Reimagining Infrastructure

verizon

Introduction: Reimagining infrastructure

Infrastructure: For most people, the word conjures up ideas of the physical – roads, bridges, buildings, water towers and storm sewers. As governments and private sector partners look to upgrade our physical infrastructure, they should consider both our critical tangible assets – the transportation, water and wastewater systems vital to our society – and the connectivity that will enable their more efficient operation. In fact, it could be argued that technology infrastructure – internet connectivity, smart technology to enhance physical assets, and cybersecurity to protect them – is as important as the concrete and steel used to construct them.

Advances in sensors, cameras and controls to monitor and operate inanimate resources, often called the internet of Things (IoT) or intelligent device ecosystems, are now capable of enhancing our physical world through digital technology. We can build smart infrastructure that improves efficiency, responsiveness, cost-effectiveness and longevity.

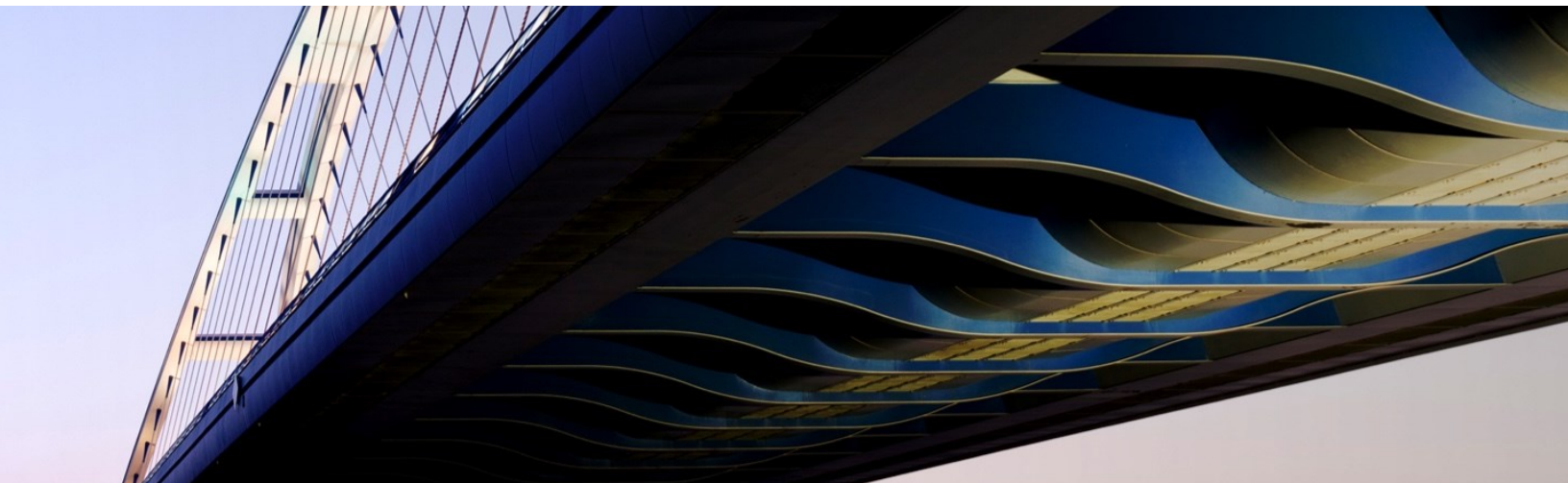
Smart infrastructure achieves these improvements through automation – sensors, data analytics and advanced communications collect and analyze data which then can be used to optimize the performance and increase the lifespan of our traditional infrastructure. For example, by using sensors to monitor the energy consumption versus human usage of public facilities (or street lights), smart infrastructure can identify areas where energy is being wasted and reduce consumption. This not only reduces costs but also helps improve comfort for facility users and reduces carbon emissions, making it more sustainable. Also, the use of smart infrastructure will play a key role in enabling electric vehicle charging stations and coordinating energy supply with utilities.

Traffic systems are another excellent opportunity for IoT sensors. They can be used throughout these systems to gather real-time data to identify congestion and accidents, then provide drivers and other users guidance to enhance the system's efficiency and avoid potential hazards. Public Works, Police and Fire can use telemetry to track their vehicles and equipment during emergency response, as well as sensors and intelligent video (fixed or drone) for near real-time situational awareness, augmenting GIS and 3D models. Also, the use of devices in buildings (or waterworks structures) can detect potential hazards like gas leaks or fires, allowing for immediate action to be taken to mitigate risks and even save lives.

One area that should not be overlooked when upgrading infrastructure technology is cybersecurity. As cyberattacks become more sophisticated and frequent, state and local governments should consider a Zero Trust approach to security. This method operates on the assumption that any user, device or network attempting to access a system is a potential threat, should prove identity for every access attempt and be provided the lowest level of access necessary. The best practice is to build security into the networks for locations, remote users and IoT while leveraging a Secure Access Service Edge - Network-as-a-Service (SASE-NaaS) model.

Overall, smart infrastructure has the potential to revolutionize the way we live, work and travel. As technology continues to advance, the possibilities for smart infrastructure are virtually limitless, and the need to protect it from cyber intrusions is all the more important.

Government, and the private sector partners who help finance, design, operate and maintain our infrastructure, will add more and more smart, innovative components in the years to come.



Contents:

Executive summary: A historic opportunity

When the Infrastructure Investment and Jobs Act (IIJA) was signed into law in November of 2021, it brought with it not just a historic amount of money – $1.2 trillion – but a historic opportunity to upgrade the very foundation of the United States. The bill recognizes the increasing convergence of our physical and virtual infrastructure, with categories for broadband and cybersecurity along with allocations for IoT solutions.

The bill also provides $65 billion in funding for connectivity – supporting remote work, telemedicine and online learning – to support digital inclusion and bring connectivity to those living in the so-called "broadband desert."

Cybersecurity will receive $2.5 billion in enhancements. These programs will help protect our vital data systems and acknowledge the fact that government is the leading target for cyberattacks. They will also help protect our physical assets, as they incorporate more and more smart technology.

Along with the increased efficiencies and cost benefits that come with the aforementioned intelligent IoT systems, investments in technology can create jobs, stimulate local economies and generally improve quality of life for communities.

That's why it's so important to think beyond fixing crumbling roads and potholes today, and use these funds to build the technologically advanced, resilient communities that will benefit our residents five or ten years from now – to future-proof our cities and states with a virtual infrastructure designed to connect and support the communities of tomorrow.

Infrastructure innovations: A brief history

Infrastructure has always been about innovation. Throughout history, its development has played a significant role in shaping the course of human civilization.

There are many examples of great engineering and man-made infrastructure throughout history: the Pyramids of Egypt, the Parthenon of Greece, Angkor Wat in Cambodia, and so on. Let's consider one that can still be seen today: the Roman Aqueduct system, built more than 2000 years ago. The aqueducts were an engineering marvel, constructed using tax dollars, that allowed Romans to dispense clean water to citizens while preventing the spread of diseases.

In the 19th century, the development of railroads revolutionized transportation and commerce. In fact, the word “infrastructure” first appeared in French during the late 1800s to describe the underlying foundation of railroads. The railroad system permitted faster and more efficient transportation of products and people across great distances, which fostered the growth of industries and the rapid expansion of cities and the settlement of territories.

In 1865, a clever oil worker from New Jersey built the first oil pipeline that ran five miles and connected Pithole, PA to the Oil Creek Railroad. The production of energy grids began in the 1880s with isolated power generation systems. Thomas Edison unveiled the nation’s first power plant in Lower Manhattan.

Natural gas pipelines as we know them first appeared in the early 1890s and carried natural gas from wells in central Indiana into Chicago. These early infrastructure systems provided energy to homes and businesses, enabling them to operate and thrive. They also brought people to places once considered to be uninhabitable.

Communications have been a prime motivation for advances in infrastructure. The telegraph was invented in the mid-19th century and allowed people to send the first instant messages over long distances. Telegraph messages had a huge impact on commerce, politics, and military strategy. Telephones came along in the late 19th century, and further reinvented communications by facilitating voice conversations. Not only was it a new way to communicate, but telephones led to entirely new industries like call centers. The development of broadband technology in the late 20th and early 21st century has transformed the way people communicate and access information. Broadband enabled the rapid growth of the internet. It’s now a critical infrastructure for our modern world that connects people for commerce, education, entertainment and healthcare.

The wireless and digital revolution that began in the late 20th century has changed the way we live. The development of mobile devices and wireless networks enabled people to connect and access data from anywhere in the world. The proliferation of digital technology has also enabled the growth of new industries like e-commerce, social media and cloud computing.

The history of infrastructure is one of discovery and progress. We grow and thrive by providing basic physical needs, structures and facilities, then moving towards fulfilling the more human requirements for connection, knowledge and well-being.

More with less: Where we are now

Even as technology infrastructure continues to advance, investment in public infrastructure has fallen. Between 2007 and 2017, public spending on infrastructure decreased by nearly $10 billion – almost a billion dollars a year.

In that same decade, money for capital projects dropped 16 percent, from $207 billion to $174 billion. There is roughly a trillion-dollar backlog in deferred maintenance costs for infrastructure in the U.S. The American Society of Civil Engineers (ASCE) compiles regular "report cards" for the state of the U.S. infrastructure. In 2021, ASCE gave an overall grade of "C-," up from a "D+" from the previous report card in 2017.

But with these challenges come opportunities, especially with the once-in-a-lifetime chance presented by IIJA. The bill offers the promise of a better future, to redefine exactly what we think of when we think of "infrastructure."

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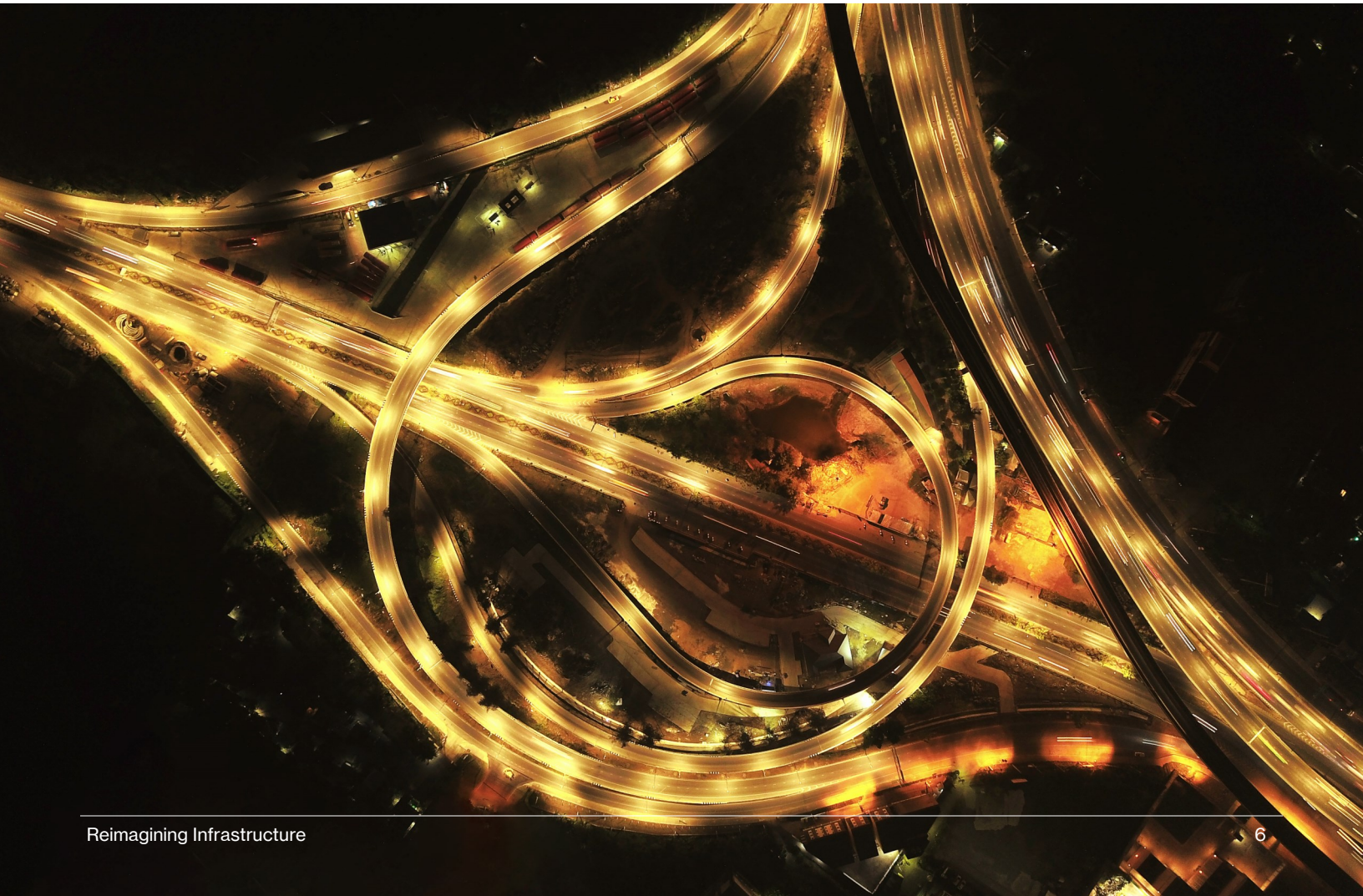


Revolutionizing the world around us

We have already seen infrastructure move from the physical to the virtual world and the “smart” combination of the two into intelligent, responsive systems; so the notion of infrastructure as a multidimensional concept is not new.

Even presenting infrastructure as a social notion is not revolutionary – during the Great Depression of the 1930s, the Federal Government’s massive New Deal program outlined some of the largest infrastructure investments in history: the Hoover Dam in Nevada, the Lincoln Tunnel in New York and the Tennessee Valley Authority (to name just a few). These projects did not just forge new transportation routes and produce new energy sources, they generated new jobs and economic development for areas desperately in need of both, while transforming society as a whole. These builds regenerated living systems for their communities.

So there is a social aspect to be considered with infrastructure, which we also saw highlighted during the pandemic years of 2020 and 2021; the importance of being able to connect via our virtual world to learn, work, access healthcare and buy food. There was a greater need for places like libraries and community centers that had public Wi-Fi. We gained new appreciation for green spaces, sidewalks, faith centers and cultural groups when we resumed face-to-face visits.

Combining that social infrastructure with physical and digital infrastructure gives us a new, multidimensional substructure and a broader understanding of the interdependence of all of these elements. By recognizing this multidimensional world, we can design and maintain an infrastructure that is responsive, resilient, cost-effective and provides us with unprecedented prospects for society and all of its members.

Technology as infrastructure

When considering this multidimensional structure, technology, especially the internet, is the connective bridge that holds it together; networks facilitate communications from wherever we are, sensors help us better understand our physical assets, and IoT controls help us optimize them and reduce their costs.

But there are other financial benefits that stem from connectivity. According to the Center on Rural Innovation (CORI), access to high-speed internet in public spaces launches new careers in tech and gives a monetary lift to freelancers and entrepreneurs. Connected communities equip underutilized workforces with better access to job training and career support, and those areas are better able to weather economic downturns or shifts in industries. And in the age of IIJA, there are several options for state and local governments to connect their constituencies, with the help of private sector partners, and an array of avenues for federal funding to be used to improve technology infrastructure.

Options for connecting our infrastructure

While "broadband" is the named category of IIJA, connectivity can be achieved in a variety of ways. In addition to cable and fiber, there are powerful wireless options that include 5G fixed wireless access (FWA), multi-access edge computing (MEC), private networking, and Network-as-a-Service (NaaS). These options do not require cable or fiber to be run underground to each facility needing connectivity.

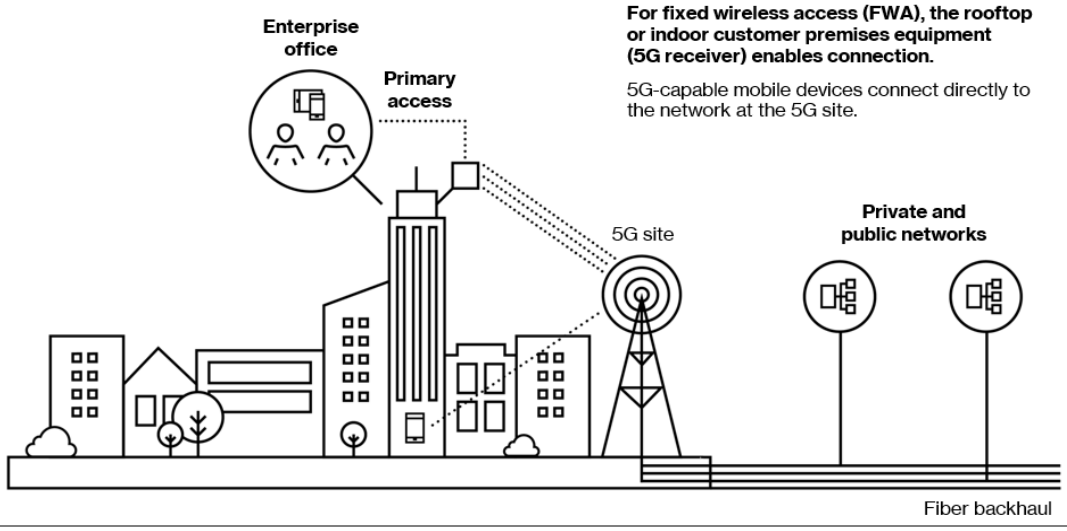
5G is the fifth generation of wireless technology and delivers high-speed internet connections with low latency and massive connectivity. It supports a wide range of applications from smart cities to remote assisted surgery. 5G is revolutionizing the way we use the internet.

FWA, or fixed wireless access, is a broadband service that uses radio waves to deliver internet connectivity to fixed locations. It's ideal for remote areas where laying fiber is not feasible. FWA delivers high-speed internet access and is becoming incredibly popular with the deployment of 5G technology. Fiber must only be connected to one tower, which can then provide connectivity to multiple facilities and devices.

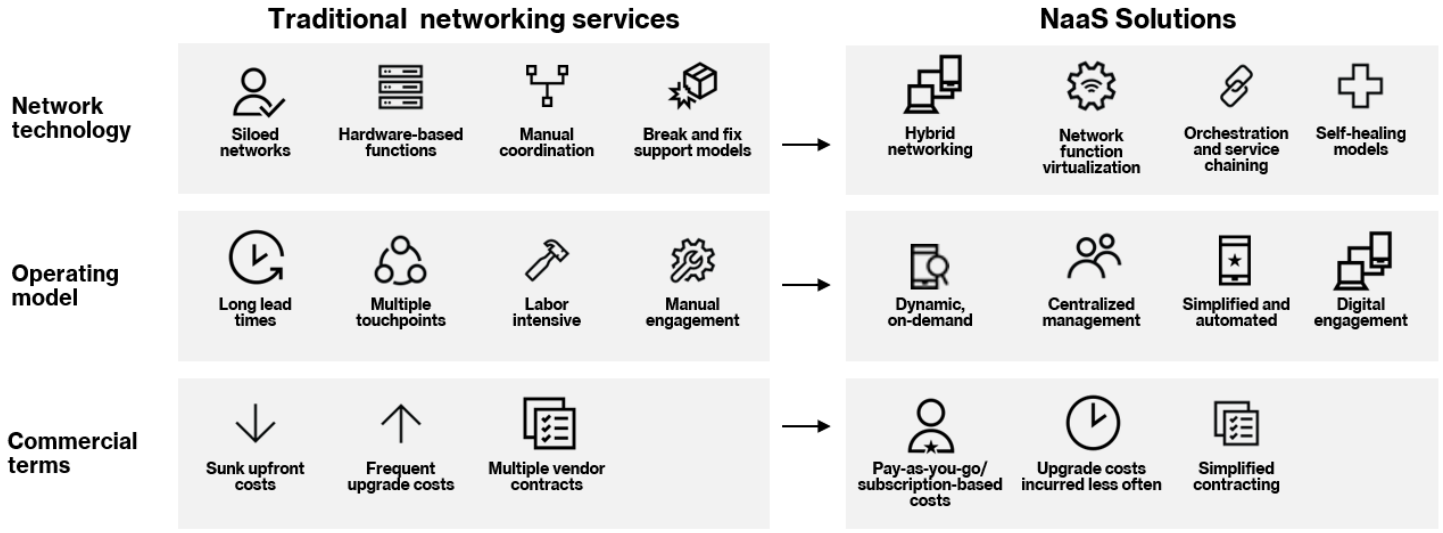
MEC enables cloud computing and storage capabilities as well as an IT service environment at the edge of a network or on premises. It produces high-bandwidth connectivity and low latency, making it an optimal solution for applications that need real-time data processing.

Private networking offers organizations a dedicated network with secure, reliable connectivity. It's a great choice for government agencies, as well as the private sector partners who help them build, operate, and maintain public infrastructure, because it provides high levels of security and reliability.

How 5G is delivered



Network as a Service (NaaS)



Network as a Service, or NaaS, seeks to make a network more agile, helping adapt to changing circumstances. It provides best-in-class network products and services in a more modular, scalable package. By mixing virtual and on-site assets, it provides more intelligent, flexible, cloud-centric network services, taking advantage of Software Defined Networking (SDN) and Network Function Virtualization (NFV) to help accelerate digital transformation.

Data management

Data is becoming ever more critical for government organizations, as is the technical infrastructure that supports its lifecycle (acquisition, storage, management, analysis, and delivery). Governments on every level have so much data and metadata to manage that even the smallest entity can struggle to maintain it. But virtual products like hybrid multi-clouds can help – hybrid multi-clouds support not only data storage and management but application development and deployment, infrastructure management, network security and even disaster recovery. Hybrid multi-clouds combine public and private cloud services to reap the specific benefits of each and meet each organization's precise needs.

More tailored for data management are data lakes. They are large repositories of data in their raw forms, which allow for flexible analysis and processing. The data lakes can also be connected and integrated using various tools and techniques, such as ETL (extract, transform, load) processes, API integrations or data ingestion systems. Data lake connectivity enables organizations to collect and combine their data from multiple sources to gain a comprehensive overview of operations.

Other data management options include data visualization programs, data analytics platforms and data governance tools.

Internet of Things / Smart Infrastructure

The Internet of Things (IoT) refers to a network of devices, sensors and software applications that communicate and exchange information and instructions with each other over the internet. Intelligent devices enable us to get more out of existing assets. IoT increases our understanding of how these assets perform and allows for better decisions around how we operate and maintain them. Automation also frees up time for humans to focus on what we perhaps do best – creative problem-solving.

For state and local governments and their private sector partners, IoT can support facilities management to optimize energy consumption and reduce costs. Intelligent sensors can monitor indoor air quality and adjust ventilation systems to improve the health and well-

being of occupants, which can be especially beneficial in public buildings like libraries, schools and community centers.

Fleet solutions can help organizations optimize longevity and management of vehicles and equipment. Telemetry can certainly monitor real-time location, speed, fuel consumption, meter readings, engine control module alerting, and other important performance metrics, with data sent directly to a fleet management system. Further, intelligent sensors and video can monitor driver alertness and behavior to provide real-time safety warnings.

Smart video relies on IoT-enabled cameras to monitor and can analyze video feeds in real-time, allowing for valuable applications like traffic management, security monitoring and threat detection. Smart video for traffic management optimizes and relays routes for public transportation and helps commuters avoid congestion, and provides Transportation Authorities and Public Safety departments valuable situational awareness

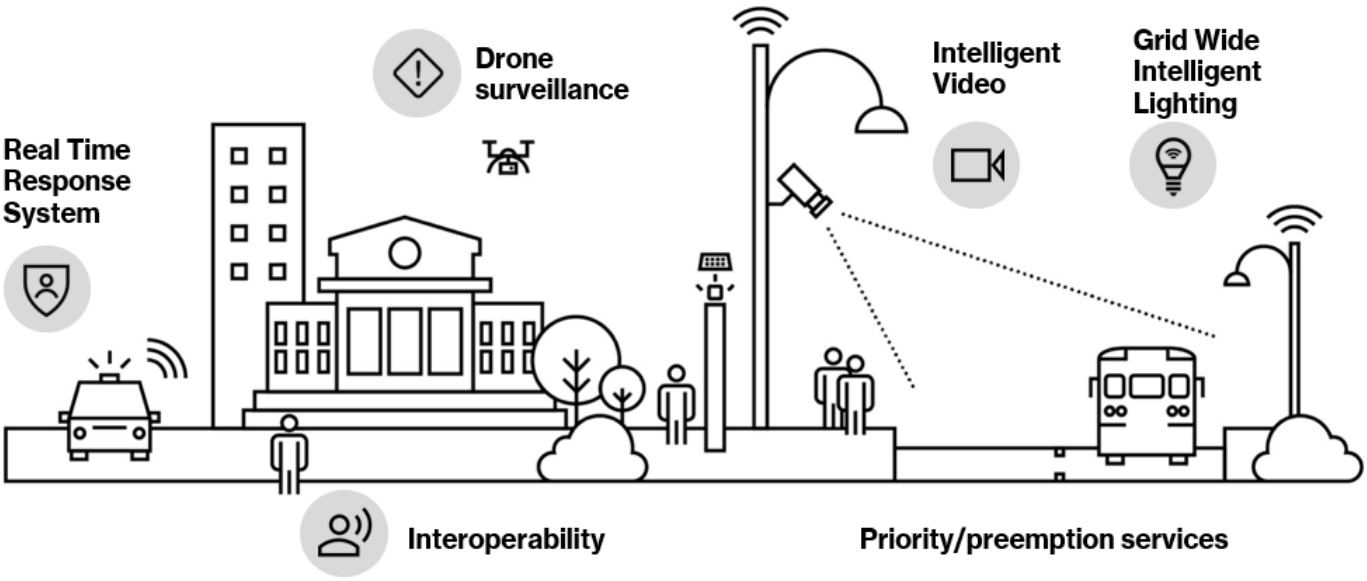
Intelligent systems can also play a significant role in managing water and wastewater systems. For years, Public Works departments have been using sensors to monitor water plant and wastewater reclamation facility processes, as well as water system pressure, pumping status, etc. These departments continue to experiment with sensors and data platforms for real-time regulatory and operational decisions, for example, for energy efficiency, chemical optimization, etc. Sensors also enable asset tracking, condition assessment, failure prediction, etc. for capital budgeting. A few recent IoT innovations include

- Analyzing influent wastewater with biomonitors to optimize treatment in real-time
- Tracking water quality data from distributed watershed sensors for impact on local water sources
- Providing water flow and quality data from public waterways to recreational users

Cybersecurity

Government and its private sector partners steward an incredible number of physical assets as well as vast quantities of sensitive data. The threat landscape is constantly evolving, so these organizations must implement robust security strategies to prevent and mitigate cyberattacks, not only for data but for our increasingly connected physical infrastructure.

IoT helps create safe, smart communities



One of the most common tools for securing data is a firewall. Firewalls filter network traffic and use established rules to enforce administrative security policies.

Virtual private networks (VPN) are also common and standard security measures. VPNs produce encrypted connections between remote users and networks, protecting systems against unauthorized access and data interception. Zero Trust Network Access (ZTNA), a modernized replacement for traditional VPNs, helps authenticate users and devices and limits access to network assets.

Distributed Denial of Service (DDoS) is a major threat to government organizations. DDoS attacks disrupt critical public services by overwhelming networks with damaging traffic. DDoS management systems can detect and mitigate these attacks in real time, filtering the malicious traffic and ensuring that systems remain fully operational.

Zero Trust architecture is a tactic that is rapidly gaining adoption. This approach requires users and devices to be authenticated prior to gaining access to network resources. Zero Trust removes the belief that there is any trusted space in a network – it operates by managing security at every level, then allows more freedom for the user who has successfully navigated the micro-segmentation. By adopting a Zero Trust posture, organizations can prevent unauthorized access to sensitive data and mitigate the risk of threats by providing users access to approved applications, both cloud and on-premise, using only approved devices. This is typically enabled through a SASE-NaaS solution, as noted above.

Another mechanism that's becoming widely used is blockchain. It's a distributed database or ledger that provides a decentralized, tamper-resistant platform for storing and sharing information, reducing the risk of data manipulation as a result of cyberattack breaches.

IoT connects the physical and virtual worlds and can create efficiency, safety, cost-effectiveness and increased longevity for our tangible assets. Connectivity is the enabler for that smart technology, and cybersecurity makes the entire infrastructure ecosystem safer. As government and its private sector partners continue to converge our physical assets and digital technologies, they will transform our communities, redefining how we build, operate and maintain our cities, counties, regions and states.

Pillars of a Zero Trust Architecture

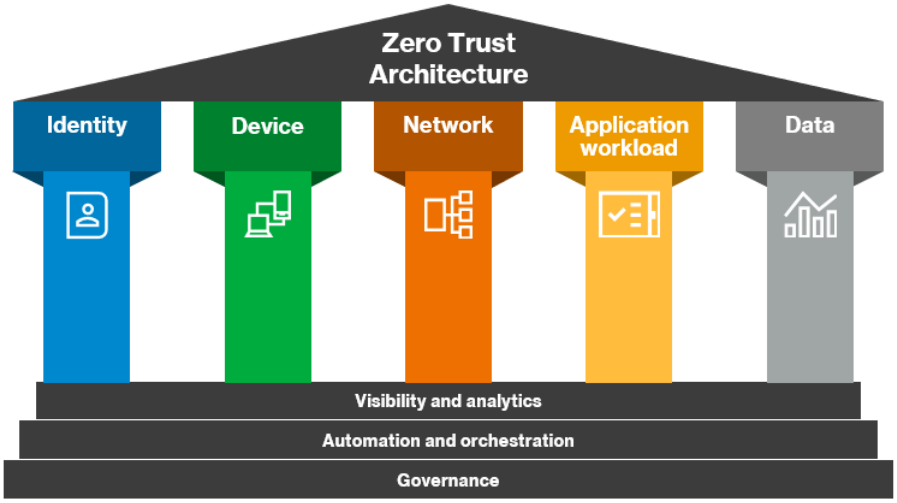
Establishing a Zero Trust Architecture is not accomplished with one security control, but many working together.

Identity: Secure, limit and enforce access to applications and data.

Device: Secure all endpoints (desktop, laptop, smartphone, IoT).

Network: Segment, isolate and control the environment with granular access.

Application workload: Secure tasks on premises, in the cloud and on virtual machines.



Data: Categorize and manage data securely to help protect it from unauthorized users.

Visibility and analytics: Improve detection of and response to atypical behaviors.

Automation and orchestration: Automate manual security processes to take policy-based actions with speed and at scale.

Governance: Audits, automated and dynamic enforcement of compliance policies.

Reimagining infrastructure: Building for the future

The Infrastructure Investment and Jobs Act (IIJA) offers an extraordinary chance to build for the future by reshaping the country's framework, boosting local economies and creating jobs. And while a significant focus of the bill is on traditional physical infrastructure, tens of billions of dollars focus on technology to implement smart technologies, bridge the digital divide, and secure our vital data and physical assets.

With the broader deployment of the Internet of Things for data acquisition and analysis, as well as the application of Artificial Intelligence and Machine Learning, government can accelerate on its path to enhanced service and greater effectiveness.

Verizon will continue to partner with governments across the nation and industry, helping lead the way towards better, smarter communities. The possibilities technology brings are inspiring–the future is full of exciting promise as we join our physical infrastructure with our digital and cyber innovations.

Helpful Links

Department of Transportation Infrastructure Law Funding Opportunities

Department of Energy Bipartisan Infrastructure Law Programs

Federal Communications Commission National Broadband Map

White House IIJA Guide Book

Verizon.com IIJA page

Verizon Public Sector technology and network solutions

Contributors

Scott Andersen

Scott is a long-time solution architect with more than 30 years of experience. He has designed solutions that span the world in a number of different industries including Financial Services, U.S. Government, State Government, Aviation, Oil and Gas and many others.

He has helped customers modernize their application portfolios. He has helped customers design new structures around how they build and use their networking solutions. Andersen developed a toolset for mission focused application evaluation called the Enterprise Resource Triangle. Through this system customers can evaluate what and how they are building applications to meet their mission goals.

Finally he has built and been a part of the management of two distinct Architecture Certifications over the years. Beyond certifications, Andersen has published a number of articles and is now focusing on Artificial Intelligence and Hybrid Cloud.

When he isn't focused on designing solutions, he is an avid writer, drone flyer and spends weekend time digging trenches. Well, perhaps the golf course doesn't appreciate the trenches but he does enjoy a good round of golf!

Brett Barganz

Brett Barganz is a Senior Principal focusing on Network-as-a-Service for Public Sector. He has expertise to lead organizations gracefully through their visions of change, especially technology transformation. He can offer insight into every part of their journey, from envisioning a solution to implementing and operating it, with a deep understanding of Public Sector and its systems from years working and consulting for local and state government. Before joining Verizon, he served 10 years in municipal and county administration roles, including manager's office, public works, police, fire, and enterprise technology. He also served five years in advisory roles, providing project management, organization change management, and IT guidance for Public Sector enterprise projects. Finally, for Verizon, he has served two years providing strategy, management, and consultative solutions support for advanced technology and networking products for Public Sector.

His academic background includes an MBA from the University of Chicago Booth School of Business, an MPA from Northern Illinois University, and a BA in Political Science from the University of Wisconsin – Whitewater.

Ray Bauer

Ray leads the Domain Specialists group at Verizon which helps enterprise and government clients achieve mission critical business outcomes leveraging technology.

Ray's communications industry experience started with CellStar, which was the first nationwide cellular agent for the top mobile network service providers across the entire United States and one of Motorola's largest global distributors.

Ray later held executive positions with GTE and Qwest. His Verizon career started in Florida with escalating strategic leadership positions serving Enterprise customers including relocation to the Midwest for twelve years, and later to the Washington DC area to work with the Federal Government and state agencies. His Verizon roles have included technical sales leadership for network, cloud, cybersecurity, managed and professional services, application enablement, and responsibility for successfully accelerating Verizon's joint go-to-market sales efforts with key partners.

Ray earned a Bachelor's degree with a major in Business from Lamar University in Texas and executive leadership certification from the Center for Creative

Leadership in San Diego. He currently resides with his family near Annapolis, Maryland and enjoys outdoor activities including volunteering with the Chesapeake Bay Foundation.

Lamont Copland

Lamont Copeland is the Director of Federal Solutions Architecture for Verizon's Global Presales organization in support of the Verizon Business Group Public Sector Vertical. He leads a team of technology subject matter experts who are focused on developing integrated, complex enterprise solutions and enabling business outcomes for Federal customers through the power of Verizon technology portfolios and partner solutions.

In his previous role with Booz Allen Hamilton, Lamont served as Senior Associate/Engineering Manager where he led a team of engineers and analysts for the Department of Homeland Security (DHS) reporting directly to the National Protection and Programs Directorate/Network Security Deployment (NPPD/NSD) Director and Chief Security Engineer for the EINSTEIN3 Program. While at Sprint, Lamont was Chief Engineer leading the engineering design and performance of Sprint's core IP network services.

Lamont holds a Bachelor's of Science degree in Electrical Engineering from Penn State University and a Masters of Business Administration with a focus on Management of Technology Innovation, Venture Capital/ Finance Investment, and Small Business Development from George Washington University.

Tony Dolezal

Tony Dolezal is a Public Sector 5G and Public Safety subject matter expert in the Verizon Business Group's Public Sector Field Marketing organization, and also leads Verizon's efforts and support for the ITEC Public Safety Interoperable Communications applied research initiative.

Tony began his career in telecommunications at MCI where he held several roles in sales, operations and marketing, including a leading role in the design and launch of the Hyperstream Frame Relay service. Later, he was co-founder of a Mexico City based communications company that was later acquired by eGlobe, and Mr. Dolezal was named Director General-Latin America for an eight-country satellite services provider.

Subsequently, he formed his own consultancy, TAD Consultants, Inc., specializing in Latin American telecommunications.

In 2011 Tony was recruited to Verizon to establish a Public Safety Professional Services practice based on his previous experiences.

Michelle Quadt

With more than 20 years of experience as an industry consultant, Michelle brings system-level thinking to infrastructure issues. In her role at Verizon, she is focused on accelerating 5G Innovation in particular bringing that innovation into the design, building and operations of large infrastructure assets.

Michelle joined Verizon in November 2020 after McKinsey & Company, where as a Senior Expert she worked at the intersection of infrastructure and public sector projects while building McKinsey's go to market capabilities for federal, state and local sectors. Before that at Booz Allen Hamilton, she served as a Principal in a variety of roles including corporate strategy, business development, strategic initiatives and account leadership.

Michelle received her BA from the University of Virginia and MA in International Economics from School of Advanced International Studies/Johns Hopkins University.

Wes Withrow

Wes Withrow serves on Verizon's U.S. Public Sector Solutions Executive Team with accountability for leading cross-functional groups that digitally transform government services.

Combined with a Johns Hopkins M.S. in Information Systems and a degree in Computer Science, he has earned the industry's top certifications: CISSP, CCSP, HCISSP, IBM Applied AI Specialization, Zscaler ZCCA-IA, ZCSP, Netskope Security Cloud Introductory, Certified SAFe 5 Agilist, AWS CCP, HDI-SCM/SCTL/SCA, CompTIA Security+/Network+, ITIL v2/v3, Six Sigma Green & Yellow Belts, Human Subjects Research, and more. He is a four-time recipient of The Johns Hopkins University Applied Physics Laboratory Special Achievement Award, Davis and Elkins College Outstanding Young Alumnus Award, U.S. Army PEO EIS Certificate of Appreciation for Medical Communications for Combat Casualty Care, Appalachian College Association Distinguished Scholar, and a WVIAC Intercollegiate Athlete Scholar.

Throughout his career, Wes has played a critical role in high-profile, high-dollar projects for the nation's largest and most prestigious government and corporate clients, including several state legislatures, federal agencies and medical institutes.

About Verizon Public Sector

Verizon serves as a trusted partner to the public sector, from rural communities to the largest State and Federal agencies. We enable better government through our best-in-class networks, innovative solutions, exceptional customer experience, and decades of success helping get mission-critical projects done right. With Verizon on their team, our customers can serve their constituents better, work more efficiently and remotely, create smart communities, empower young learners, help ensure public safety, and respond quickly to emergencies.

For more information, please visit: Verizon Public Sector.