operational Committee will be the Technical Chair, one member will be the Security Chair, and one person will be the Privacy Chair. A quorum is comprised of seven or more members who are present in-person, telephonically, or through video conference and the Operational Committee shall use a majority of the Members voting process. The Operational Committee shall schedule meetings on a monthly basis, or more frequently as necessary or at the call of the Secretary of the Department of Innovation and Technology or designee.

The Operational Committee will conduct, at the request of the Secretary of the Department of Innovation and Technology or designee, as an entire body or individual members working together, the following activities regarding specific Data Exchange Service:

a. Maintaining a list of all E-MOU Partners, their designated representative(s) and their preferred contact information where they can be reached, which shall be made accessible to all E-MOU Partners by posting on a website;
b. Receiving reports of Breaches, notifying Partners of Breaches, receiving confirmation from Partners when the security of their Systems have been restored after Breaches, and notifying Partners when all issues leading to a Breach have been resolved. Notification of a Breach to the Operational Committee does not relieve the Partner of its responsibilities under Applicable Law, including any required notifications that a Breach has occurred and any related notifications required due to a breach of any shared information;

c. Advising the Secretary of the Department of Innovation and Technology or designee when to issue a finding or suspend data exchanges based on a sanctioned Incident Response Handling Plan and in accordance with Appendix 4 of this E-MOU;

d. Advising the Secretary of the Department of Innovation and Technology or designee how to resolve Disputes between Partners in accordance with this E-MOU;

e. Managing the amendment of this E-MOU in accordance with Appendix 2 of this E-MOU;

f. Developing, evaluating, prioritizing, and adopting Specifications, including Emergent Specifications, changes to such Specifications, and the artifacts required by the Validation Plan in accordance with Appendix 5 and Appendix 6 of this E-MOU. Any Specifications developed shall be consistent with Applicable Law;

g. Maintaining a process for managing versions of the Specifications, including migration planning;

h. Evaluating requests for the introduction of Emergent Specifications into the production environment used by the Partners to perform a Data Transmittal;

i. Performing impartial review of Partners’ compliance with the Specifications as defined in Appendix 5 of this E-MOU; and

j. Work with the original Discloser Agency to respond to Freedom of Information Act Requests, subpoenas, court orders or other third party requests related to the Data.

k. Fulfilling all other responsibilities delegated by the Secretary of the Department of Innovation and Technology or designee to the Operational Committee as set forth in this E-MOU.

l. Right to conduct an audit of the environment of any Partner-specific IT system that will be receiving data through this E-MOU.

m. Create and maintain a record of any disclosure of Data made to any other person or entity not already denoted in an Attachment A to Appendix 5. The record of disclosure shall record the name of any additional person or entity receiving the Data, the legitimate and legal interest of the disclosure, and a description of the Data included in the disclosure.
ARTICLE IV
USE OF DATA

a. **Permitted Purpose.** Partners shall only Request and Transmit Data in accordance with Applicable Law, including 45 CFR §164.508(c). Partners shall enforce this rule with its users, employees, vendors and any other person or entity that receives, sends, or has access to Data pursuant to this E-MOU.

b. **Permitted Future Uses.** Recipients shall only retain and use Data in accordance with Applicable Law, the business purpose as defined in the Specification Sheet for Electronic Data Interchange (EDI) Service and/or Extract, Transform and Load (ETL) Service when applying for a Data Exchange Service as described in Attachment C to Appendix 5, the data sharing document executed between the Recipient and the Discloser, and the Recipient’s record retention policies and procedures. Recipients shall not disclose Data to any outside entity or person, including subcontractors, without the written permission of the Discloser.

c. **Management Uses.** The Secretary of the Department of Innovation and Technology, or designee, may request operational measures from Partners regarding use of exchanged data, and Partners agree to provide requested measures in accordance with Applicable Law, for the purposes listed in Article VIII of this E-MOU, Expectations, Duties, and Responsibilities of the Partners.

d. **Authorization.** The Partner certifies that unless permitted or required to share data by Applicable Federal and/or State law, it has obtained a Uniform Authorization to Exchange Information which permits it to disclose Data for the Individual served by the Partner for whom an inquiry is made, pursuant to this E-MOU. If the Partner does not have a signed Uniform Authorization to Exchange Information, but has a previously-signed Authorization, the previous authorization may be sufficient until the Uniform Authorization to Exchange Information is signed. Such Authorization may be included as part of the Individual’s application form or it may be a separate consent to release form which is kept in the Individual’s file. In either case, the Individual must sign the Authorization, or where the Individual is a minor, the Individual’s parent or legal guardian. If the Individual has a representative authorized to act on his or her behalf, the representative may sign the release.

e. **Tracking of Authorizations.** The Partners agrees to track the expiration and/or revocation of Authorizations in compliance with the requirements of 45 CFR §164.508, and specifically

1) **164.508(b)(2) Defective authorizations.** An authorization is not valid if the document submitted has any of the following defects: (i) the expiration date has passed or the expiration event is known by the covered entity to have occurred; (ii) the authorization has not been filled out completely, with respect to a required element; (iii) the authorization is known by the covered entity to have been revoked; (iv) the authorization creates a compound authorization (164.508(b)(3)) or violates the prohibition on conditioning authorizations (164.508(b)(4)); (v) any materials information in an authorization is known by the covered entity to be false.

2) **164.508(b)(5) Revocations of authorizations.** An Individual may revoke an authorization provided under this section at any time, provided that the revocation is in writing, except to the extent that information has been shared already or action has taken place already in reliance on the authorization..
ARTICLE V
SYSTEM ACCESS POLICIES

a. Autonomy Principle. Each Partner agrees to have Partner Access and Disclosure Policies. Each Partner acknowledges that Partner Access and Disclosure Policies may differ among them as a result of differing Applicable Law and business practices. Each Partner agrees to be responsible for encrypting data in transit using current industry standard algorithms agreed on by the parties involved before transmission occurs based on the application of its Partner Access and Disclosure Policies to the requested Data. Each Partner shall comply with Applicable Law, this E-MOU, and all applicable Specifications in Transmittal of Data.

b. Authentication. Each Partner agrees to employ an approved credentialing service (for example, “Entrust” is a service provider that would provide PKI (Public Key Infrastructure) credentialing services) through which the Partner, or its designee, uses the Digital Credentials to verify the identity of each User prior to enabling such User to Transmit Data. The “approved credentialing service” must meet State, Federal, and Industry standards. It must also be commonly used, verifiable, and known to as being used in existing Data exchanges.

ARTICLE VI
ENTERPRISE SECURITY

a. General. Each Partner agrees to proceed according to requirements contained in (FISM) NIST SP800-39, Managing Information Risk. Furthermore, each Partner shall be responsible for maintaining a secure environment compliant with State policies, standards and guidelines, and other Applicable Law that supports the Transmission of Data in compliance with the Specifications. Partners shall follow the specifics contained in (FISM) NIST SP800-47, Security Guide for Interconnecting Information Technology Systems and shall use appropriate safeguards to prevent use or disclosure of Data other than as permitted by this E-MOU, the (FISM) NIST SP800-47, and Applicable Law, including appropriate administrative, physical, and technical safeguards that protect the confidentiality, integrity, and availability of that Data. Appropriate safeguards shall be those required by Applicable Law related to Data security, specifically as contained in (FISM) NIST SP800-53, Security and Privacy Controls for Federal Information Systems and Organizations. Additional safeguards recommended and/or required by the Secretary of the Department of Innovation and Technology or designee or the State’s Chief Information Security Officer will be met, including but not limited to encryption of Data in transit and at rest using current industry standard algorithms agreed on by the parties involved before transmission occurs. Each Partner agrees to, as appropriate under Applicable Law, have written privacy and security policies, including Access and Disclosure Policies, in place before the Partner’s respective Effective Date for data exchange, meeting both FIPS PUB 200, Minimum Security Requirements for Federal Information and Information Systems, and (FISM) NIST SP800-60 Volume 1, Guide for Mapping Types of Information and Information Systems to Security Categories. To the extent permitted under Applicable Law, Partners shall comply with any Specifications that define expectations with respect to enterprise security.

b. Malicious Software. Each Partner agrees to employ security controls so that Data Transmittal will not introduce any viruses, worms, unauthorized cookies, Trojans, malicious software, “malware,” or other program, routine, subroutine, or Data designed to disrupt the proper operation of a System or any part thereof or any hardware or software used by a Partner in connection therewith, or which, upon the occurrence of a certain event, the passage of time, or the taking of or failure to take any action, will cause a System or any part thereof or any hardware,
software or Data used by a Partner in connection therewith, to be improperly accessed, destroyed, damaged, or otherwise made inoperable. Partner agrees to meet the requirements contained in (FISM) NIST SP 800-53, Security and Privacy Controls for Federal Information Systems and Organizations, (FISM) SP800-60, Volume 1, Guide for Mapping Types of Information and Information Systems to Security Categories, and FIPS PUB 200, Minimum Security Requirements for Federal Information and Information Systems.

c. In accordance with Applicable Law, each Partner on its side of the exchange shall be responsible for procuring, and assuring that its Users have or have access to, all equipment and software necessary for it to fulfill its responsibilities under this E-MOU. Each Partner shall ensure that it is meeting the requirements set forth in (FISM) NIST SP800-53, Security and Privacy Controls for Federal Information Systems and Organizations and that all computers and electronic devices owned or leased by the Partner used to store, transmit, receive, and permits access are properly configured, including, but not limited to, the operating system, web server, and Internet connectivity. Each Partner shall comply with FIPS PUB 200, Minimum Security Requirements for Federal Information and Information Systems. Partners shall ensure that System solutions that store, transmit, receive, and permits access are compliant with the Specifications and with the requirements contained in (FISM) NIST 800-60, Volume 1, Guide for Mapping Types of Information and Information Systems to Security Categories.

d. Each Partner shall, through its agents, employees, and independent contractors, have the ability to monitor and audit all access to and use of its System related to this E-MOU, for system administration, security, and other legitimate purposes. Each Partner shall develop auditing activities that meet the requirements in (FISM) NST SP800-137, Information Security Continuous Monitoring (ISCM) and shall perform those auditing activities required by the Specifications.

e. Security Standards for Transmission of Data. Data should be encrypted to appropriate framework or regulation relevant to the policy, using current Industry standard algorithms agreed on by the parties involved. Electronic signatures should be used in transmissions to identify the source and destination.

f. Exception Process. A Partner which does not yet fully meet the requirements set forth above in Article VI may apply to the Operational Committee with a proposed plan to share data during the process of coming into full compliance with the stated requirements. The request will be assigned to the Security Chair, who, in partnership with the Office of the State’s Chief Information Security Officer, will review the request and provide a recommendation to the full Operational Committee.

ARTICLE VII
SPECIFICATIONS

a. General Compliance. Each Partner shall comply with all of the Specifications under this E-MOU, and identified hereto as Appendix 5, unless compliance would be a violation of Applicable Law.

b. Adoption of Specifications. The Partners hereby acknowledge the role of the Operational Committee as the mechanism whereby the Partners can jointly advise the adoption of Service Specifications and Emergent Specifications, and that the Operational Committee, at the direction of the Secretary of the Department of Innovation and Technology, may recommend the
adoption of amendments to, or repeal and replacement of, the Service Specifications at any time, as outlined in Appendix 3 and Appendix 5 of this E-MOU.

c. Specification Amendment Process. The Specifications shall be amended as set forth in Appendix 3 of this E-MOU.

ARTICLE VIII
EXPECTATIONS, DUTIES, AND RESPONSIBILITIES
OF PARTNERS

a. Minimum Requirements for Partners Regarding Data Requests. All Partners that make Data Requests, or allow their respective Users to make Data Requests, shall have a collaborative relationship and shall respond to Data Requests when made to them by another Partner in the affirmative, unless specifically prohibited by Applicable Law. If the request cannot be fulfilled, the Partner shall provide the Legal authority on why the request cannot be complied with and how to overcome the prohibition. A Partner shall fulfill its duty to respond to Data Requests by either (i) responding to the Data Request within ten (10) business days with the requested Data, or (ii) responding to the Data Request within ten (10) business days that the Data is not available or cannot be exchanged, with the Legal authority on why the request cannot be complied with and how to overcome the prohibition. Data Transmittals in response to Data Requests shall comply with the Specifications, this E-MOU, applicable Partner Access and Disclosure Policies, any applicable agreements between Partners and their Users, and Applicable Law. Partners must be approved to request data from the specified Data Exchange Service as defined in Appendix 5 and 6. Nothing in this E-MOU shall require a Data Transmittal that would violate Applicable Law. However, if the transmission of the Data to Partners is specifically prohibited by state or federal law, Partners shall work to identify if any edits, deletions or additional protections can be made to comply with state and federal laws allowing Data to be provided to a Partner. Partners shall provide the data with plans and procedures for ensuring data shared between the Partners continues to be protected in accordance with such laws.

b. Users and Information Technology Service Provider (ITSPs). Each Partner shall require that all of its Users and ITSPs perform Data Transmittal only in accordance with the terms and conditions of this E-MOU and the applicable Specifications, including without limitation those governing the authorization, use, confidentiality, privacy, and security of Data.

c. Specific Duties of a Partner When Transmitting Data. Whenever a Partner Transmits Data to another Partner or User, the Transmitting Partner shall do so in compliance with Applicable Law, this E-MOU, the applicable Partner Access and Disclosure Policies, and the applicable Specifications.

d. Privacy and Security.

1. Applicability of Privacy and Security Regulations. To maintain the privacy, confidentiality, and security of Data, and in determining Data security (including but not limited to where the Enterprise information shall be maintained and who has access to the Data), each Partner shall comply with Applicable Law, applicable Partner Access and Disclosure Policies, the Specifications, this enterprise standard and this E-MOU, and will meet all of the requirements set forth by the State’s Chief Information Security Officer in conformity with (FISM) NIST SP800-53, Security and Privacy Controls for Federal Information Systems and Organizations.
2. **Safeguards.** Partners shall use reasonable and appropriate administrative, physical and technical safeguards as defined by the State’s Chief Information Security Officer in conformity with (FISM) SP800-47, Security Guide for Interconnecting Information Technology Systems, and comply with the Specifications to protect Data and to prevent use or disclosure of Data other than as permitted by this E-MOU.

3. **Breach Notification.** Partners shall report to the Secretary of the Department of Innovation and Technology or designee all Breaches that threaten the security of the State’s databases and Data communications resulting in exposure of Data protected by federal or state laws, or other incidents compromising the security of the State’s information technology systems with the potential to cause major disruption to normal agency activities based on the sanctioned Incident Response Handling Plan and in accordance with Appendix 4 of this eMOU. Such reports shall be made to the Secretary of the Department of Innovation and Technology or designee within 24 hours from when the Partner discovered or should have discovered the occurrence. Partners shall also comply with any Applicable Law regarding data breaches.

4. **Conflict of Obligations.** This Article shall not be deemed to supersede a Partner’s obligations (if any) under relevant security incident, breach notification or confidentiality provisions of Applicable Law or pursuant to the Statewide Incident Response Plan.

5. **Conflict of Compliance.** Compliance with this Article shall not relieve Partners of any other security incident or Breach reporting requirements under Applicable Law including, but not limited to, those related to Individuals.

c. **Responsibilities of the Partners.** Each Partner hereby agrees to the following:

1. **Data Requested by the Operational Committee.** Except to the extent prohibited by Applicable Law, each Partner has provided, and agrees to continue to provide, the Operational Committee with all Operational Measures reasonably requested by the Operational Committee and needed by the Operational Committee to discharge its duties under this E-MOU or Applicable Law. Any Operational Measures provided by a Partner to the Operational Committee shall be responsive and accurate. Each Partner agrees to provide Notice to the Operational Committee if any Operational Measures provided by the Partner to the Operational Committee materially changes. Each Partner agrees to cooperate in the confirmation or other verification of the completeness and accuracy of any Operational Measures provided. At any time, each Partner agrees to cooperate with the Operational Committee in such requests, given reasonable prior Notice. The goal is for the Partner to respond to a request within 24 hours; if the Partner cannot respond within 24 hours, the Partner shall request additional time to respond and such reasonable requests will be granted. If a Partner cannot in good faith provide Operational Measures as requested by the Operational Committee, the Partner may ask for relief from the request in writing to the Operational Committee.

2. **Execution of the E-MOU.** Each Partner shall execute this E-MOU and return an executed copy of this E-MOU to the Secretary of the Department of Innovation and Technology or designee. In doing so, the Partner affirms that it has full power and authority to enter into and perform this E-MOU. The Partner Executive shall be the representative authorized to sign on behalf of the Partner agency. The Partner Executive or designee shall maintain the E-MOU documents and make it accessible to all Partners, members of the Operational Committee, and
any other stakeholders that the Secretary of the Department of Innovation and Technology or designee determines require access.

3. **Compliance with this E-MOU.** Except to the extent prohibited by Applicable Law, each Partner shall comply fully with all provisions of this E-MOU.

4. **Agreements with Users.** Each Partner shall have established agreements with each of its Users that require the User to, at a minimum: (i) comply with all Applicable Law; (ii) reasonably cooperate with the Partner on issues related to this E-MOU; (iii) Transmit Data only for a permitted purpose; (iv) use and disclose Data received from another Partner or User only in accordance with the terms and conditions of this E-MOU; (v) within 24 hours after determining that a Breach occurred, User will report such Breach to the Secretary of the Department of Innovation and Technology or designee and the State’s Chief Information Security Officer, as well as following its agency’s internal reporting procedures; (vi) refrain from disclosing to any other person any passwords or other security measures issued to the User by the Partner; (vii) sign the User Acknowledgement form found in Appendix 5, Attachment D; and (viii) cooperate with any external audits. Notwithstanding the foregoing, for Users who are employed by a Partner or who have agreements with the Partner which became effective prior to the Effective Date, compliance with this Section may be satisfied through written policies and procedures that address items (i) through (vi) of this Section so long as the Partner can document that there is a written requirement that the User must comply with the policies and procedures.

5. **Agreements with Vendors.** To the extent that a Partner uses vendors in connection with the Partner’s Transmittal of Data, each Partner affirms that it has established agreements with each of its vendors, including ITSPs, that require the vendor to, at a minimum: (i) comply with Applicable Law; (ii) protect the privacy and security of any Data to which it has access; (iii) as soon as reasonably practicable after determining that a Breach occurred, report such Breach to the Partner; (iv) not to re-disclose information without written consent of the Partner; (v) use information only for the purposes for which it was made available under the Business Purposes provided in the Specifications Sheet as described in Appendix 5; (vi) agree to the same restrictions on the access, use, and disclosure of Data as contained herein; (vii) reasonably cooperate with the other Partners to this E-MOU on issues related to this E-MOU; (viii) sign the User Acknowledgement form found in Appendix 5, Appendix D; and (ix) cooperate with any external audits.

6. **Creation of Test Data.** Certain Partners may agree to create Test Data (non-Individual/hypothetical data created for testing purposes only) to be used by other Partners for testing. Any Test Data shall not contain Production Data. Test Data shall be created in accordance with the Validation Plan and used only within a Test environment.

7. **Accuracy of Data.** When Transmitting Data, each Partner hereby represents that at the time of Transmittal, the Data it provides is (a) an accurate representation of the Data contained in, or available through, its System, (b) sent from a System that employs security controls that meet standards in accordance FIPS PUB 200, Minimum Security Requirements for Federal Information and Information Systems, provided in a timely manner and in accordance with the Specifications.

8. **Use of Data.** Each Partner shall use Data transmitted to it only in accordance with the provisions of this E-MOU and as permitted or required by Applicable Law.
9. **Requests for Data.** Data User shall notify the Operational Committee and the original Discloser Agency immediately when Data User receives a Freedom of Information Act Request, subpoena, court order or other third party request related to the Data. The Operational Committee, in conjunction with the Disclosure Agency, shall determine whether the information sought contains identifiable or confidential information and whether it shall be released. Data User shall refer all such communications to the Operational Committee and original Discloser Agency for their joint response and shall notify the requestor that the Data remains the property of the State. Nothing in this section shall require Data User to not comply with a valid court order.

10. **Compliance with Laws.** Each Partner shall fully comply with all Applicable Laws.

   f. **Treatment of Data.** Each Recipient agrees to hold all Data in confidence and agrees that it shall not, during the term or after the termination of this E-MOU, re-disclose to any person or entity, nor use for its own business or benefit, any such Data obtained by it in connection with this E-MOU, unless such use or re-disclosure is permitted or required by Applicable Law and in accordance with the terms of this E-MOU. It is the responsibility of Recipients handling and processing data to ensure data is only used in compliance with the Business Processes listed in the Specifications sheet as described in Appendix 5. See Appendix 5, Attachment D.

   g. **Disclaimers.**

   1. **Reliance on a System.** Each Partner acknowledges and agrees that: (i) the Data provided by, or through, its System is drawn from numerous sources, (ii) the Data is specific to the point in time when drawn, and (iii) it can only confirm that, at the time of the Data Transmittal the Data are an accurate representation of Data contained in, or available through its System. Nothing in this E-MOU shall be deemed to impose responsibility or liability on a Partner related to the clinical accuracy, content or completeness of any Data provided pursuant to this E-MOU. The Partners acknowledge that other Partners’ Digital Credentials may be activated or suspended at any time; therefore, Partners may not rely upon the availability of a particular Partner’s Data.

   2. **Carrier lines.** All Partners acknowledge that the Transmittal of Data between Partners is to be provided over various facilities and communications lines, and Data shall be transmitted over local exchange and Internet backbone carrier lines and through routers, switches, and other devices (collectively, “carrier lines”) owned, maintained, and serviced by third-party carriers, utilities, and Internet service providers, all of which may be beyond the Partners’ control. Provided a Partner uses reasonable security measures, no less stringent than those directives, instructions, and specifications contained in this E-MOU and the Specifications and Applicable Law, the Partners assume no liability for or relating to the integrity, privacy, security, confidentiality, or use of any Data while it is transmitted over those carrier lines, which are beyond the Partners’ control, or any delay, failure, interruption, interception, loss, Transmittal, or corruption of any Data or other information attributable to Transmittal over those carrier lines which are beyond the Partners’ control. Use of the carrier lines is solely at the Partners’ risk and is subject to all Applicable Law. If a Breach occurs and it is determined that it happened because of a Carrier issue, the Partner responsible for the Data being transmitted is the responsible party for the Breach Notification. However, data should be encrypted using current industry standard algorithms agreed on by the parties involved before transmission occurs.
ARTICLE IX
TERM, ADDITION, SUSPENSION AND REINSTATEMENT

a. **Term.** The initial term of this E-MOU shall be for a period of one year commencing on the Effective Date. Upon the expiration of the initial term, this E-MOU shall automatically renew for successive one-year terms unless terminated by the Secretary of the Department of Innovation and Technology by providing to Partners at least ninety (90) days prior written notice of the termination of this E-MOU.

b. **Addition.** On-boarding new Data Exchange Services shall be in accordance with Appendix 1, Section 1 of this E-MOU.

c. **Suspension or Reinstatement.** Suspensions and Reinstatements of Data Exchange Services shall be in accordance with Appendix 1 (Sections 2, 3 and 4 respectively) of this E-MOU.

d. **Effect of Termination of Data Exchange Project.** Upon termination of a Data Exchange Services, and transfer of Data back to the Discloser (if requested by the Discloser), the Recipient is required to and shall purge all Data in its possession, including on computer hardware or software and in paper form. This purge must be performed in a manner no less restrictive than set forth in the requirements for “Purge” contained in NIST SP800-88, Appendix A: Minimum Sanitization Recommendation for Media Containing Data.”

e. **Dispute Resolution Process.**

1. **General.** If any Dispute arises between Partners regarding the implementation of this E-MOU, those Partners agree to commence efforts to resolve such dispute in good faith via a designated subcommittee of the Operational Committee. The subcommittee will be formed by the Operational Committee within seven (7) business days after written notification of the Dispute. Any Partner may submit written notification of a Dispute to the Operational Committee. If the Disputed Matter has not been resolved by the subcommittee within thirty (30) days after first having been referred to the subcommittee (or at any earlier time, if requested by Partners who are parties to the Dispute), such Dispute may be referred to the Secretary of the Department of Innovation and Technology or designee for resolution.

2. **Activities during Dispute Resolution Process.** Pending resolution of any Dispute under this E-MOU, the Partners agree to fulfill their responsibilities in accordance with this E-MOU, unless the Partner is suspended by the Secretary of the Department of Innovation and Technology or designee.

3. **Implementation of Agreed Upon Resolution.** If, at any point during the Dispute Resolution Process, all of the Partners to the Dispute accept a proposed resolution of the Dispute, the Partners agree to implement the terms of the resolution in the agreed upon timeframe.

4. **Disputes between a Partner and the Operational Committee.** If any Dispute arises between a Partner and the Operational Committee, such Disputed Matter is escalated to the Secretary of the Department of Innovation and Technology or designee for resolution.
5. **Dispute Resolution before Suspension.** Partners agree to address differences using this Dispute Resolution Process as their initial method to resolve disagreements with other Partners. A good faith effort should be made proactively to resolve differences between Partners before the Operational Committee will consider interceding to recommend suspending a Partner from a Data Exchange Service for failing to fulfill their E-MOU defined duties.

6. **Appeal to the Chief Operating Officer.** If, following resolution of a Dispute by the State's Chief Information Officer, a Partner believes in good faith that the resolution would violate the Partner’s legal obligations or be contrary to the best interests of the State, the Partner may submit the Dispute to the Governor's Chief Operating Officer (or another designee of the Office of the Governor). The Partner, the State's Chief Information Officer, and other interested persons shall provide information about the Dispute to the Chief Operating Officer upon request to enable a review of the Dispute and the initial resolution. The State's Chief Information Officer will revise the resolution as necessary upon direction from the Chief Operating Officer to ensure that the resolution complies with all legal obligations and is in the best interests of the State.

**ARTICLE X**

**MISCELLANEOUS**

a. **Notices.** All Notices to be made under this E-MOU shall be given in writing to the authorized Partner’s representative at the address listed with the Operational Committee, and shall be deemed given: (i) upon delivery, if personally delivered or through the State’s inter-agency mail system; (ii) upon the date indicated on the return receipt, when sent by the United States Postal Service Certified Mail, return receipt requested; and (iii) if by electronic Transmittal, upon the date and time of sending the Notice is directed to an electronic mail address listed with the Operational Committee.

b. **Governing Law.** This E-MOU shall be governed by and construed in accordance with the applicable laws of the United States and the State of Illinois.

c. **Amendment.** An amendment of the E-MOU may be recommended by agreement of at least two-thirds of the Operational Committee to submit to the Secretary of the Department of Innovation and Technology for his/her approval. All Partners agree to sign an amendment adopted in accordance with the provisions of this Section in accordance with Appendix 1. Partners shall have the right to challenge an Operational Committee recommendation to amend the E-MOU, with the challenge being considered a Disputed Matter and resolved based on the Dispute Resolution Process described in Appendix Two of this E-MOU.

d. **Entire E-MOU.** This E-MOU, together with all Appendices and Attachments, constitutes the entire agreement. The official, executed version of this E-MOU shall be maintained in an electronic form by the Secretary of the Department of Innovation and Technology or designee. The Secretary of the Department of Innovation and Technology or designee shall maintain the E-MOU is a format that is accessible to all E-MOU Partners.

e. **Validity of Provisions.** In the event that any Section, or any part or portion of any Section of this E-MOU, is determined to be invalid, void or otherwise unenforceable, each and every remaining Section or part or portion thereof shall remain in full force and effect.

f. **Priority.** In the event of any conflict or inconsistency between a provision in the body of
this E-MOU and any attachment hereto, the terms contained in the body of this E-MOU shall prevail.

g. **Headings.** The headings throughout this E-MOU are for reference purposes only, and the words contained therein may in no way be held to explain, modify, amplify, or aid in the interpretation or construction of meaning of the provisions of this E-MOU. All references in this instrument to designated “Sections” and other subdivisions are to the designated Sections and other subdivisions of this E-MOU. The words “herein,” “hereof,” “hereunder,” and other words of similar import refer to this E-MOU as a whole and not to any particular Section or other subdivision.

h. **Relationship of the Partners.** Nothing in this E-MOU shall be construed to create a partnership, agency relationship, or joint venture among the Partners. Neither the Operational Committee nor any Partner shall have any authority to bind or make commitments on behalf of another Partner for any purpose, nor shall any such Partner hold itself out as having such authority. No Partner shall be held liable for the acts or omissions of another Partner.

i. **Effective Date.** With respect to the first two Partners to this E-MOU, the Effective Date shall be the date on which the second Partner executes this E-MOU. For all Partners thereafter, the Effective Date shall be the date that the Partner executes this E-MOU.

j. **Counterparts.** This E-MOU may be executed in any number of counterparts, each of which shall be deemed an original as against the Partner whose signature appears thereon, but all of which taken together shall constitute but one and the same instrument.

k. **Third-Party Beneficiaries.** There shall exist no right of any person to claim a beneficial interest in this E-MOU or any rights occurring by virtue of this E-MOU.

l. **Force Majeure.** A Partner shall not be deemed in violation of any provision of this E-MOU if it is prevented from performing any of its obligations by reason of: (a) severe weather and storms; (b) earthquakes or other disruptive natural occurrences; (c) power failures; (d) nuclear or other civil or military emergencies; (e) terrorist attacks; (f) acts of legislative, judicial, executive, or administrative authorities; or (g) any other circumstances that are not within its reasonable control. This Section shall not apply to obligations imposed under Applicable Law.

m. **Time Periods.** Any of the time periods specified in this E-MOU may be changed pursuant to the mutual written consent of the Secretary of the Department of Innovation and Technology and the affected Partner(s).

n. **Ownership.** Any Data provided by a Discloser to a Recipient shall remain the property of the Discloser even after it is provided to a Recipient. Recipient shall not obtain any right, title, or interest in the Data.

o. **Court Order or Subpoena.** In the event that any Data is required to be disclosed in response to a valid order to a court of competent jurisdiction or other governmental body of the United States or any political subdivisions thereof. Only the minimal necessary Data shall be disclosed to the extent necessary and for the purposes of the court or other governmental body. The Partner will be notified of the order and provided with a copy of such order and Partner may seek a protective order.
p. **Public Notification.** If required by Applicable Law, Partner will post a copy of this E-MOU for public access.
FERPA ADDENDUM

This Family Educational Rights and Privacy Act (20 U.S.C. § 1232g; 34 C.F.R. Part 99) ("FERPA") Addendum ("Addendum" or "FERPA Addendum") is an add-on to the State of Illinois Enterprise Memorandum of Understanding ("E-MOU"). It is applicable only in those situations where the Recipient obtains, transmits, uses, maintains, retains, processes, or disposes of Personally Identifiable Information (defined below) regarding students from the Illinois State Board of Education ("ISBE") in order to fulfill its obligations to ISBE pursuant to the E-MOU. ISBE is required by law to collect and store student records (105 ILCS 5/2-3.31), and takes seriously its obligations to secure information systems and protect the privacy of data collected, used, shared and stored by the agency. This Addendum sets forth the minimum requirements under the research and the audit or evaluation exceptions to FERPA. If any conflict exists between the terms of this Addendum and the E-MOU, the terms of this Addendum shall govern. If only de-identified data (defined below) will be used, this Addendum is not applicable (34 C.F.R. § 99.30).

DEFINITIONS (34 CFR § 99.3)

"Authorized representative" means any entity or individual designated by a State or local educational authority or an agency headed by an official listed in §99.31(a)(3) to conduct—with respect to Federal- or State-supported education programs—any audit or evaluation, or any compliance or enforcement activity in connection with Federal legal requirements that relate to these programs.

"Disclose", "disclosure" or "re-disclose" means to permit access to or the release, transfer, or other communication of personally identifiable information contained in education records by any means, including oral, written, or electronic means, to any party except the party identified as the party that provided or created the record.

"Education program" means any program that is principally engaged in the provision of education, including, but not limited to, early childhood education, elementary and secondary education, postsecondary education, special education, job training, career and technical education, and adult education, and any program that is administered by an educational agency or institution.

"Personally Identifiable Information" ("PII") includes, but is not limited to—(a) The student’s name; (b) The name of the student's parent or other family members; (c) The address of the student or student's family; (d) A personal identifier, such as the student's social security number, student number, or biometric record; (e) Other indirect identifiers, such as the student's date of birth, place of birth, and mother's maiden name; (f) Other information that, alone or in combination, is linked or linkable to a specific student that would allow a reasonable person in the school community, who does not have personal knowledge of the relevant circumstances, to identify the student with reasonable certainty; or (g) Information requested by a person who the educational agency or institution reasonably believes knows the identity of the student to whom the education record relates.

"De-identified data" means data that does not identify a particular individual, program, classroom, school, institution or district and with respect to which there is no reasonable basis to believe the data can be used to identify a particular individual, program, classroom, school, institution or district. Personally identifiable information has been removed or obscured from the data in a way that minimizes the risk of unintended disclosure of the identity of individuals, programs, classrooms, schools, institutions or districts and information about them whether through single or multiple releases, and taking into account other reasonably available information. 34 C.F.R. § 99.31(b)(1).
Recipient agrees to hold Confidential Student Information, which includes both PII and de-identified data subject to FERPA, in strict confidence. Recipient will not use or disclose Confidential Student Information received from or on behalf of ISBE except as permitted or required by this Addendum, as required by law, or as otherwise authorized in writing by ISBE. ISBE has sole authority to authorize and approve data access and may limit the number of authorized contractors, subcontractors, or agents under this Addendum. Recipient must create and maintain a record of any disclosure of Confidential Student Information. The record of disclosure must record the name of any person or organization receiving the Confidential Student Information and their legitimate interest under 34 C.F.R. § 99.31 in requesting or obtaining the Confidential Student Information. Upon ISBE’s request, Recipient must provide a copy of the record of further disclosures to ISBE. 34 C.F.R. § 99.32(b)(2)(i) and (ii).

AUDIT OR EVALUATION EXCEPTION. 34 CFR §§99.31(a)(3) and 99.35

ISBE formally designates Recipient as its authorized representative for purposes of audit or evaluation of Federal- or State-supported education programs, or to enforce or to comply with Federal legal requirements that relate to those programs. The disclosure of the specified PII from education records is in furtherance of an audit, evaluation, or enforcement or compliance activity regarding such education programs. The specific PII being disclosed from education records is identified in Appendix 5 to the E-MOU and described therein with sufficient specificity to ensure that it falls within the audit or evaluation exception. Recipient will include a description of how the PII from education records will be used, the methodology and why disclosure of PII from education records is necessary to accomplish the audit, evaluation, or enforcement or compliance activity.

Recipient agrees to use the PII from education records only to carry out an audit or evaluation of Federal- or State-supported education programs, or for the enforcement of or compliance with, Federal legal requirements related to these programs. Recipient agrees to protect the PII from education records from further disclosures or other uses, except as authorized by ISBE in accordance with FERPA. Approval to use the PII from education records for one audit or evaluation does not confer approval to use it for another.

Recipient will dispose of or return all Confidential Student Information to ISBE within ten (10) days, upon ISBE’s request. All Confidential Student Information received pursuant to this Addendum shall be disposed of upon termination, cancellation, expiration, or other conclusion of the E-MOU. Disposal means the return of the Confidential Student Information to ISBE or destruction of the Confidential Student Information as directed by ISBE, including purging of all copies from the Recipient’s computer systems. Upon disposal of the Confidential Student Information, Recipient will confirm to ISBE in writing the destruction of Confidential Student Information. Recipient agrees to require all employees, contractors, subcontractors, or agents of any kind to comply with this provision.

Recipient agrees to establish and maintain policies and procedures, consistent with FERPA and other Federal and State confidentiality and privacy provisions, to protect PII from education records from further disclosure and unauthorized use, including limiting use of PII from education records to only authorized representatives with legitimate interests in an audit, evaluation, or enforcement or compliance activity. Such policies and procedures will be described in Appendix 5.

STUDIES EXCEPTION. 34 CFR §99.31(a)(6)

Recipient is an organization to whom ISBE can disclose PII from an education record of a student under the studies exception because the disclosure is to conduct studies for, or on behalf
of ISBE, educational agencies or institutions to: (A) Develop, validate, or administer predictive tests; (B) Administer student aid programs; or (C) Improve instruction.

Recipient will specify in Appendix 5 the purpose of the study, describe its scope and duration and identify the information, including any PII, being disclosed. Recipient agrees to use PII from education records only to meet the purpose or purposes of the study.

Recipient will conduct the study in a way that does not allow personal identification of parents and students by individuals other than representatives of Recipient with a legitimate need to know, and will take steps to maintain the confidentiality of the PII from education records at all stages of the study, including within the final report, by using appropriate disclosure avoidance techniques.

Recipient agrees to destroy all PII from education records when the information is no longer needed for the purposes for which the study was conducted. ISBE will determine the specific time period for destruction based on the particular study.
State of Illinois
Enterprise Memorandum of Understanding (E-MOU)

Appendices
Appendix 1
Procedures for Adding a New Partner and Suspending a Partner

1. Adding a New Partner

When an Applicant requests to join this E-MOU, the request shall be directed to the Chairperson of the Operational Committee in writing. As laid out in Appendix 5, Section 1 of this E-MOU, the Applicant must submit an E-MOU Data Services Request Form to inform the Operational Committee which Data Exchange Services it wants to access. There are different E-MOU Data Services Request Forms for sending data and for receiving data. If the Applicant’s request is approved, the Applicant must submit an Internal Control Questionnaire (“ICQ”) to the Operational Committee laying out details of how the Applicant intends to secure the data it will receive. There is no ICQ required if only sending data. Finally, if the Applicant’s ICQ is approved, Applicant must submit a Specification Sheet listing a specific business reason why access is desired. Again, there is a different Specification Sheet for sending data and for receiving data.

If no concerns are identified, the Applicant will be approved to begin new partner testing as defined by the On-boarding Validation Plan in Appendix 6 to be reviewed and amended, as necessary, by the Operational Committee of this E-MOU.

Once the Applicant has successfully completed the On-boarding Validation Plan as defined in Appendix 6, the Chairperson shall facilitate a review by the Operational Committee within ten (10) business days of the User Acceptance Testing (UAT) Report for compliance with the Validation Plan. For the Applicant to be recommended for Production access by the Operational Committee, at least two-thirds of the Members of the Operational Committee must approve the submitted UAT Test Report.

If the Applicant’s Test Report for UAT is recommended by the Operational Committee (the timeframe for review of the Applicant will be determined by the Operational Committee), such recommendation shall be forwarded by the Chairperson within the next business day to the State’s Chief Information Officer or designee for a final decision. If the decision is to accept the Operational Committee’s recommendation, the Applicant will be considered a Partner and shall execute this E-MOU with its supporting appendices. The State’s Chief Information Officer or designee shall forward the approval to the Operational Committee for their information.

If the Operational Committee does not recommend approving the Applicant’s UAT Test Report, the Operational Committee will so advise the Applicant, with specific remediation guidance to improve compliance when re-testing.

2. Suspension

A. Voluntarily by the Partner
Appendix 1
Procedures for Adding a New Partner and Suspending a Partner

1. Service Level Interruptions

Partners may experience temporary service level interruptions from time to time. These service level interruptions may be planned or unplanned. A service level interruption may result in a Partner having to temporarily cease Data Transmittals with other Partners. To ensure that all Partners are aware of service level interruptions, the Partner experiencing the service level interruption agrees to notify the State’s Chief Information Officer or designee and members of the Operational Committee of the interruption prior to the interruption as early as possible but no later than one business day before the interruption, if planned (and Partner agrees that if planned, the interruption will occur outside of normal business hours if possible); or as soon as reasonably practicable after the interruption begins, if unplanned. The State’s Chief Information Officer or designee shall simultaneously notify all other Partners of the interruption. Since a service level interruption does not involve the suspension of a Partner’s Digital Credentials, the Partner agrees to be responsible for taking all technical actions necessary to resolve a service level interruption. During a service level interruption, the Partner agrees to continue to comply with the terms and conditions of the E-MOU.

2. Voluntary Suspension

If a Partner decides that it requires a temporary suspension of its Digital Credentials and its responsibility for complying with the terms of the E-MOU, it agrees to provide Notice to the State’s Chief Information Officer and members of the Operational Committee of its need for a temporary voluntary suspension at least twenty-four (24) hours prior to commencing its voluntary suspension. The Notice shall specify the reason for, the commencement date of, and the duration of the voluntary suspension. The State’s Chief Information Officer or designee shall approve such Voluntary Suspension and simultaneously notify all other Partners of the voluntary suspension.

B. With Cause

If the Operational Committee finds that a Partner is in material default of the performance of a duty or obligation imposed on the Partner by this E-MOU, it shall recommend that the State’s Chief Information Officer or designee notify the Partner, in writing as soon as possible but no later than 2 business days after the recommendation, of such default. Material defaults include, but are not limited to, failure to comply with:

- any privacy, security or confidentiality obligations in the E-MOU;
- repeated failure to fulfill the duties of a Partner, including a requesting or responding Partner as provided for in the E-MOU; and
- any Breach of the representations in the E-MOU.
Appendix I

Procedures for Adding a New Partner and Suspending a Partner

If the Partner does not substantially cure its material default within thirty (30) days following receipt of the written Notice of such default from the State’s Chief Information Officer or designee, the Operational Committee may recommend that the State’s Chief Information or designee suspend the Partner.

Additionally, the Operational Committee shall investigate all complaints, reports, or other information received regarding concerns that a Partner’s information technology (IT) system is creating an immediate threat of Data Breach or will cause irreparable harm to another party, including, but not limited to, another Partner, a User, the Office of the State’s Chief Information Officer, or an Individual whose Data is exchanged pursuant to this E-MOU. The Operational Committee shall notify the State’s Chief Information Officer or designee of any recommendation that such Partner be issued a finding requiring a corrective action plan to remedy the issue for the specific IT System.

When the complaint, report, or other information indicates that a suspension from receiving data to a Partner’s specific IT system must be implemented immediately and, in the judgment of the Chairperson, it is not practical to delay the suspension until the Operational Committee is convened, the Chairperson shall immediately:

- take all technical actions necessary to carry out the suspension including, but not limited to, suspension of the Partner’s Digital Credentials to receive, but not provide, data to E-MOU Partners from the IT system in question;
- call a special meeting as soon as possible of the Operational Committee to evaluate the recommendation of suspension; and
- notify the suspended Partner of the suspension (as well as the other Partners of the decision).

The investigation by the Operational Committee discussed above may follow the immediate action.

If the Chairperson determines that immediate suspension is not required, the Operational Committee may initiate an investigation of the complaint, report, or other information. The Operational Committee Chairperson shall immediately notify the Partner(s) in question of the investigation.

The Operational Committee shall meet as soon as practicable, but no later than five (5) business days after the receipt of the complaint by the Operational Committee, to evaluate the suspension action by the Chairperson. The suspension shall remain in effect until the Operational Committee meets to evaluate the suspension and makes a recommendation to the State’s Chief Information Officer or designee to affirm, modify, or terminate the suspension.
Appendix 1

Procedures for Adding a New Partner and Suspending a Partner

If the Chairperson of the Operational Committee is, or reports to, an employee of the Partner identified by the complaint, the Chairperson shall recuse himself/herself from the investigation of the complaint and defer complaint oversight duties to the Vice-Chairperson.

If a complaint is referred to the Chairperson and such complaint has not been resolved by the Operational Committee within thirty (30) days after it was first referred to the Chairperson (or such longer period as agreed to in writing by the Partners who are parties to the complaint), then the complaint shall be escalated to the State’s Chief Information Officer or designee for resolution. If the State’s Chief Information Officer or designee cannot reach a decision within five (5) business days from the referral or does not state that an additional five (5) business days is necessary to reach a decision, then the complaint is dismissed with no action taken against the Partner.

If, through the investigation, the Operational Committee recommends that a Partner is (i) creating an immediate threat or (ii) will cause irreparable harm to another party including, but not limited to, another Partner, a User, the Office of the State’s Chief Information Officer, or an individual whose Data are exchanged pursuant to the E-MOU, the Operational Committee may recommend to the State’s Chief Information Officer or designee that such Partner be issued a finding requiring a corrective action plan to remedy the issue for the IT system. If the State’s Chief Information Officer or designee concurs in the recommendation, the State’s Chief Information Officer or designee shall take all technical actions necessary to carry out the finding or suspension including, but not limited to, suspension of the Partner’s Digital Credentials to receive data from, but not provide data to E-MOU Partners from the IT system in question. As soon as reasonably practicable after suspending a Partner, but in no case longer than twelve (12) business hours, the Operational Committee Chairperson, with the concurrence of and through the Office of the States’ Chief Information Officer, shall provide the suspended Partner with a written summary of the reasons for the suspension and notify all other Partners of the suspension.

The suspended Partner agrees to provide the Operational Committee with a written plan of correction or an objection to the suspension within five (5) business days of being notified of the suspension.

Any objection shall specify the reason that the Partner feels the suspension is inappropriate. The plan of correction shall detail the action that the Partner is taking to address, mitigate and remediate the issue(s) that were the basis for the suspension as outlined in the summary and include a timeframe for such actions. The Operational Committee shall meet and review a suspended Partner’s plan of correction or objection within five (5) business days of receipt from the Partner; determine whether to recommend to the State’s Chief Information Officer or designee to accept or reject the plan of correction or affirm the suspension; and communicate such decision to the State’s Chief Information Officer or designee who will act on such recommendation and provide his/her decision to the subject Partner and the Operational Committee.
Appendix 1

Procedures for Adding a New Partner and Suspending a Partner

If the Operational Committee rejects the plan of correction, it shall work in good faith with the suspended Partner to develop a mutually acceptable plan of correction. If the Operational Committee and the suspended Partner cannot reach agreement on the content of the plan of correction or on the reasons supporting the suspension, the Operational Committee may submit the Dispute to the State’s Chief Information Officer for resolution.

Any suspensions imposed shall remain in effect until the Partner is reinstated with this E-MOU. A finding requiring a Corrective Action Plan, but not a suspension, shall describe the action that the Partner is taking to address, mitigate and remediate the issue(s) that caused the Operational Committee to make the finding and include a timeframe for such actions. The Partner’s corrective action plan in response to an Operational Committee finding shall be submitted within thirty (30) days of the finding being issues. The Operational Committee shall meet and review a Partner’s corrective action plan at the next regular meeting following the submission of the corrective action plan from the Partner; determine whether to recommend to the State’s Chief Information Officer or designee to accept or reject the plan; and communicate such decision to the State’s Chief Information Officer or designee who will act on such recommendation and provide his/her decision to the Partner and the Operational Committee no later than five (5) business days after receipt from the Operational Committee.

3. Reinstatement

A. After Voluntary Suspension by a Partner

The Partner’s notification of a voluntary suspension shall state the commencement date and the duration of the suspension. The Partner may extend the duration of the voluntary suspension should it be necessary as determined by the Partner.

Either on the date indicated by the Partner in the suspension or extension request or at an earlier time if requested by the Partner, the State’s Chief Information Officer or designee shall take all technical actions necessary to reinstate the Partner’s ability to participate in the Data Exchange Service including, but not limited to, the reinstatement of the Partner’s Digital Credentials.

B. After Suspension with Cause

When a Partner’s ability to participate in the Data Exchange Service has been suspended by the Operational Committee with cause, the Partner agrees to provide evidence to the Operational Committee of the Partner’s fulfillment of the obligations of its plan of correction. The Operational Committee shall review such evidence at its next regularly scheduled meeting following receipt from the Partner.
Appendix 1

Procedures for Adding a New Partner and Suspending a Partner

If the Operational Committee is not satisfied that the Partner has met its obligations under its plan of correction, the Operational Committee Chairperson shall inform the Partner of the deficiencies within five (5) business days of reaching that decision. The Partner will have the ability to submit additional evidence that addresses such deficiencies.

When the Operational Committee is satisfied that the evidence presented indicates that the Partner has fulfilled its obligations under the plan of correction, it shall recommend that the State’s Chief Information Officer take all technical actions necessary to reinstate the Partner’s ability to participate in the Data Exchange Service including, but not limited to, the reinstatement of the Partner’s Digital Credentials. Such action should be completed as soon as possible but not later than three (3) business days after reaching that decision. The State’s Chief Information Officer, or designee, shall inform all the Partners of such reinstatement forthwith.
Appendix 2
Process to Amend the E-MOU

1. Submission of Proposed Amendments to the E-MOU

Any Partner may submit in writing to the Operational Committee Chairperson a request for an amendment to the E-MOU. All requests for proposed amendments shall identify:

- the section of the E-MOU that is the subject of the requested amendment (if any);
- a description of why the requested amendment is desired;
- the proposed language for the requested amendment; and
- an analysis of the expected impact of the requested amendment.

2. Consideration of Proposed Amendments to the E-MOU

If, after considering the request at the next regularly-scheduled meeting, the Operational Committee determines that the request does not have merit, it shall communicate this determination to the requesting Partner.

If, after considering the request at the next regularly-scheduled meeting, the Operational Committee determines that the request has merit, the Operational Committee shall forward the request to the State’s Chief Information Officer or designee to seek approval of the recommended amendment. When the Operational Committee seeks approval of such amendments, the Operational Committee shall provide the State’s Chief Information Officer or designee with the following information:

- a copy of the proposed amendment to the E-MOU;
- description of why the requested amendment is desired and any foreseeable impact of the amendment;
- statement regarding whether the proposed amendment is necessary in order for the Operational Committee or Partners to comply with Applicable Law; and
- projected effective date for the proposed amendment.

If the State’s Chief Information Officer or designee agrees with the proposed amendments to the E-MOU, the State’s Chief Information Officer or designee will advise all of the Partners of such decision and the effective date for the proposed amendment.

3. Approval or Rejection of Proposed Amendments to the E-MOU

The Operational Committee shall meet to vote on recommending proposed amendments to the E-MOU. For proposed amendments to be recommended by the Operational Committee, at least two-thirds of the members of the Operational Committee must approve the amendment.
Appendix 2

Process to Amend the E-MOU

Once an amendment is recommended by the Operational Committee, and the State’s Chief Information Officer agrees with the recommendation, all Partners are advised to sign the amendment to the E-MOU prior to the effective date of the amendment.
Appendix 3
Change Process for Data Exchange Services

1. Requests for Change

A. Development Changes

The Operational Committee shall have the authority to adopt new E-MOU Service Specifications or Specification of Service and use of Emergent Specifications, and to adopt amendments to, or repeal and replace, the E-MOU Service Specifications or Specification of Service (collectively a “Development Change”). Service Specifications must conform to those found in Appendix 5 of this E-MOU.

B. Compliance Changes

The Operational Committee shall have the authority to recommend to the State’s Chief Information Officer to adopt new or to make Changes to existing E-MOU Service Specifications or Specification of Service that are necessary: (1) for compliance with Applicable Law; or (2) to maintain the integrity of Data being exchanged (collectively a “Compliance Change”). For Compliance Changes, and upon request from the Operational Committee, a task group may evaluate the Change and provide comments to the Operational Committee.

2. Receipt

All requests for Changes shall be directed in writing to the Operational Committee Chairperson. The Operational Committee Chairperson shall catalog all requests for Changes upon receipt.

The catalog shall include:

a. Type of the proposed change (e.g. new, amendment, repeal)
b. Name and version number of the specification;
c. Whether the proposed change is a Development Change, Compliance Change or a request for consultation;
d. Brief description of the reasons for the proposed change (e.g., to enhance metadata available about a document, to meet requirements of a new use case or to comply with a specific law or regulation);
e. Description of the actual changes;
f. Preliminary analysis of the potential business and technical impact to Partners and their Users;
g. Copy of the Specification; and
h. Requesting agency and date of request.

The catalog will be made available online.
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Change Process for Data Exchange Services

3. Evaluation

The Operational Committee shall, within thirty (30) business days after being informed by the Chairperson of receipt, forward the request for change to a task group designated by the Operational Committee for technical evaluation of the request and to make a recommendation to the Operational Committee. During consideration of the request for change, the task group may request additional information from the Operational Committee, Partners or the requesting Partner, as the task group deems reasonably necessary.

A. Evaluation Criteria for Proposed Changes

1. Evaluation of Development Changes.

If the change is a Development Change, the Operational Committee Chairperson shall ensure each Partner is provided a copy of the original proposed Change. Each Partner shall respond in writing to the Operational Committee Chairperson by a designated response date with the following information:

a. whether the implementation of the Development Change will have a significant adverse operational or financial impact on the Partner;
b. whether implementation of the Development Change will require the Partner to materially modify its existing agreements with its Users or third parties;
c. whether the Partner believes that implementation of the Development Change will require an amendment to the E-MOU, including amendments to the permitted purposes; and
d. whether the Partner would implement a change (if optional), and
e. whether the implementation would potentially violate applicable law and a description of the potential violation.

The Partner agrees to provide rationale for each affirmative response. The task group or the Operational Committee may request additional information from Partners to further evaluate the responses.

2. Determination of Development Changes.

The task group shall review responses from the Partners to inform its recommendation to the Operational Committee about the proposed change. Factors in considering the proposed change shall include:

a. whether the change has a significant adverse operational or financial impact on at least 20% of Partners;
Appendix 3
Change Process for Data Exchange Services

b. whether the change requires at least 20% of Partners to modify their existing agreements with Users or third parties;
c. whether the proposed change requires an amendment to the E-MOU; and
d. whether the proposed change may violate applicable law.

In addition, the task group shall consider the implications of the change to the policies and procedures for the Data Exchange Service.

If a new Agency becomes a Partner after Partners have been asked to respond to questions about the Development Change but before the designated response date, this new Partner will be given an opportunity to respond by the designated response date.

The task group shall present its recommendation to the Operational Committee at the Operational Committee’s next regularly scheduled meeting following the designated response date. The Operational Committee shall review the task group’s recommendation and make a final recommendation to the State’s Chief Information Officer regarding whether the Development Change should be approved.


If the proposed Change is a Compliance Change, the task group shall review the Change to assess its impact. The task group shall meet with the Operational Committee and present its findings and recommendations on the Compliance Change within three (3) weeks of the task group receiving the proposed Compliance Change. The Operational Committee shall review the task group’s recommendation and make a final recommendation to the State’s Chief Information Officer or designee within two (2) weeks of receiving the task group’s recommendation.


For both Development Changes and Compliance Changes, the task group shall assess and make recommendations to the Operational Committee regarding the timeline for implementing the Change including, but not limited to, the number of prior versions of the Specification that should be supported and the amount of time that Partners should be given to migrate to the new Specification. The Operational Committee shall provide an opportunity for affected Partners to provide feedback on their preferred timeline and ability to absorb the additional work required by any changes. The task group shall consider:

a. Whether the Change impacts interoperability among the Partners;
b. The number of versions of the Specification that will be supported for backward compatibility purposes and the business implications of such support;
c. If multiple versions will be supported, a sunset date for such support as the multiple versions are collapsed;
Appendix 3
Change Process for Data Exchange Services

d. The business implications for Partners related to migrating to the new Specification;
e. The number of Partners and number of transactions that will be impacted by the new Specification;
f. The amount of time that Partners should be given to migrate to the new Specification;
g. Whether legislative or regulatory changes are required;
h. The time it will take to conduct a security review of the changes with the State’s CISO; and
i. Sunset dates as “old” specifications are retired.

The task group shall present its recommendations regarding implementation to the Operational Committee at the same time it presents its other recommendations regarding the same Change to the Operational Committee. The Operational Committee shall review the task group’s recommendation and make a final determination regarding the timeline to recommend to the State’s Chief Information Officer.

B. Response

1. Development Changes.

At the conclusion of the response period established during the evaluation of the proposed Change, the Operational Committee shall evaluate whether to recommend to the State’s Chief Information Officer that the Development Change be approved, if revisions to the E-MOU will be required and a proposed timeline for implementation. The recommendation of the Operational Committee regarding the Development Change and the proposed timeline for implementation shall be communicated to the State’s Chief Information Officer or designee. Revisions to the E-MOU necessitated by approved Development Changes will be performed in accordance with Appendix 2 of this E-MOU.

2. Compliance Changes.

Based upon responses from the Partners, the Operational Committee shall provide input to all Partners on the impact of the Compliance Change and the recommended timeline for implementation.
Appendix 4
Procedures for Breach Notification

1. Procedures for Partner Breach Notification

A. Notification Process

1. Upon initial indication of a Breach, the Partner(s) responsible for or affected by the Breach shall report to the State’s Chief Information Officer or designee and the Chief Information Security Officer. Such reports shall be made within 24 hours from when the Partner discovered or should have discovered the occurrence. Partners shall also comply with any Applicable Law regarding Breaches.

2. Following this Notification to the State’s Chief Information Officer or designee and the Chief Information Security Officer, the Partner(s) shall immediately provide Notice to the members of the Operational Committee by sending an email to the Operational Committee Chairperson.

3. The Operational Committee will develop detailed notification instructions for specific types of breaches (for example, FTI, SSA, FPLs) involving Individual confidential or protected information. These instructions will include procedures to work with privacy officers regarding compromised Data. Once developed, these detailed notification instructions shall be submitted to the State’s Chief Information Officer for his/her approval. Once approved, these instructions shall be incorporated into this Appendix and will be followed accordingly.

A secure section of the future website shall be created solely for the purpose of Breach reporting. This website function shall be designed to automatically email all Operational Committee Members that a Breach Notification has been uploaded.

B. Notification Content

The Notification shall include sufficient information for the Operational Committee to understand the nature of the Breach. For instance, such Notification shall include, to the extent available at the time of the notification, the following information:

- one or two sentence description of the Breach;
- description of the roles of the people involved in the Breach (e.g., employees, Users, Citizens, service providers, unauthorized persons, etc.);
- the specific Data or Type of Data that is the object of the Breach;
- partners likely impacted by the Breach;
- number of Users or records impacted/estimated to be impacted by the Breach;
- actions taken by the Partner to mitigate the Breach;
- current status of the Breach (under investigation or resolved); and
- corrective action taken and steps planned to be taken to prevent a similar Breach.
Appendix 4
Procedures for Breach Notification

The Notification shall not include any confidential or protected Data. The Partner agrees to supplement the information contained in the Notification as it becomes available. Supplemental information should be uploaded to the secure portion of the future website and directed to the same addresses used for the original Notification.

If, on the basis of the information available to the Partner, the Partner believes that it should temporarily cease Data Transmittals with all other Partners, it may undergo a service level interruption or voluntary suspension in accordance with Appendix 1 of this E-MOU.

2. Disposition of Breach Alerts and Notifications

A. Review of the Breach by the Operational Committee

The Operational Committee Chairperson shall facilitate a meeting of the Operational Committee upon receipt of the Breach alert or Notification as soon as practicable for the purpose of reviewing the Notification and determining the following:

1. the impact of the Breach or potential Breach on the privacy, security, confidentiality and integrity of the Data Transmittals;
2. whether the Operational Committee needs to take any action to suspend the Partner(s) involved in the Breach or potential Breach in accordance with Appendix 1 of the E-MOU;
3. whether the Operational Committee should take any other measures in response to the Notification or alert.
4. the Operational Committee shall, if needed; request additional information from the Partner(s) involved in the Breach or suspected Breach to fulfill its responsibilities. However, with respect to suspected Breach alerts, the Operational Committee is encouraged to hold inquiries and requests for additional information to allow the Partner time to determine whether a Breach actually occurred. After determination of whether a suspected Breach is indeed a Breach, there should be documentation kept by the Partner of the event that occurred, in order to maintain records of review, in case of audit, etc.

B. Determination of Breach Resolution

Once complete information about the Breach becomes available, the Operational Committee shall meet as soon as possible to determine whether the Corrective Actions taken by the Partner(s) involved in the Breach are sufficient to mitigate the Breach and prevent a similar Breach from occurring in the future. Once the Operational Committee is satisfied that the Partner(s) have taken all appropriate measures, the Operational Committee shall deem the Breach resolved and will so advise the State’s Chief Information Officer or designee of such recommendation. Upon renewal
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Procedures for Breach Notification

of any Data Requests, Partners shall list any data breaches that occurred in the previous twelve (12) months and provide an updated status on any corrective action plan arising from the breach.

1. This resolution will be communicated to all Partner(s) involved in the Breach and those Partners that ceased Data Transmittals with the Partner(s) involved in the Breach.

2. If those Partners do not resume Data Transmittals with the Partner(s) involved in the Breach within a reasonable period of time and no longer than ten (10) business days after the resolution was communicated, the Partner(s) involved in the Breach and cessation shall engage in the Dispute Resolution Process with the State’s Chief Information Officer in accordance within this E-MOU.

3. Lessons learned on the root cause of the Breach will be communicated by the Operational Committee to all Partner(s), including those not involved in the Breach, to prevent a recurrence of the event in the future.
Appendix 5
Requirements for Data Exchange Services

Each Data Exchange Service must identify details specifying the business need, data content, security expectations, availability and dependency requirements. Those requirements are outlined in the section that follows. In addition, each Data Exchange Service must be validated according to testing requirements as identified in Appendix 6 of this E-MOU.

1. Specifications for New/Revised Data Service.

Data Exchange Services are generally the transmission and transformation of data. The latency can range from near real-time to regularly schedule batch file processing. The records layout can be fixed length, with each byte in the file having a pre-determined meaning, or can be variable length with delimiters. The mode of transportation should always be secure, but can be done via web-services or secure modes such a SFTP. These options will be driven by the needs of the business use of the Data Service.

A. Process for Requesting New/Revised Data Services
   i. Applicant must complete and submit an E-MOU Data Service Request Form, which can be found in Attachment A to this Appendix, to the Operational Committee. Applicants shall use this template upon an initial request or revision of data from Partners in accordance with the E-MOU.
   
   ii. The Operational Committee shall review new or revised data service requests at their next regularly scheduled meeting after the data service request is made. If the data service request is approved, the Operational Committee will contact the Applicant and request they complete and submit the E-MOU Internal Control Questionnaire (“ICQ”). (ICQ is only required if Partner is receiving Data; not required if solely sending data.) The ICQ can be found in Attachment B to this Appendix. Applicants shall use this template to request or revise a data service request in accordance with of the E-MOU.

1. The Operational Committee shall conduct an initial review of new or revised ICQ within thirty (30) days of their submission and shall make a determination within said thirty (30) days, and no longer than ninety (90) days from date of submission as described below in this paragraph. If no initial review has occurred within thirty (30) days of submission to the Operational Committee, the ICQ shall be approved. Upon initial review of the ICQ, the Operational Committee may request clarification or additional information from the Applicant within thirty (30) days of the submission. Clarification and/or additional information shall be provided back to the Operational Committee within thirty (30) days of the request. Review of an ICQ shall take no longer than ninety (90) days in total, however, the Applicant may request an extension of the review period from the Operational Committee in writing before the ninety (90) day review period expires.

2. If the ICQ is approved, the Applicant shall begin to draft a Specification Sheet as well as any necessary User Confidentiality Agreement Acknowledgement Form*. (If only sending data, there is a different Specification Sheet required and no User Confidentiality Agreement Acknowledgement Form is required.) A Specification
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Requirements for Data Exchange Services

Sheet can be found in Attachment C to this Appendix. A User Confidentiality Agreement Acknowledgement Form can be found in Attachment D to this Appendix.

*The requesting entity is required to have each person who is authorized to access the data sign a User Confidentiality Agreement Acknowledgement form

B. Specification Sheet

1. **Data Service Name**
   Name the service in a business friendly fashion. Describe so it is clear what type of business function is being performed. Like services should be named in a consistent method to enable reuse and effective management.

2. **Statement of Business Purpose**
   Describe the business purpose of the Data Service in terms that existing Partners, the Operational Committee and potential Partners, will understand. Be sure to identify value or benefits that a Partner may realize using this service. Also include risks and operational impacts incurred by not implementing service.

3. **Business Data of the Service**
   Define the data fields included in the interface for this Data Service. Detail should be kept at the business level with technical specifics coming through functional and non-functional requirements. In addition to the name of each field in the data, additional attributes are defined to fully describe each element including:

   i. **Data type** - defines the form of Data included so the consumer of the service better understands possible values for that type; the operations that can be done on values of that type; the meaning of the Data; and the way values of that type can be reported. Valid types of business Data include:
      - Number – any numeric value
      - Money – special subset of Number to represent a financial transaction value
      - Boolean – denotes positive or negative value; can be interpreted as Yes/No; True/False; 0/1
      - String – defines the value as an alphanumeric string; variable length
      - Code – A limited set of valid values

   ii. **Source of the Data** – identifies where the Data originated from, useful in understanding how to interpret the data values, how to protect the Data and how the Data can be operated on. Typical sources include
      - Citizen – was provided by a Citizen or User
      - Partner – sourced from a State Agency, either active or inactive with the Exchange
      - 3rd party – is provided by an external third party entity, not affiliated with any state Agency
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- SSA – field content came from the Social Security Administration
- IRS – field content came from the Internal Revenue Service
- CMS - field content came from the Centers for Medicare and Medicaid Services
- Other

iii. Origin – further defines the source of the Data including the system, application and data field which were the source of the content. Serves to clarify the applicable business functions allowed with the data content.

iv. Special format assumptions – identifies special formatting that should be applied to the field content by the Partner consuming the service. Formatting is based on patterns which can be used to define input/output masks on the field. Example patterns include:
- (###) – field value must be numeric up to 999.
- (###.##) – field value must be numeric up to 999 and allows 2 digits of decimal precision
- (0) – field value must be between 0 and 9; zero will be treated as a default
- ($##.####) – field value must be up to $99.99; fractional parts of a dollar will preserve ten and one digits by retaining a zero.
- (MM/DD/YYYY) – field value will be treated as a multi-part date field
- (APPROVED|REJECTED|PENDED) – field value must be one of the pre-defined values listed

v. Security Requirements – additional security considerations should be applied to this data field within data. Typically this represents the user’s sensitivity of the content. Recognized types include:
- PII – Protected Personally Identifiable Information
- PHI – Treat as Protected Health Information
- MH/BH – Treat as mental/behavioral health data
- PCI – Payment Card Industry
- SSA – Treat as SSN content under Illinois and federal legislation
- EDUCATION – Treat as educational data, subject to FERPA (Family Educational Rights and Privacy Act)
- SUBSTANCE ABUSE – Treat as substance abuse information under federal law

vi. Validation – Detail what data checking routines will be put in place to ensure (i) message format and content are valid and (ii) content has been received without error.

4. Delivery Model

Does this service send (push) Data to others or does the service receive (pull) Data from others? Identify which model the service typically operates under. Document any business requirements or assumptions for the event that triggers the data service.
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Document if any logic exists to support restarting the service should the transfer fail unexpectedly. Include details on how to initiate the restart process.

Define details on the data transfer process. Trace the business path of the data transfer from source system to target location. Identify if any updates or transformations are made to the data in transit. Capture details on the transport protocol that will be applied transferring the data. Note if the transport protocol changes along the path. Also indicate the transfer/transmittal protection requirements to ensure the Data content is protected appropriately per Applicable Law.

5. Physical Designation of the Service
This section serves to outline details about the physical implementation of the data service. As previously noted, most of the technical details on data services will be found in related IT documents such as Partner-specific technical implementation standards.

Define format details about the service. What type of file is being processed: XML, CSV, Fixed Format. Record if the file includes a header and/or footer row and the supporting details.

Define any validation necessary to confirm complete transmission of the service. These validations may include check-sums, record counts, or total matching with header/footer.

Where possible, data services should comply with interface standards approved by the State’s Chief Data Officer. Identify which interface standard is being leveraged from the inventory. If the data service does not follow a Data Governance approved standard, identify the business rationale for this approach.

The data service should be classified as to whether it is considered to be a ‘full-refresh’ (ignore everything previously transmitted), a ‘delta’ (This updates the data this service has previously supplied), or ‘append’ (An addition to everything previously supplied). Some services may require that multiple options be available at certain times such as a normally provide a ‘delta’ but in the circumstance where the data becomes out of sync, do a ‘full-refresh’.

If the data service requires additional logging or archiving capabilities beyond the baseline provided by the Data Exchange, outline the business requirements for these capabilities. Clarify if the additional requirements have impact on Data availability or security requirements.
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6. Security Requirements
Identify if the data service must comply with specific security requirements (State or Federal) because it transmits protected content such as Protected Personally Identifiable Information (as defined by State Law) or Protected Health Information (as defined by Federal Law). Identify the business requirement that mandates such protected information be transmitted. Reference Partner System Security Plans, policies and procedures as compliance material.

Evaluate if additional Partner-specific restrictions should be applied on the data service transmission. Include User or Group level restrictions if applicable. If the data is of a protected nature, the data may be shared only with a subset of specifically authorized Partners. Identify the business needs that define which Partners should have access to (or are prevented from accessing) the data service content. Business needs should include requirements stipulated by Applicable Law.

Authorized transmissions should contain language regarding manipulation of data or files, authorization prior to transmission and use of message authentication codes.

Confirm that Applicable Law has been reviewed and if existing Data Exchange Authorization language will allow Data Transmittal. If additional authorization is required, identify the legal requirements to be addressed and then state why it is necessary to share the Data.

7. Service Level Agreements
Document what business timeframes the data service must be available to Partners. Relate availability to a stated business requirement. Is this a high-availability service that should be available 24x7 because citizens might access at any time? Is the data service only required during business hours such as when a call center will be open?

Identify if this data service mandates specific business continuity or disaster recovery requirements. Do these include specific expectations regarding Data loss during an event? What timeframe expectations exist if the data service must be recovered in a disaster? Link these points to a stated business requirement.

Document Operating Measures for the data service. Consider what the expected transaction load for the data service will be per 15 minutes while operating. Define if the data service will experience peak volume periods, per day, week, month or seasonally. If a real-time data service, define the expected response time in seconds during normal and stressed operation.

8. Related Service Dependencies
Define any data services that must be executed in conjunction with this service. Identify the business nature of the workflow between these services. Capture the order
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dependency (sequence) the services must be executed under. Declare any special business assumptions that may exist because these services must work as a transaction.

9. **On-boarding Validation Plan**
Outline the strategy and plan to validate a Partner’s successful integration and use of a data service. The On-boarding Validation Plan should define the approach on how to on-board an Applicant as a consumer of the service. This includes the testing objective, methods for testing new functions, total time, resources required, testing environment and any testing assumptions being made. This plan shall be reviewed and amended, as necessary, by the Operational Committee.

The test cases will exercise various integration aspects with the service including both normal operations and exception error handling from the client/consumer side of the service.

Each test case should include:

i. Case # - a unique identifier for this test in the overall validation plan

ii. Test Scenario – a description of the test script to be performed. Must define input testing values and any other environmental requirements to be used.

iii. Test Type – defines the:
- Positive – test case validates successful function or feature in the data service interface. Test results identify expected data that should be received using the service accurately.
- Negative - test case validates exception handling with the data service. Test results identify the error condition to be expected.
- Stress - test case serves to validate the data service and Partner interface can perform as expected in a high demand situation.
- Endurance - test case serves to confirm the data service and Partner interfaces will perform positively during a sustained period of execution.
- Dependencies – test case serves to validate that prior dependencies, if any, have been met.

iv. Expected Results – description of the expected results of the test case.

v. Once a test case passes, the output should be stored to automate future regression testing. Each time a result is modified the output must be updated.
Appendix 6
New Partner Testing and Validation Requirements

This section describes the testing activities to be performed by a potential Partner new to the Data Exchange Services or an existing Partner wishing to access new Data Exchange Services (referred to as Applicant). The Operational Committee shall develop the Testing environments that will include the necessary security controls sufficient to protect the sensitivity of the Data. Once developed, such Testing environments shall be included as an Appendix herein.

The process for Applicants to join the Data Exchange Services is described in Appendix 1 of this E-MOU.

A. Select Services to Adopt

i. The Applicant must complete and submit an E-MOU Data Service Request Form. See Appendix 5, Section 1(a)(i). (Step #1)

ii. The Operational Committee shall review new or revised data service requests at their next regularly scheduled meeting after the request is made. See Appendix 5, Section 1(a)(2). (Step #2)

iii. If the data service request is approved, the Operational Committee will contact the Applicant within five (5) working days and request they complete and submit the E-MOU Internal Control Questionnaire ("ICQ"). See Appendix 5, Section 1(a)(2). (Step #3). (If only moving data into an HHSi2 data environment, and Partner is not considering receiving data, then this will not be a required step.)

iv. If the ICQ is approved, the Applicant shall begin to draft a Specification Sheet as well as any necessary User Confidentiality Agreement Acknowledgement Form. See Appendix 5, Section 1(a)(3) (Step #4). (If only moving data into an HHSi2 data environment, and Partner is not considering receiving data, then this step will not be required.)

v. The Operational Committee shall conduct an initial review of new or revised ICQ within thirty (30) days of their submission. See Appendix 5, Section 1(a)(4). (Step #6)

vi. If no concerns are identified (Step #5), the Applicant is approved to begin testing.

vii. State’s Chief Information Officer will schedule and activate the selected services for the Applicant in the development environment (Step #7) within ten (10) business days.

viii. Applicant Partner may begin testing with the selected services in the development environment (Step #8).

B. Conduct Tests

i. Testing can be conducted using the approved Enterprise automated testing tools, or performed manually by the Applicant Partner.

ii. Testing will focus on peer-to-peer testing of the Applicant Partner’s system against an implementation of the selected service(s) in the target environment (Step #9).

iii. Validation is concerned with confirming that the interactions occur successfully as described by the selected service(s) on-boarding Validation Plan. Data Service Request Validation requires data checking routines that ensure (i) message format and content are valid; (ii) content has been received without error; (iii) header and trailer record counts match the data received.
Appendix 6

New Partner Testing and Validation Requirements

iv. Testing will be accomplished by performing the test cases as identified in the selected service(s) on-boarding Validation Plan, and capturing the evidentiary artifacts defined in the on-boarding Validation Plan to enable review by the Operational Committee (Step #10).

C. Report Test Results

Although the Operational Committee expects to be in close contact with an Applicant during the testing process, the Applicant is required to submit a test report to the Operational Committee (Step #10), accompanied by logs, screen shots, and other evidentiary artifacts as identified in the selected service(s) on-boarding Validation Plan.

D. Validation

i. The Operational Committee will review the produced evidence, consulting within its internal membership as needed.

ii. The Operational Committee will provide an opinion of the Applicant test report within ten (10) business days from submission (Step #11).

iii. With approval from the Operational Committee, the Applicant may proceed to the next environment in the promotion sequence (Step #12).

iv. If the Operational Committee does not approve the Applicant test report, the Operational Committee will advise the Applicant with specific remediation guidance to improve compliance when re-testing (return to Step #9).

v. The workflow is repeated by the Applicant for development, testing, training and User acceptance testing environments. Each must be performed in sequence.

vi. Once the Applicant has successfully completed the User acceptance testing, the Applicant test results will be reviewed by the Operational Committee for production environment access (Step #13) and recommendation to the State’s Chief Information Officer regarding a Partner’s authority to send and/or receive or have access to Data. (Step #14).
Attachment A to Appendix 5

New Partner Testing and Validation Requirements

In the course of administering the Illinois state programs and related service activities, Illinois State Agencies collect information from individuals, employers and providers. Some of that information is public; most is confidential. Information that identifies a person or an employer is protected in Illinois in accordance with stringent state and federal laws. Those laws allow Illinois State Agencies to release some confidential information if the request or requestor meets specific requirements.

Complete and submit the following application in order to be considered for legal access to certain confidential data collected by the State. Please note the required fields below, indicated with a red asterisk:

* Required

Legal name of the requesting entity: *

Legal name of the owner entity: *

Name of Preparer or Contact Person: *

Contact Email Address: *

Contact Phone Number (primary): *

Street Address: *

City *

State *

Zip Code *

What specific data points are you requesting? Please include a description of the data points. *

How do you intend to use the data? *

At which location(s) will the data be used? Please include the specific address(es). *

If required or permitted by applicable law, under what legal authority would you like to obtain access to the data? Please include any specific law and/or citation. If no law restricts access to this Data, please respond N/A. *
Attachment A to Appendix 5
New Partner Testing and Validation Requirements

How many staff will be accessing the data? Please include a listing of the specific individuals. *

Do you intend to share the data with subcontractors? Please include a listing of the specific subcontractors. *

Additional questions specific to the data or Agency from which the request is being made:

(For Agency staff only: please add additional questions required by state or federal law managing the dissemination of this specific information type.)
Attachment B to Appendix 5
Internal Control Questionnaire

INSTRUCTIONS

The following questions serve as the Internal Control Questionnaire for the Applicant Partner’s security procedures relating to the E-MOU documents and electronic media as part of the E-MOU contractual requirements.

When answering the questions in this document, the answers should be entered on the line directly below the question.

After completion, the form should be printed out and signed by the Disclosure Officer and the Director from the Agency.

The Agency should complete the contact information below for all parties involved in supplying information.

<table>
<thead>
<tr>
<th>Name</th>
<th>Title</th>
<th>E-mail</th>
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</thead>
<tbody>
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</tbody>
</table>

It is advisable for the Applicant Partners to collect and maintain documented evidence to back up answers to this report in the instance of an audit.

A. General Information

1. Do you currently utilize an E-MOU data service?

   a. If yes, please describe the type of data and what format the data is in? (paper documents, electronic media, etc.)
Attachment B to Appendix 5
Internal Control Questionnaire

2. How is data received? (Tumbleweed, ConnectDirect, other Secure Data Transmission (SDT)-list)

3. Are paper documents or electronic media created from the E-MOU data (letters, reports, etc.)? If yes, please describe what paper documents or electronic media are created.

4. How are the paper documents or electronic media distributed?

5. Are any paper documents or electronic media provided to a contracted State Agency or Contractor? (e.g., consolidated storage center, offsite storage location)
   a. If yes, please provide the Site Name and Address for each facility that house E-MOU paper documents or electronic media.

6. What safeguard controls are in place when transmitting and processing the E-MOU paper documents or electronic media at these locations?

7. Where are E-MOU paper documents or electronic media stored before and after processing at these locations? (Agency, Data Center, Other-list)

8. For E-MOU electronic media, do you keep back-up files? If so, how are data files backed up, by whom, and on what type of media?

9. For E-MOU electronic media, what is the retention period of back-up media and how many generations of back-up files exist at this time?

B. Security

I. Physical Security

10. Please describe the physical security of the Applicant Partner’s Headquarters and any State Agency and/or User? (e.g. keypad locked doors, alarm systems, guard desks, locations, hours, etc.)
   a. If keypads are used, is each attempt logged? Who reviews the access logs? (Name and title)

   b. Who monitors any alarm systems? (e.g. Intrusion Alarms, Security Cameras, Motion Detectors, Exit Alarms) (Name and title)
Attachment B to Appendix 5
Internal Control Questionnaire

11. Are all paper documents or electronic media containing E-MOU data and devices through which E-MOU data is received, stored, processed, or transmitted at these facilities locked or otherwise secured? (e.g., restricted access server room, locked server rack, restricted access media library)?

   a. If yes, please describe how they are locked or secured, including key control procedures, and/or combination lock control procedures for each separate facility.

12. Is E-MOU data transmitted via fax machine?

   a. Where is the receiving fax machine located? (location in office)

   b. Are all individuals in the receiving location authorized to access E-MOU data?

13. For each facility, do visitors/vendors sign a visitor access log?

   a. If yes, what information is captured on the log? Where is the log stored and for how long?

14. Who has access to the Data Center at the Applicant Partner’s Headquarters and any State Agency or User contracted with by the requesting Agency after core business hours? (Name and Title)

   a. How is security enforced after core business hours?

II. Application Security

Partner should supply information in “Section II. Application Security” ONLY if they store or process E-MOU electronic media in Agency applications.

15. Are application users supplied with unique user IDs?

   a. How does the user receive their user ID?

   b. Are accounts configured to lock after 3 failed login attempts?

   c. Are user IDs disabled after 90 days of inactivity?

16. Is the application configured to lock/terminate the session after 15 minutes of inactivity?

17. Does the Partner track and document application security incidents on an ongoing basis?
Attachment B to Appendix 5
Internal Control Questionnaire

18. Is E-MOU data transmitted via email?
   
a. How is the data protected? (encryption - describe)

19. Does the Partner have web-based applications?
   
a. Is E-MOU data accessible through a web site?

20. What software and version is used for Virus Protection?

21. What software and version is used for Spam/Spyware Protection?

22. What software and version is used for Intrusion Detection?

23. Does the Partner provide annual security awareness training regarding the handling of confidential data? If yes, please describe.
   
a. Are there records maintained to track employee completion of this training?

C. Restricting Access

24. Is E-MOU electronic media kept separate or is it commingled with other information?

25. Can E-MOU paper documents or electronic media within agency records be located and separated easily?

26. How is access limited to authorized personnel?

D. Disposal

27. Is paper waste material with E-MOU data generated?
   
b. How is the paper waste material destroyed? (recycle bins, locked containers, waste baskets, other container)
   
c. Is a contractor used to pick up the paper waste material?
      
i. If yes, please provide the name of contractor:
      
ii. Where does the contractor take the paper waste material for destruction?
Attachment B to Appendix 5
Internal Control Questionnaire

E. Additional questions specific to the data or Agency from which the request is being made:

(For Agency staff only: please add additional questions required by state or federal law managing the dissemination of this specific information type.)

I acknowledge that I've been presented and reviewed the responses laid out here in the Internal Controls Questionnaire as a part of the E-MOU contractual requirements.

/s/  
____________________________________________________  __________
Disclosure Officer  Date

/s/  
____________________________________________________  __________
Attachment C to Appendix 5
Specification Sheet for a Data Service

A. Data Service Name

Define a user friendly name
ex: DMV_ValidateCitizenIdentity

B. Statement of Business Purpose

Single short paragraph to define the business purpose of this service

C. Business Data of the Service

<table>
<thead>
<tr>
<th>Business Field Name</th>
<th>Group / Category</th>
<th>Data Type</th>
<th>Business Source</th>
<th>Origin</th>
<th>Special Format</th>
<th>Security Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Field names in business friendly terms</td>
<td>Collection or organization of like data</td>
<td>number, money, Boolean, String</td>
<td>Citizen, Partner, 3rd party, SSA, IRS, DHS, CMS, etc.</td>
<td>Define where the data content came from? System/Entity/Field</td>
<td>Define as a mask to filter input/output</td>
<td>PII, PHI, PCI, SSA, etc.</td>
</tr>
</tbody>
</table>

D. Delivery Model

Is this a push vs. pull interface? (Select one)

Yes or No

Sends data (push) when triggered
Attachment C to Appendix 5
Specification Sheet for a Data Service

| Yes or No | Provides data (pull) when requested? |

Define business requirements to trigger the interface

*Short paragraph that defines the triggering event for the service*

Required transport mechanism

*What transport protocol will be used, FTP, FTPS, PDP, NAS, etc. (keep in mind any security requirements for the protection of the data content)*

E. Physical Designation of the Service

Where can the physical description be found?

*Define where in the SOA catalog this service can be found or other archive location.*

Does this Data Service align with a current VITA Data Governance approved interface?

*Define which standard aligned with or define why the service is now aligned.*

What format is the physical interface defined with?

*Define – MQ, WSDL, other based*

Logging Requirements
Attachment C to Appendix 5
Specification Sheet for a Data Service

Does the data service enforce special logging requirements? IRS, SSA, COV, etc

Archiving Requirements

Does the data service enforce additional transaction archiving requirements?

F. Security Requirements

Does this interface require specific security requirements?

Describe special security handling because of PII, PHI, PCI, HIPAA, HITECH, SSA, IRS content

Should this interface only be available to a subset of Partners and/or Users?

If so – define parties to include or exclude; be clear.
Cite the Federal/State code that mandates this limitation

Will the interface require additional citizen consent?

If so – cite the Federal/State code that mandates consent be collected

G. Service Level Agreements

Availability of service

Define hours the service is required; 24x7, 8-5 business hours, weekends, etc.

BC/DR requirements

Does the service require additional business recovery or disaster recovery considerations? Indicate yes/no and if so, state the business
Attachment C to Appendix 5
Specification Sheet for a Data Service

need/requirement, along with any Federal/State code that mandates such.

Transaction load/volume capacity expectations
What’s the expected transaction load per 15 minutes? What’s the highest (peak) # of transactions expected in a business day?

Performance/response time expectations
Is this a real-time service? Other? What’s the expected response time in seconds?

H. Related Service Dependencies

Define any Services that must be used in conjunction with this Service

<table>
<thead>
<tr>
<th>Name of related service</th>
<th>Define the relation to this service</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name of related service</td>
<td>Is it essential/compulsory as a required predecessor or invoked as a sub-service?</td>
</tr>
</tbody>
</table>

Define special business assumptions that may exist because of these dependences

Does this create additional requirements for security, data accuracy, reporting, etc? If so, state those additional requirements, including any mandated citations.

I. Additional Questions Specific to the Data or Agency from which the Request is Being Made.

(For Agency staff only: please add additional questions required by state or federal law managing the dissemination of this specific information type.)

J. On-boarding Validation Plan
**Attachment C to Appendix 5**

**Specification Sheet for a Data Service**

<table>
<thead>
<tr>
<th>Test Objective</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Short paragraph defining the overall testing approach for Partners accessing this service</em></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Testing time</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Specify the length of time needed for testing activities</em></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Resources Needed</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Specify the resources needed from Operational Committee members, members of DoIT, etc. to conduct and complete testing activities</em></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Testing Environment</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Specify the exact environment for which you will need access and plan to conduct testing activities</em></td>
</tr>
</tbody>
</table>
Attachment C to Appendix 5
Specification Sheet for a Data Service

Assumption

List all assumptions for testing activities

<table>
<thead>
<tr>
<th>Case #</th>
<th>Scenario</th>
<th>Type of Test</th>
<th>Expected Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 to N</td>
<td>Describe the test case including input data values</td>
<td>Positive, Negative, Stress, Endurance</td>
<td>Describe the expected results</td>
</tr>
</tbody>
</table>


Attachment D to Appendix 5
User Confidentiality Agreement Acknowledgement Form

ACKNOWLEDGEMENT FORM __________ of ________________

INDIVIDUAL’S FULL NAME:____________________________________________________

JOB TITLE AND LOCATION:____________________________________________________

EMPLOYER’S NAME:___________________________________________________________

IF EMPLOYER IS NOT [RECIPIENT], PLEASE EXPLAIN:____________________________

REASON(S) FOR INDIVIDUAL’S ACCESS TO DATA:________________________________

I ________________________________ acknowledge that all Data received through the statewide E-MOU is confidential and must be protected from unauthorized disclosure and use. I have been provided access to a copy of the Data Sharing Agreement (whether on paper or electronically) and agree to abide by the same restrictions and conditions that apply to Data User with respect to the Data as stated in Article IV. I have been instructed by the Partner on the permissible use(s) of the Data and will not use the Data for any other purpose. Partner has provided me with a list of the individuals with whom I may share the Data. I understand that I may not share the Data with any other entity or person, including but not limited to other employees, agents, or contractors of Partner who are not authorized to access the Data. I have received instructions from Partner on the proper way to store, handle, and protect the confidentiality of the Data and shall take all necessary steps to reduce the risk of unauthorized disclosure of use. I understand that I must report all violations of this agreement to the E-MOU Operational Committee per Article VI. Finally, I understand that unauthorized use of disclosure of the Data to any unauthorized individual or entity, is punishable by State and Federal statues that impose legal sanctions.

INDIVIDUAL

Signature:____________________________________________________________________

Date:________________________________________________________________________

FOR RECIPIENT:

1
Attachment D to Appendix 5
User Confidentiality Agreement Acknowledgement Form

Name:__________________________________________
Title:__________________________________________
Signature:______________________________________
Date___________________________________________
Rappahannock Electric Cooperative

Smart Grid Initiative

Scope of Work

Rappahannock Electric Cooperative’s (REC’s) Smart Grid Initiative project deployed smart meters across the service territory and a supporting communications infrastructure, as well as a meter data management system (MDMS) to help manage the increased data available from the smart meters. The project also deployed distribution automation equipment, including supervisory control and data acquisition (SCADA) and automated controls on distribution voltage regulators to improve power quality, reduce line losses, and reduce operations and maintenance costs through monitoring and control of distribution voltage.

Objectives

REC implemented digital improvements and a variety of new technologies and grid upgrades to ensure more efficient and reliable power delivery. In addition, full smart meter coverage allowed REC to introduce and test advanced pricing programs and a prepay program.

Deployed Smart Grid Technologies

- **Communications infrastructure**: The project deployed new digital microwave backhaul links and a point-to-multi-point data radio network which delivers distribution SCADA and meter data from substation collectors to REC headquarters. A power line communications-based network using two-way automatic communications systems technology connects substation data collectors to meters and demand response devices.

- **Advanced metering infrastructure**: The project deployed 54,200 smart meters across REC’s service territory, which completes coverage for all of REC’s customers. The newly installed meters have functionalities such as outage detection, power quality monitoring, and tamper detection; and 10,572 of the installed meters have remote connect and disconnect functionality.

- **Direct load control devices**: The project deployed direct load control devices to customers who volunteered for the demand-side management program. The devices control water heaters and air conditioners and enable REC to lower peak demand, lessening the utility’s need to purchase power at the most expensive times. This reduces REC’s electric supply expense.

At-A-Glance

Recipient: Rappahannock Electric Cooperative
State: Virginia
NERC Region: SERC Reliability Corporation
Total Project Cost: Redacted
Total Federal Share: Redacted

Project Type: Advanced Metering Infrastructure

Customer Systems

Electric Distribution Systems

Equipment

- 54,200 Smart Meters
- AMI Communications Systems
  - AMI Meter Communications (Point-to-Multi-Point Radio, Power Line Carrier)
  - AMI Backhaul Network (Microwave)
- Meter Data Management System
- 14,865 Direct Load Control Devices
- Distribution Automation Equipment for 66 Circuits
  - Distribution Automation Communications Network
  - SCADA Communications Network (Point-to-Multi Point Radio)
  - Voltage Regulator Controls
  - Usage Monitoring System

Key Benefits

- Reduced Electricity Costs for Customers
- Reduced Operating and Maintenance Costs
- Increased Electric Service Reliability and Power Quality
- Reduced Costs from Equipment Failures, Line Losses, and Theft
- Reduced Truck Fleet Fuel Usage
- Reduced Greenhouse Gas Emissions
which helps to reduce future energy costs to the utility’s members.

- **Distribution automation systems:** The project deployed advanced automated equipment to improve distribution equipment performance. REC deployed automated distribution voltage regulator controls. SCADA has been installed in all REC substations, allowing the utility to monitor its entire distribution system. REC can thus better respond to changes in load and system conditions, increasing system reliability while reducing operation costs and outages. REC also replaced 792 down-line single-phase hydraulic reclosers with a mixture of three-phase and single-phase electronic-controlled vacuum reclosers. These new reclosers provide the platform for future system monitoring and control.

- **Distribution system energy efficiency improvements:** The project integrated automated voltage regulator controls with power quality monitoring and reverse power capability. The network of regulators improves voltage and volt–ampere reactive (VAR) control, improves power quality, and increases distribution capacity by reducing energy losses on the distribution system.

### Benefits Realized

- **Improved customer service and reduced electricity costs:** These newly deployed technologies have reduced manual processes, improved meter data quality, increased data storage capabilities, and supported more accurate calculations of unbilled revenue. The meter data processed through the MDMS supports improved operational efficiency, customer service, energy forecasting, distribution system reliability, and regulatory compliance. Specifically, the MDMS has reduced high bill complaints since REC now has reliable hourly data, and the system provides quicker notification of meter failures at both a communications and hardware level. Integrating the AMI system with REC’s customer information system provides additional operational efficiencies and improved customer service. Furthermore, full smart meter coverage has allowed REC to offer additional rate programs and monitor electricity demand more accurately.

- **Reduced operating and maintenance costs:** As a result of AMI and MDMS deployments, operational cost savings have been realized through automation of meter reading and customer service activities.

- **Improved electric service reliability:** The AMI system allows for faster, more efficient outage detection and diagnosis, as well as reduced restoration times. System operators can ping meters to get a clearer picture of what is happening in the field and deploy restoration field crews more efficiently. In many cases, the AMI system identifies the outage, a crew is dispatched, and power is restored—all without any customers calling to report the outage. The cooperative has also been able to take advantage of the automated voltage regulator controls’ reverse power capability. There is no longer a need to send outage restoration crews to the downed-line regulator locations to manually turn the regulator controls off when lines are being back-fed to restore service. This allows the outage restoration crews to focus their efforts on locating and making repairs.

- **Reduced costs from theft:** New AMI features include tamper detection that allows utility personnel to locate and fix theft-of-energy situations quickly and cost-effectively.

- **Reduced truck fleet fuel usage:** The project has saved fuel and avoided pollutant emissions, thanks to both more efficient crew dispatching and the elimination of manual meter reading.

- **Improved safety:** The new electronically controlled reclosers have provided REC with additional flexibility in its system protection and coordination schemes. The reclosers allow system engineers to isolate feeders with a greater degree of certainty by utilizing the electronic recloser controls advanced/customizable coordination curves. This
flexibility allows the cooperative’s system engineers to better protect the electrical system, thus providing additional safety for REC employees and the general public.

**Dispositions Learned**

- The use of good construction contractors; especially those experienced with the technologies and who have established relationships with the utility to help perform the work is essential in order to meet project goals and deadlines. While it is tempting to assume utility staff can do it all, when the right partners are selected, both the utility and the project benefits.
- Just as with contractors, project teams should spend a good deal of time evaluating software vendors and select more mature products that have proven track records.
- Strong pre-planning is crucial to project success.
- Ordering equipment and materials well in advance helps ensure that they are available when needed and the project does not experience delays. An example REC experienced was when their AMR module manufacturer was delayed in shipping new modules to their meter manufacturer. The AMR module delay was caused by the manufacturer not being able to obtain certain electronic components manufactured off-shore. The delay caused the new meter production to be delayed and ultimately affected delivery schedules for new meters.
- Open and frequent communications throughout the project organization and with the public will help eliminate problems and is essential to a successful project. For example, REC held a regular weekly meeting with key project staff throughout the project duration. Contractors and vendors provided monthly updates on status, giving the project manager an opportunity to address any potential issues early. REC began its promotion of enrolling members into its load management program with an extensive cooperative marketing campaign that included bill inserts, updates on the REC website, and articles published in the cooperative’s monthly magazine, which informed customers of changes associated with the project. Later the campaign transitioned into a proactive outbound call campaign, which dramatically helped with enrollments and participation into the utility’s direct load control programs.

**Future Plans**

REC continues to install AMI equipment and smart meters as the system grows. By completing the system-wide installation of the AMI equipment and meters, the cooperative has been able to develop and initiate additional rate options and a prepay system for its members. REC will continue to enhance or replace technologies to take full advantage of the related equipment that was and continues to be installed.

**Contact Information**

Shawn McDonough, PMP
Project Manager
Rappahannock Electric Cooperative
smcdonough@myrec.coop