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SMARTER,
SAFER CITIES
Improving Public Safety
in the age of AI and IoT

Citizen Safety and Security, core pillars for the City of the Future, assure better quality of life to its citizens. Together, Dell Technologies and Intel are delivering on that promise, helping cities lay the right technology foundation for that journey.

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Public Safety in cities is on the cusp of quantum improvement with the support of disruptive new digital technologies; Dell & Intel have the cutting edge toolkit to support the effort to improve the safety and security of citizens across the globe.

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OVERVIEW

Cities have long been at the center of human progress and innovation, and today are more so than ever before. They create opportunities for people to more efficiently learn and share knowledge, conduct trade, build tight communities and enhance quality of life. Cities move civilization forward.

Although cities are key to our society's development, the growth of large metropolitan areas around the world is relatively recent, particularly when measured against the duration of human beings' existence. For the first 95% of our history, very few sizable settlements were established. Cities of more than one-million people arose only during the last 1% of homo sapiens' time on earth, growing to 500 such cities in the world today.[1]

Today, 55% of the world's population lives in urban areas, growing to 68% by 2050 according to current forecasts. At the heart of this growth are megacities—cities with more than 10 million inhabitants. By 2030, there will be as many as 43 megacities on Earth, up from only 10 in 1990.[2] This explosive urban population growth is just one example of why cities must respond and adapt to new pressures and increasing expectations. From health, transportation, housing, safety, security, education and environment to culture and tourism, today's public safety and city leaders have an historic opportunity to harness innovation and mobilize public and private resources for the benefit of their citizens – their community.

TODAY,

55% **OF THE WORLD'S POPULATION LIVES IN CITIES**

GROWING TO 68% BY 2050

Looking back 150 years, the Age of Industrialization shifted the paradigm about what cities could accomplish. More recently, the Information Age is changing city life in equally dramatic ways. An emerging community of civic leaders, data scientists, technologists, and companies are 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 while protecting safety and privacy.

A confluence of advances in information and communication technologies (ICT), the Edge, Internet of Things (IoT), Artificial Intelligence (AI), computer vision, and related technologies are enabling cities to modernize infrastructure. These advances in technology can ultimately allow cities to tap into the wisdom of residents, visitors and businesses as they drive to improve community, services and quality of life.

Making our cities "smarter" means equipping them with the tools to address the pressing problems that their citizens care most about. To live, work, play, socialize, and raise families in today's large and complex cities, citizens should feel safe and secure. Safer cities attract businesses, foster innovation, provide unmatched opportunities and create stability for sustained growth. With city populations on the rise, urban planners, municipal governments, and businesses must make important decisions about prioritizing safety and security. By working collaboratively, public and private entities can lay the groundwork to ensure public safety and enable economic development.

The Opportunity for Smarter, Safer Cities

Today's city leaders are embracing the concept of a 'Safe City' through efforts and initiatives that provide security, improve traffic flow and enhance sustainability, while helping to smooth operations and positively impact quality of life in modern urban centers.[3] For example, in the event of an emergency, video cameras and sensors give detailed information to public safety officials so that they can assess situations more effectively and respond faster. An intelligent system triggers several emergency response actions, including deploying first responders, medical teams, and firefighters to the precise location of the emergency.

1 World Bank. Have Humans Evolved to Manage Megacities? 18 Sep 2014.
2 United Nations. World Urbanization Prospects 2018. 16 May 2018.
3 IHS Markit. The Safe City: Assessing Opportunities and Challenges in a Budding Security Concept. 12 Dec 2018.

Ambulances move more freely through the city, connected to a network integrated with traffic signals and communicating with hospital staff en route. Sensor networks facilitate the complex task of monitoring the scene to detect potential hazards. Public safety officials can manage nearby crowds and enforce restricted zones at various locations across a city to ensure safety. A digitally connected city can come together to organize and optimize resources and ultimately protect lives.

Intel and Dell Technologies have a combined portfolio of cutting-edge technologies and solutions that are at the forefront of helping cities become smarter and safer, both today and the future. With decades of experience delivering state of the art technology together, Intel and Dell Technologies power every segment of the intelligent, connected world of Smart Cities—from the device, to the network, to the cloud, to insights. Intel, Dell Technologies, and a vast set of ecosystem partners are working together to create a more vibrant, extensible, and sustainable way for city leaders to implement Smart City strategies.

This booklet provides an overview for how City and Public Safety Leaders can develop Smart City strategies for public safety. These strategies bring together solutions that help cities improve emergency preparedness, provide first responders and law enforcement with greater situational awareness and intelligently help manage multiple aspects of daily life in the city, including traffic, transportation and infrastructure. With these advances, cities can achieve the ultimate goal of improving quality of life for citizens.

With the number of cars traveling our roads around the world expected to double in the coming decades, new ways of responding to accidents, controlling traffic lights, and creating better flow will be needed to keep traffic moving. Even with new roads and bypasses, this ever-increasing level of traffic could quickly outstrip the ability of road networks to cope in many busy areas, such as cities.[4]

Cities have an opportunity to solve for these issues today and plan for sustainable growth and improved public safety for citizens now and in the future.

4 BBC. The Technology That Could End Traffic Jams. 12 December 2018.

TIME GIVEN BACK

15 days

Smart Cities have the potential to 'give back' three working weeks' worth of time to every city dweller every year.

HOW WILL THIS TIME BE CREATED?

60H saved

Mobility
Smart Traffic Systems including dynamic traffic light phasing and smart parking reduce time in traffic. Open Data Platforms enable citizens to choose the fastest metro/bus lines.

35H saved

Public Safety
Machine Learning-enabled software such as PredPol used to predict crime spots on a given day. ITS here is used to prioritize emergency service vehicles through traffic light phasing and driver re-routing.

9H saved

Healthcare
Healthcare preventative apps & telehealth aim to reduce average physician visits by promoting better overall wellbeing. While improved administration and preliminary diagnosis reduce wait times.

21H saved

Productivity
Apps or digital services will simplify administrative processes when citizens interact with city agencies.

BENEFITS TO SMART CITY INHABITANTS

More Time for Family and Friends
Enough time to enjoy a meal with friends or family twice a week.

Get Active
Exercise for 45 minutes 3 times a week, every week of the year.

Improved Recovery
Studies have indicated that wounds take up to 25% longer to heal when individuals are chronically stressed. 110 million people die every year as a direct result of stress.

Decreased Risk of Depression
Lost productivity and medical expenses from depression costs over $83 billion annually: $11.30 for every person on the planet, every year.

Improved Earning Potential
The cost of stress can be high: if left unaddressed, it could mean that individuals' potential earnings fall by $10,000.

City Leaders are looking to ensure coordination across city departments and agencies to keep citizens safe from a range of risks, including emergencies, natural disasters, crime, and terrorism. As urban populations increase globally, public safety is critical to enable urban growth, reduce economic costs and address crime. By improving public safety, cities also can build trust in law enforcement, thereby facilitating a more productive police presence. Investing in public safety lays the groundwork for citizen peace of mind and a stable, cohesive community.

Solutions for public safety can help make cities more safe, efficient, responsive, and sustainable. For example, emergency response solutions can have substantial benefits for citizens. According to Juniper Research, the intangible benefits of Smart Cities will result in 4 million citizens leading happier lives every year. This would be achieved through a number of ways including a 15% improvement in emergency response times and a 10% reduction in crime. Both benefits also help to reduce the impact of stressful life events. How can such outcomes for citizens be achieved? Leading Smart Cities are leveraging technological advances in combination with existing services and personnel to work smarter. For example,

> *"With smart policing strategies, Philadelphia's crime rate is at its lowest in 50 years"*
>
> Kevin Ebi
> **DIRECTOR**
> SMART CITIES COUNCIL

- **Machine learning** can be utilized to generate predictions around where crime is likely to occur on any given day. This allows law enforcement to target patrols in such areas, helping reduce crime more efficiently. It is estimated that this solution could lead to the **prevention of 3 million crimes.** In addition to this, Machine Learning can be deployed as a tool for CCTV analysis; detection of unusual activity in real-time can serve to reduce response times to crime. Machine Learning can also be used to predict where fires or flooding might happen.
- **Integrating emergency services with traffic management.** When cities integrate their emergency services with the municipal traffic control system, the prioritization of emergency services vehicles and re-routing of civilian traffic can reduce arrival times by nearly 50%, based on recent integration projects. In medical terms, the 'golden hour' refers to the period of time after a life-threatening incident where treatment is most likely to save lives. Note that this 'hour' is not always an hour, depending on the severity of the circumstances; nonetheless, in all instances, the result of faster emergency response times is an increase in average life expectancy. Improving response times has a global impact, in the context of violent crime, road traffic incidents and chronic conditions such as heart disease. The research showed that in critical situations, every minute without CPR or defibrillation reduces survival chances by 10%; therefore, the study's modest 15% improvement in response times highlights that fact that every minute counts.[5]

5 Juniper Research, Smart Cities – What's in It for Citizens, Nov 2018.



ADDRESSING CHALLENGES

For all the public safety and security benefits offered by adopting Smart City solutions, adoption also poses many challenges. Finding the best-fit technology is often not the toughest challenge in transforming to a smarter, safer city. Common difficulties are found in funding, gaining stakeholder approval and building citizen support.

Taking steps forward in small ways and partnering with trusted advisors will help build short-term wins while keeping the future vision in mind. By leveraging the knowledge of trusted partners like Intel and Dell Technologies, City and Public Safety Leaders have access to collective knowledge from labs, solution centers and briefing centers that Dell Technologies and Intel have built together.

As City and Public Safety Leaders begin the journey to a safer, smarter city, engaging with stakeholders and colleagues on the below considerations will help better define the city's future.

Putting transparency first

Leading cities that prioritize transparency and secure storage of personally identifiable information (PII) ensure that their citizens are well-served and are more likely to score higher on citizen sentiment assessments and/or in the public arena.

Applying new technologies in support of public safety missions raises new questions about civil liberties, meaning individual protections, and how far cities can and should go to protect citizens. For instance, video can capture activity outside of the purpose it's intended for, such as traffic levels at a busy intersection. Facial and object recognition technology, embedded in applications that analyze images and videos (and now integrated with cameras), can detect people, text, scenes, activities and inappropriate content.

With AI, recognition capabilities get smarter over time. Organizations also continue to add new features, further pushing the boundaries of what's appropriate to track and what isn't. Compounding all of this is the need to protect private citizen data through laws and regulations pertinent to the city jurisdiction, and sensible planning and deployment of solutions where data is exposed publicly. Europe's Global Data Protection Regulation (GDPR), in effect since May of 2018, is an example of a wide-ranging mandate that covers consent, security, notification and other elements of private data which requires any organization that handles EU citizen data to follow strict rules. Stiff financial penalties await organizations who are not in compliance.

Prioritizing transparency before implementation is a recommended best practice from leading Smart Cities. Part of the planning process should include robust procedures for the secure storage of PII and sensible policies around the removal of unnecessary content and the period for which it's kept.

Engaging citizens for input and approval

Early and active engagement of citizens is crucial to a Smart City initiative's success. Best practices from successful Smart Cities show that success is found through a community-driven, bottom-up approach to envisioning and implementing Smart City technologies. After all, technology is simply an enabler of the goal to enhance city services and improve quality of life.

During open planning discussions, City and Public Safety Leaders can provide details about expected outcomes and benefits, along with the challenges and risks. Citizens who understand how and why taxpayer money is spent are much more likely to be supportive. Lyon, France, for example, has created a "working together" model based on open innovation and agile practices where citizens and public-private organizations come together to contribute to and test in-progress service offerings and incubate new ideas.[6]

6 http://www.business.greaterlyon.com/innovation-in-greater-lyon-53.html

Understanding and planning for the needs of all citizens should be a component of the impact analysis for any Smart City project. The digital divide in a city (i.e. the gap in access to information, technology and connectivity which results in inequalities among citizens) can negatively impact the success of a Smart City Project if not addressed.

For those citizens that are interested in participating in the transformation to a smarter, safer city, open data initiatives can help foster collaboration and a culture of innovation. Furthermore, a Smart City framework can create better service experiences for citizens by recognizing and rewarding them for their participation. Open data portals or marketplaces fueled by open data policies and connected systems can be transformational in bringing new services to citizens and making the city stronger for future growth as well. New York City has an open data law that requires all public data to be made available on a single web portal. It's aiming to develop a master data platform to facilitate interagency communications under a single operating system. To accomplish this, they first need to work through community relations, leadership, funding and data governance problems, which they are in part addressing by working with other cities around the world to identify sensible solutions.[7]

Evolving systems and policies

In a shifting landscape of increasing population in urban areas combined with enhanced threats to public safety; systems, policies, processes and personnel that have been in place for years, which may have worked well in the past, may prove less than ideal in the near future. Additionally, the capabilities of new technologies and changes to operational processes (intentional or not) can amplify classic challenges for Public Safety leaders such as:

1. Internal and external information-sharing
2. Integrating and digesting numerous and disparate data feeds to inform situational awareness
3. Communicating to vital internal and external audiences
4. Protecting sensitive information from bad actors/organizations who seek to disrupt and exploit operations.

As infrastructure and systems are modernized, whether by choice or by necessity, evaluating impact to the daily duties of public safety officials including first responders, departmental teams supporting public safety through technology and communication, as well as leadership who interacts with citizen groups in the community, will be critical to a city's success.

Moving ahead, despite resource limitations

Funding may be the largest obstacle cities face to digital transformation. Grants, subsidies and taxes, all counted on by cities to fund large projects, may not be available due to tightening budgets and unreliable federal subsidies. Furthermore, City and Public Safety Leaders may be averse to thinking about financing sources outside of traditional methods like municipal bonds.

When trying to overcome budget restrictions, City and Public Safety Leaders should consider broadening the discussion by illustrating all the areas a single project can impact. For example, a typical smart street light project offers the following benefits:

- **Energy savings** by using high-efficiency LED lights
- **Transportation benefits** by housing cameras and sensors for smart parking and traffic management
- **Sustainability improvements** by using its communications network for smart water and smart grid
- **Enhanced public safety** through better illumination, gunshot detection and video
- **Economic development** improvements by hosting community Wi-Fi or kiosks that help citizens and tourists.

7 https://www.innovations.harvard.edu/cities-address-hurdles-sharing-data

An array of city services including personnel and procedures should be considered part of the solution and impact area for any Smart City initiative. If tangible benefits can be identified for optimizing specific services or personnel operations, this will open the potential for blending forecast budgets with the additional resources (people, time and funds) to implement a Smart City solution.

KEY PUBLIC SAFETY USE CASES



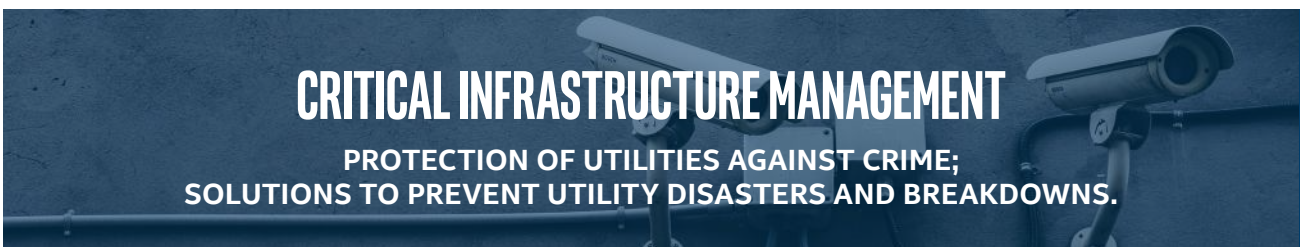












Looking to cities that are leading the way in improving Public Safety can provide learnings for Public Safety and City Leaders to model in their own community. A great resource to consult is from The Economist Intelligence Unit, which ranks cities across the globe in their annual 'Safe Cities Index'. In the third edition from 2019, 60 cities were evaluated across 57 indicators covering four pillars of **digital security, health security, infrastructure security, and personal security.**[8] In each area evaluated, leading cities prioritized fundamentals, such as easy access to high-quality healthcare, dedicated cyber-security teams, community-based police patrolling or disaster continuity planning. Those cities who did not rank highly were lower for a variety of reasons. Cities looking to improve public safety and security should consider the basic pillars and how each one can be addressed through careful planning.

Safe Cities Index 2019, Economic Intelligence Unit

DIGITAL SECURITY

The top five:

1. Tokyo
2. Singapore
3. Chicago
4. Los Angeles
5. San Francisco

HEALTH SECURITY

The top five:

1. Osaka
2. Tokyo
3. Seoul
4. Amsterdam
4. Stockholm

INFRASTRUCTURE SECURITY

The top five:

1. Singapore
2. Osaka
3. Barcelona
4. Tokyo
5. Madrid

PERSONAL SECURITY

The top five:

1. Singapore
2. Copenhagen
3. Hong Kong
4. Tokyo
5. Wellington

Focusing on core elements of public safety and security is a winning strategy for cities and the citizens that inhabit them. Statistical analysis of the 2019 Safe Cities Index shows that performance in a single pillar correlates very closely with the other pillars. In other words, cities tend to rank high, medium or low across every security pillar rather than having good results in one and lagging in others.

The implication for Public Safety and City Leaders is that planning to improve public safety and security can yield benefits across the board. Investing in infrastructure technology, for example, can yield citizen health benefits, while enhanced cyber-security will protect the ability of the city to be resilient in all types of security, not just protection of digital systems.

8 Economist Intelligence Unit, Safe Cities Index, 2019.

CASE STUDY

New York City

Data, predictive modelling and inter-agency coordination helps New York improve public safety standards Once known as the 'murder capital' of the USA, New York has made substantial inroads in addressing improved public safety standards over the past 20 years. In fact, the city now ranks as the safest of all of the major cities in the country.

Data-driven Approaches: New York was the pioneer of statistical policing, beginning with the deployment of CompStat in 1994. This program was relatively simple in nature (mapping and logging crimes according to time series and location data), but allowed the police force to identify key crime hot-spots and devise strategies aimed at increasing public safety in each area. CompStat's legacy has since formed the foundation for modern policing across the globe. More recently, the city conducted a 2-year trial of HunchLab, a predictive crime software solution. Where previously the city's 'stop and frisk' program served a statistically effective, albeit highly controversial, method of reducing

crime rates in the city, the new software uses data and statistical modelling, including historical crime data, terrain modelling as well as time and weather information to correlate where crimes happen with specific types of locations. These types of approaches do not stop at law enforcement. With capacity to inspect only one-third of the city's buildings annually, the NYC fire department required an innovative approach to reducing building fire damage. Here, it compiled a list of 60 factors influencing building fire risks. These factors, alongside historical data and predictive modelling have allowed the department to target areas most likely to require building safety inspection.

Cross-departmental Vision: New York's Smart City strategy applies a multi-pronged approach for improving public safety. In this context, the city aims not only to reduce the number of road traffic incidents and violent crime, but also the manner in which these are treated. For instance, emergency response teams are well-integrated, allowing disparate agencies to function more efficiently, while a disaster response strategy has been established to better co-ordinate emergency response with the public in the event of a major incident. This latter development is key, considering that the city has been subject to the second highest number of terrorism-related events of the cities evaluated in the study.





PUBLIC SAFETY AND SECURITY USE CASES

Use cases are emerging from 'Safe City' initiatives around the world. Cities approach public safety and security in a variety of ways, depending on recent events, physical and infrastructure characteristics, and the concerns of the community.

SOLUTION SPOTLIGHT

Bac Ninh, Vietnam

Challenge: To help encourage international investment, the city of Bac Ninh, Vietnam, wanted to enhance public and commercial security. To do this, the city needed a consolidated command and control operations center for e-government, e-citizen, computer vision and Edge and IoT systems. To support a planned deployment of 50,000 cameras over the next five years, the city also needed a scalable and integrated video surveillance system.

Solution: Collaborating with ecosystem partners Qognify for VMS and XRVision for FR, Dell Technologies created a solution that leveraged Dell EMC Isilon Data Lake design for deep analytics, high capacity, and density supporting VMS, VA, CAD, and IOC.

Result: As a result of the Safe City solution deployment, Bac Ninh gained recognition for becoming the first Digitally Transformed Safe City in Vietnam. The solution helps create a safer environment for citizens and the city by reducing the crime rate. In addition, the city has increased operational productivity and efficiency and improved the police and emergency response rate to incidents.

For more information about how Dell Technologies is helping cities build strong foundations for their future, visit www.DellEMC.com/DigitalCities

Incident detection and management

Connected streetlights with an optical and/or microphone sensor can give information to public safety officials so that they can respond faster. First responders can benefit from low latency optical sensors around a city to assess situations. A 5G-connected ambulance can move freely through a city by connecting to a network communicating with traffic signals as well as with doctors at the hospital's trauma center en route.

Gunshot detection

Gunshot detectors use digital microphones installed on buildings or along streets that listen specifically for gunshots. They can provide near instantaneous notification, triangulate the location of shooters and shot direction, and even detect the type of gun. With the ability to send near-real time notifications directly to a central command center and to an officer's phone, law enforcement are able to respond faster, save lives, and increase the chance of catching perpetrators. In a Fresno, California, neighborhood in 2017, gunshot detection technology helped catch a criminal who fired multiple shots at people. Officers were alerted almost immediately after the shots were fired and were able to capture the suspect who was still in the area where the crime occurred.[9] Gunshot detection also adds another layer of data onto the bigger picture of where and what types of crime are occurring, feeding into predictive policing efforts.

Emergency response

In a 5G-enabled Smart City, emergency detection can trigger several emergency response actions, including faster deployment of first responders, medical teams and firefighters to the precise location of the emergency. In addition, when a fire is detected, the system can automatically close fire shutters and turn on fire sprinklers wherever necessary. Fires can also be detected by building sensors, that send an alarm to the Building Management System, which then sends commands to the actuators in the building. 5G also enables faster response time—fire sprinklers are turned on within 1 to 2 seconds from the time a fire's detected.

Predictive policing

Cities can combine and analyze all the data generated from resources such as drones, wearable cameras, facial recognition, video and images to identify or predict hotspots for street crime and deploy police more efficiently. Officials from Manchester, New Hampshire, for example, after experiencing 400 drug-related deaths in 2015, along with an increase in burglaries and armed robberies, created a predictive policing system using crime statistics, weather patterns and other information overlaid on top of a city map. The model generates predictive hot spots indicating where new crimes might occur resulting in a 60% crime prediction accuracy within a 500-foot radius of where a crime was predicted to occur and a total crime reduction impact of 28%.

Sensor monitoring

Sensors embedded in critical infrastructure such as buildings, bridges, and power plants monitor structural data to identify potential dangers, protecting citizens and the economic well-being of the city. Sensor networks aim at monitoring the state or behavior of an environment using various types of sensors such as microphones, CO2 sensors, pressure sensors, humidity sensors, and thermometers. These sensors usually incorporate machine learning algorithms to form a distributed monitoring system that can detect data anomalies. Sensor networks facilitate the complex task of monitoring an environment to detect potential hazards, operational failures, malfunctions and more. This can help improve safety by automatically triggering a specified response, such as a machine's emergency stop, when detecting a problem.

Crowd management

Cities can understand when, how, and why crowds form, as well as predict their movements and actions. At a large music festival, organizers and security can use a combination of crowd management technologies to improve the overall experience while keeping attendees and workers safe. For example,

9 https://apnews.com/977b4025bc334e8ab50d24486cb9fa03

network data via Edge and IoT sensors can gauge crowd densities at different locations, identify how many people are visiting concessions, queue waiting times for toilets, and determine if security is needed for directing pedestrian traffic in crowded areas.

Public health

By combining Big Data analysis with healthcare information, cities can prevent major healthcare outbreaks before they happen. Deloitte identified a city where administrators use geospatial analysis to visualize complex data on maps, enabling them to target neighborhoods for specific interventions.[10] Such analyses can visualize the geographic extent and impact of problems such as child abuse and neglect, drug abuse, unemployment, and health issues. The data often invites meaningful questions about factors that drive these specific challenges, and let administrators focus resources on the neighborhoods—or even particular housing developments in need.

Smarter infrastructure

The possibilities for protecting first responders and improving the lives of citizens through implementing a smarter infrastructure area endless. Connecting sensors at the edge through high-speed, modern networks to the data center and cloud for High Performance Computing (HPC) create unique opportunities for learning from data in fluid, fast paced situations as well as longer-term, subtle trends.

New Orleans

New Orleans, where police are understaffed relative to city size, created the Real Time Crime Center (RTCC) that placed infrastructure and technology in high crime areas. With cameras sending continuous feeds back to RTCC, officers were given greater situational awareness of activity throughout the city, helping them perform their duties more efficiently and effectively.[11]

Barcelona

Barcelona uses sensors in different areas to detect the presence of pollution, humidity, temperature, people and noise. It even revamped garbage collection by installing smart bins to collect and vacuum waste into underground storage. This reduces the smell of trash and noise pollution from garbage trucks. It also enables the city to detect waste levels that come from different places and optimize the collection of waste, decreasing the resources and time needed for this service.

Washington D.C.

D.C. created the Urban Living Labs project that focuses on creating a network of sensor hubs across various university campuses in the city. Focused currently on collecting environmental data on air quality and other ambient information such as air temperature, humidity and barometric pressure, it will transport and house the data centrally within GWU's High Performance Computing (HPC) environment for analysis and reporting.

Cross-department coordination

Public safety agencies and other government departments are working together to share appropriate information to improve cross-agency and cross-department coordination. For example, in response to a series of floods and mudslides, Rio De Janeiro created a central command center with inputs from more than thirty city agencies. The shared information enables city agencies to map high-risk areas for floods and flood-related landslides and create an early warning and evacuation system to help low-income residents of the city's favelas.[12] In the United States, the sheriff's office in Wake County, North Carolina acts as the central data hub for all the county's public safety-related data, which other agencies can access and utilize as needed. This saves the county money by eliminating the need for additional personnel to manage their own agency solutions and freely share all criminal justice and civil process data among each agency.[13]

10 https://www2.deloitte.com/content/dam/Deloitte/us/Documents/public-sector/us-fed-building-the-smart-city.pdf
11 https://www.genetec.com/solutions/resources/new-orleans-public-safety-systems
12 McKinsey Global Institute, Smart Cities: Digital Solutions for a More Livable Future, June 2018.
13 http://data-wake.opendata.arcgis.com

"True public safety and security are the most basic jobs of any government or organization and are best achieved when law enforcement and technology come together to help ensure a safer and smarter world. By adopting today's emerging technologies, including computer vision, Edge and IoT, organizations have already begun to deliver on the promise of a safer and smarter future."

Ken Mills
GENERAL MANAGER, INDUSTRY EDGE AND IOT, DELL TECHNOLOGIES

TECHNOLOGY TRENDS DRIVING SAFER CITIES

The world of IT is being completely redefined where evolution in technologies are driving transformation. New principles and capabilities are emerging across the entire IT stack, from the hardware to the software layer, and across the entire IT ecosystem. These forces are reinventing how ecosystems are formed, re-designing the rules for application development and deployment, and recreating how application designers, developers, operators and users collaborate in this myriad of interconnections. This section highlights the major technology trends that are accelerating the pace of evolution to smarter, safer cities.

Computer Vision

Computer vision helps reduce crime by assisting law enforcement in identifying and apprehending criminals before they jeopardize public safety. Optical sensor technology can help enable public safety officials with situational awareness and positive response in multiple scenarios including crowd control, civil unrest, identifying missing persons and for emergencies at a large sporting event. Additionally, computer vision can also be used as a forensic tool to review video footage or evidence for unsolved crimes. Computer vision systems typically include optical sensors, AI and computer vision capabilities, and video management software (VMS) for incident management, visualization, analytics, and search.

Cybersecurity

A number of cities have already adopted heterogenous Edge and IoT sensors and applications for enhancing city services. With this trend comes the need for IT security standards applying to the Edge and IoT infrastructure with granular visibility and control for all connected devices, applications and networking. For example, ransomware of video cameras or hacking into video systems can disrupt processes, threaten infrastructures and compromise the privacy of citizens. It's incumbent upon cities to employ best practices to prevent such cybersecurity attacks. The EU for example, recently created the European Union Agency for Cybersecurity (ENISA), which provides recommendations on cybersecurity, supports policy development and its implementation, and collaborates with operational teams throughout Europe.[14]

Best practices for video sensor cybersecurity include:

- **Passwords.** Educate end-users on the need for strong passwords and limit access to master passwords.
- **Disable features.** Minimize options for attackers by turning off non-essential features, including audio channels, unused switch ports and device location.
- **Audits and testing.** Work with video sensor vendors to conduct audit testing and understand how vendors are working to improve the overall security of products.
- **General Data Protection Regulation (GDPR).** Be aware of GDPR requirements in the EU that could define video sensor data as 'unique personal data', which may require encryption of video feeds.
- **Firewalls.** Make sure video cameras are never connected directly to the internet.

14 https://www.enisa.europa.eu

- **Encryption.** Secure access with HTTPS to protect the management exchange between cameras and the VMS server.
- **Promotion and education.** Work with vendors to educate users on best practices to prevent cybersecurity attacks.
- **Software/firmware updates.** Enable automatic updates to ensure systems stay up to date.

Wearables and embedded sensors

Smartwatches can help law enforcement, fire departments and emergency medical services teams stay mobile, going wherever emergencies take them. Real-time location, safety and emergency data from the first responder to the dispatch center can enable emergency personnel to be more effective in situations where handheld devices aren't always practical. Sensors embedded in the environment can detect noise, movement, temperature and other things, which can all be extremely helpful in providing safe environments and public security. Imagine for example, an audio sensor located on the outside of a building that detects the sound of gunfire, identifies its location and alerts dispatchers to the scene.



LAS VEGAS, USA

SOLUTION SPOTLIGHT

Las Vegas, USA

Challenge: The city of Las Vegas, USA, wanted to improve law enforcement and emergency response time and accuracy to public safety incidents. Authorities needed a way to identify specific types of incidents and provide real-time alerts. The solution needed to be capable of identifying a person or vehicle of interest, while gathering data on pedestrian, vehicle, and bicycle movements for economic development.

Solution: NTT DATA Services and Dell Technologies created the 'Accelerating Smart' solution for the city of Las Vegas. Designed to improve safety, Accelerating Smart uses Internet of Things (IoT) devices, high-definition video cameras, and sound sensors to monitor a public area within the City's Innovation District. The solution incorporates Dell EMC's hyper-converged infrastructure and IoT gateways, as well as VMware's virtualization software hosting predictive analytics applications. The city deployed high-definition video cameras and microphones around streets, parks, and venues. Micro-data centers near sensors run advanced analytics including deep learning AI, creating a secure, distributed platform in the designated public area to expedite analytics and improve situational awareness. Video and sound data inputs from the area, integrated with publicly available, historical data sources (such as crime, weather and social media data) allow the Cognitive Foundation embedded in NTT DATA's Smart City solution to apply advanced analytical processing to facilitate safety decision making. The solution leverages NTT orchestration components for remote management. Dashboards and alerts are provided to the command center.

"Public Safety in cities is on the cusp of quantum advancement with the support of disruptive new digital technologies; Dell Technologies and Intel have cutting edge tools to support the effort to improve the safety and security of citizens across the globe."

Michael Sherwood
CIO, CITY OF LAS VEGAS

Result: Accelerating Smart has helped the city improve situational awareness and provide insights for public safety decision makers through early notification of potential and active incidents. By leveraging cognitive analytics, including Artificial Intelligence and machine learning technologies, the Smart City solution learns normal patterns of activity occurring in public places and can detect and alert the authorities of those patterns that appear abnormal to reduce response times for first responders. Additionally, Accelerating Smart enables real-time alerts for public crowd density, number of vehicles, sound alerts and more, which allows predictive alerts, validation of critical alerts and a reduction in the amount of data required to be processed by the City.

Las Vegas implemented a platform which can enable future expansion to other Smart City use cases. This innovative solution has been recognized by the Smart Cities Council and by the Smart 50 Awards, which honors the most transformative smart projects of the year.

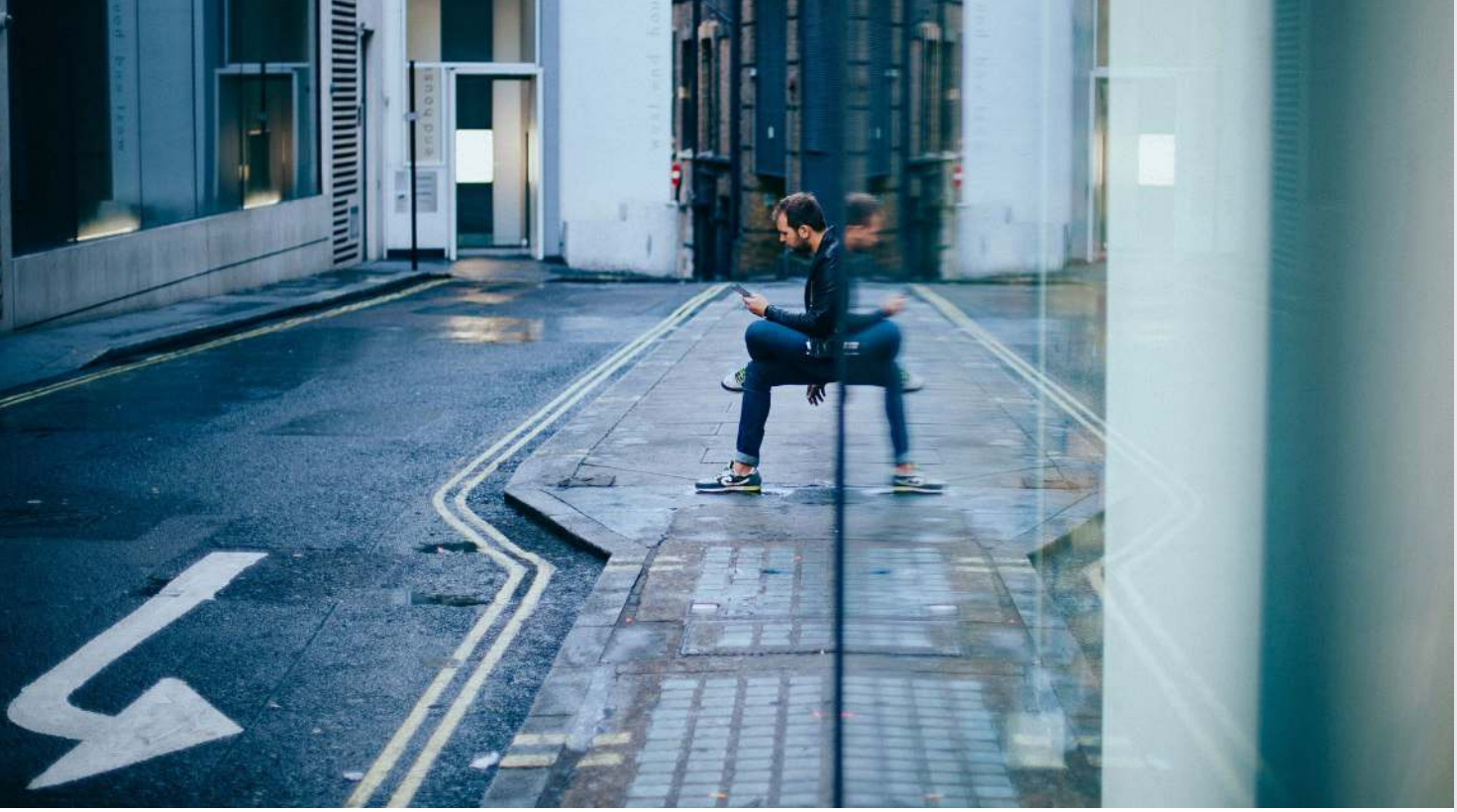
For more information, watch the video. Additional information can be found on the Dell Technologies website and the NTT Data website.

Crowdsourcing

With crowdsourcing, cities can tap into the collective intelligence of the public at large to complete a task or solve a problem, creating a sense of collaboration between cities and their citizens. While social media and texting apps let citizens report crimes and other issues related to public safety, they may not always provide features needed to make a report. New platforms including voice-to-text capabilities can improve communications, and even incentivize citizens to report incidents. When agencies respond back to acknowledge receipt, it further incentivizes citizens to engage because they know their information isn't falling on deaf ears.

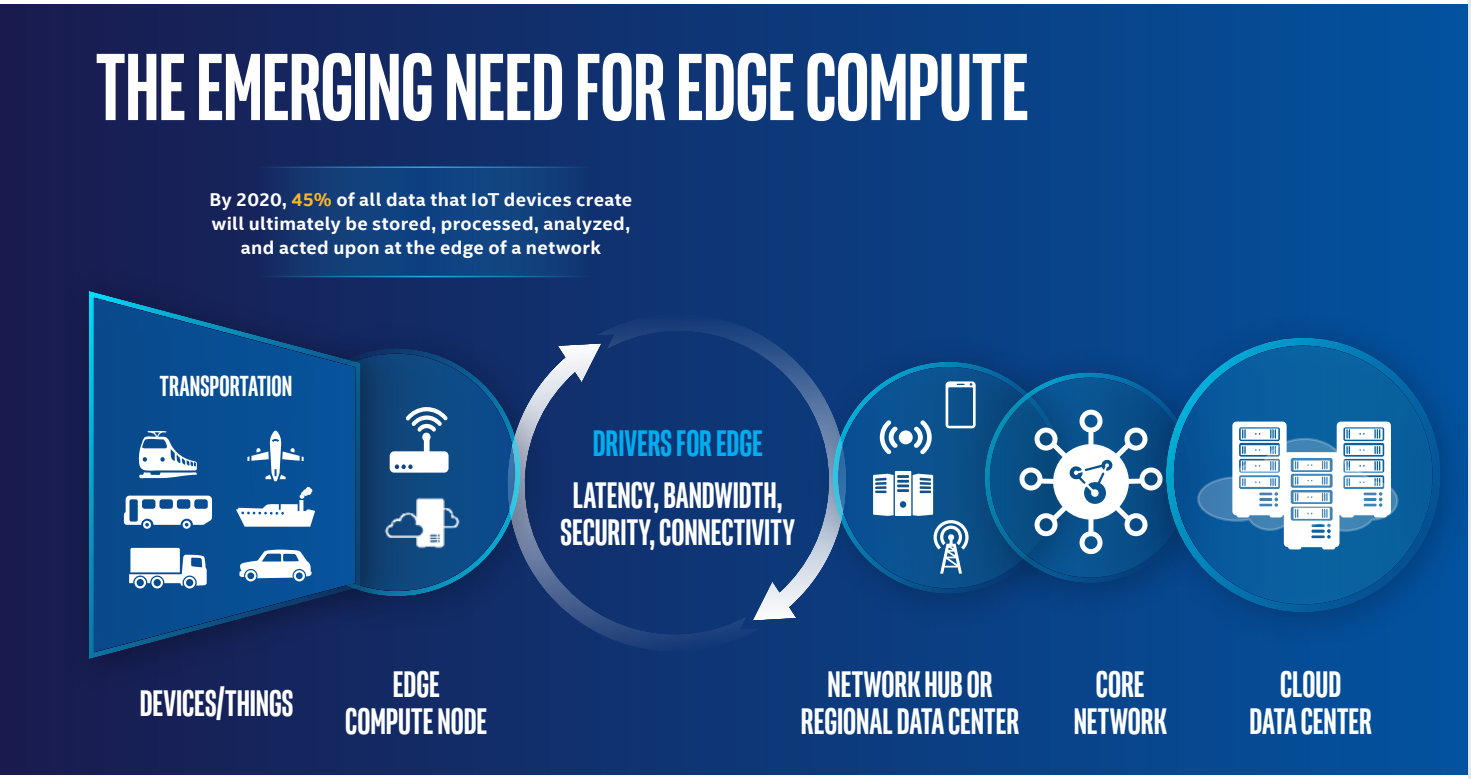
The importance of 'shared'

It's not enough to have a smart infrastructure. Using access controls and protocols, it should also be shared. At the very least, shared with other city departments. And, when practical, shared with regional partners such as utilities, universities, counties, transportation authorities, and neighboring cities.



5G Technology

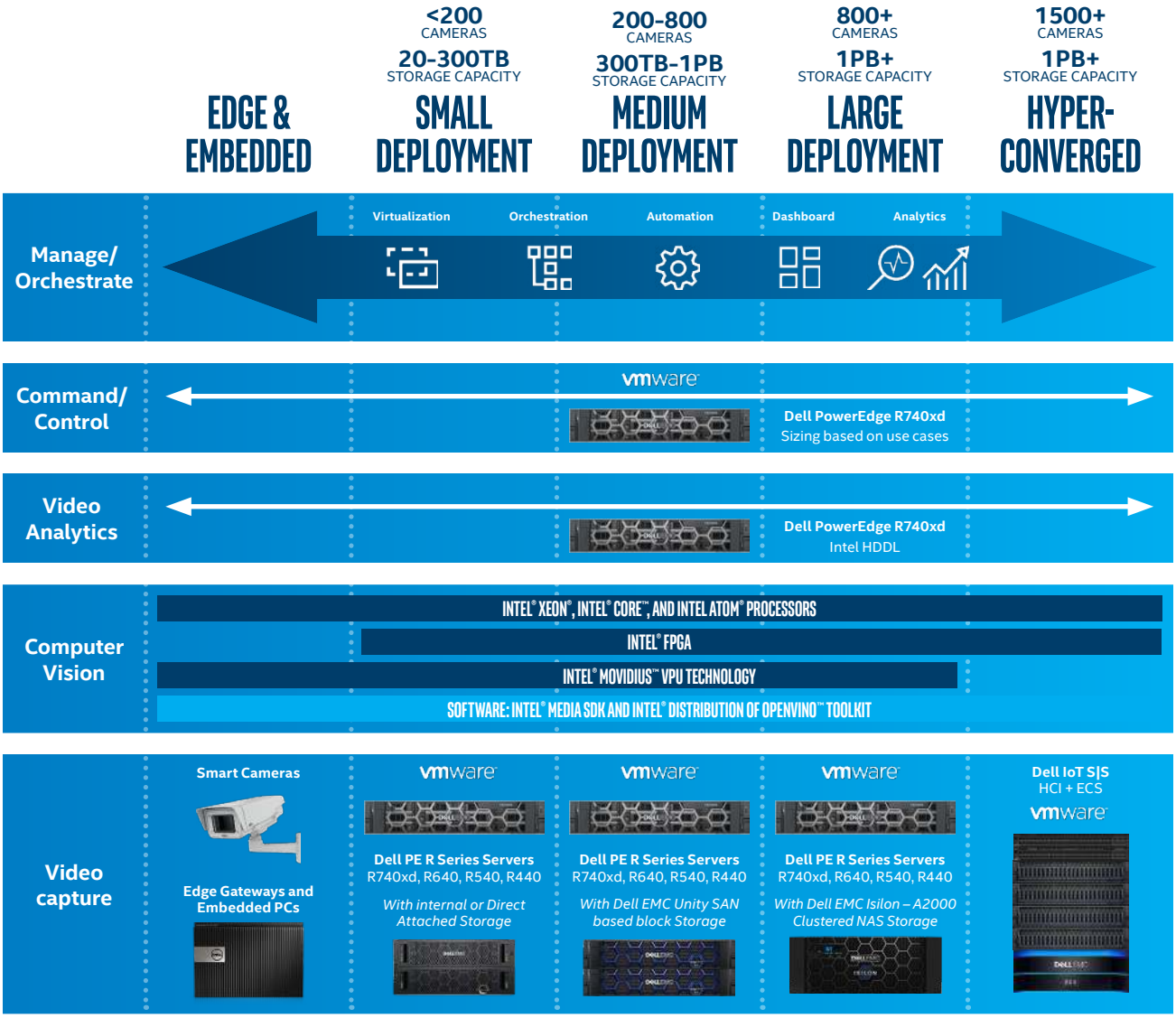
5G technology enriches the urban quality of life, bringing enhanced services, actionable insights and better use of public resources to billions of people. 5G-transformed networks with gigabit speeds and edge computing make cities run smoother, safer and smarter with real-time, data-backed insight. Compared to 4G, 5G-transformed networks deliver 10X less latency, 50X more speed and 1000X more capacity. 5G enables public safety use cases including incident detection and management, emergency response, sensor monitoring, and crowd management.



SOLUTIONS FROM INTEL AND DELL TECHNOLOGIES

Edge and IoT, AI, video sensors, and analytics are all converging to create new value across the public safety. But the applications of the future will not run on the technology of the past.

Together, Intel and Dell Technologies are bringing new capabilities to the Edge with performance-optimized, cloud-ready solutions that excel even in space- and power-constrained environments. These proven solutions can help reduce the cost and complexity of IT by consolidating data and applications, even while delivering new capabilities like vision and inference. This means Smart Cities can improve efficiency, reduce total cost of ownership (TCO) with a consistent infrastructure, and create safer cities.



Intel® Vision Products

With Intel® Vision Products, a portfolio of acceleration tools designed specifically for AI at the edge, Smart Cities can take advantage of near real-time information to help them make better decisions in a timely manner. Intel® technologies enable Smart Cities to innovate AI models and computer vision solutions that are high performance, low power, and easy to scale.

From smart cameras built on Intel® silicon, to edge compute devices (e.g. Network Video Recorders, gateways, video analytics appliances, etc.) powered by Intel® acceleration silicon, to the cloud—where training and analytics can run—Intel now offers the industry's broadest portfolio of assets to cover Artificial Intelligence use cases from the camera to the cloud:

- **Intel® Xeon® scalable processors:** powerfully designed to handle the broadest range of AI workloads including vision and deep learning.
- **Intel® FPGA:** real-time, programmable acceleration for deep learning inference workloads.
- **Intel® Movidius™ Myriad™ VPU:** cutting edge solutions for deploying on-device neural networks and computer vision applications at ultra-low power.
- **Intel® Nervana™ Neural Network Processor (NNP):** a new class of hardware purpose-built for the most intensive deep-learning training and inference.
- **Intel® Vision Accelerator Design products:** to meet the demands of computer vision applications at the Edge and to enable solution providers and their customers to take advantage of a wide spectrum of video analytics-based use cases. Based on Intel® Movidius™ VPUs and Intel® Arria® 10 FPGAs, the Intel® Vision Accelerator Design products provide powerful deep neural network inference for fast, accurate video analytics.
- **Intel® Distribution of OpenVINO™ Toolkit:** comprehensive toolkit for quickly developing multiplatform applications and solutions that emulate human vision.

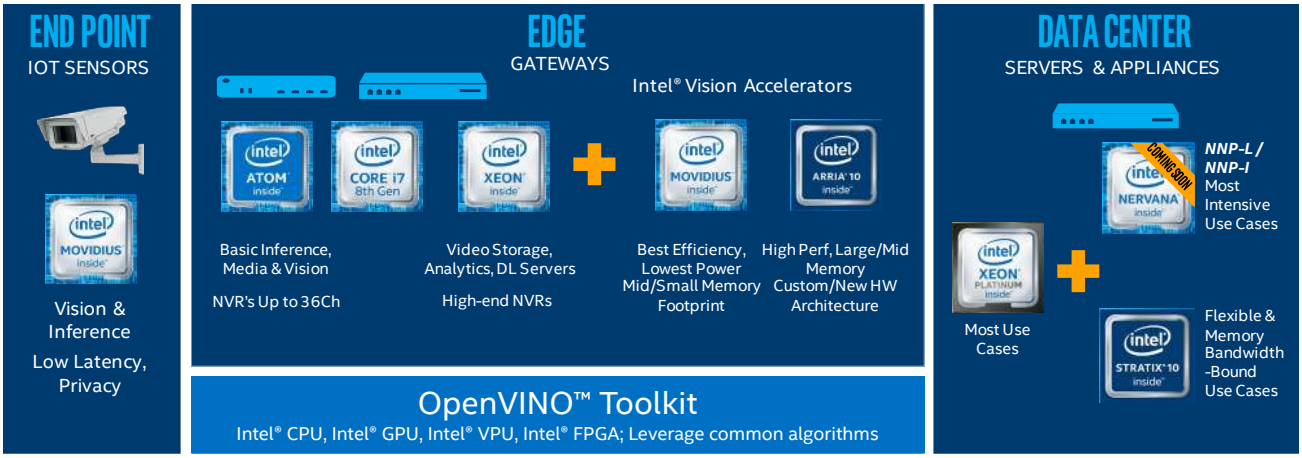
"Imaging and video use cases create extraordinary amounts of data and need an intelligent vision solution to rapidly analyze data near the edge, respond in near real time, and move relevant insights to the cloud. The new Dell Technologies IoT Solution for Safety and Security powered by Intel® Vision Products including Intel® Xeon® Scalable processors and the OpenVINO™ toolkit, provides the performance, efficiency and open compute platform necessary to speed deployment of computer vision solutions to transform vision data into valuable business insights from edge to cloud."

Jonathan Ballon
VICE PRESIDENT, INTERNET OF THINGS GROUP, INTEL

The Intel® Movidius™ VPU (Vision Processing Unit) product line offers key capabilities for computer vision at the Edge. It features high performance inferencing, low power, low cost, a small footprint, and broad and easy scalability. Intel FPGAs parallel hardware enables developers to customize Real Time AI engines optimized for performance, power, and cost. These two technologies, combined with the existing Intel® architecture portfolio, create a continuum of training to inferencing capabilities from the camera to the cloud, providing the right choice of silicon to match acceleration to the desired use case.

Finally, in order to accelerate development across Intel's wide range of Intel® processors and accelerators, Intel offers rich software tools, including the Intel® Distribution of OpenVINO™ Toolkit designed to fast-track development of computer vision applications and streamline deep learning inference. The toolkit allows developers to quickly scale workloads across multiple types of silicon to leverage the best choice of Intel technologies across their designs.[15]

15 While any standard algorithm will run on any Intel® silicon architecture, performance may vary from one architecture to another. However, in some cases, extra work may be needed using the Intel® CV SDK to port an algorithm from one architecture to a difference architecture.



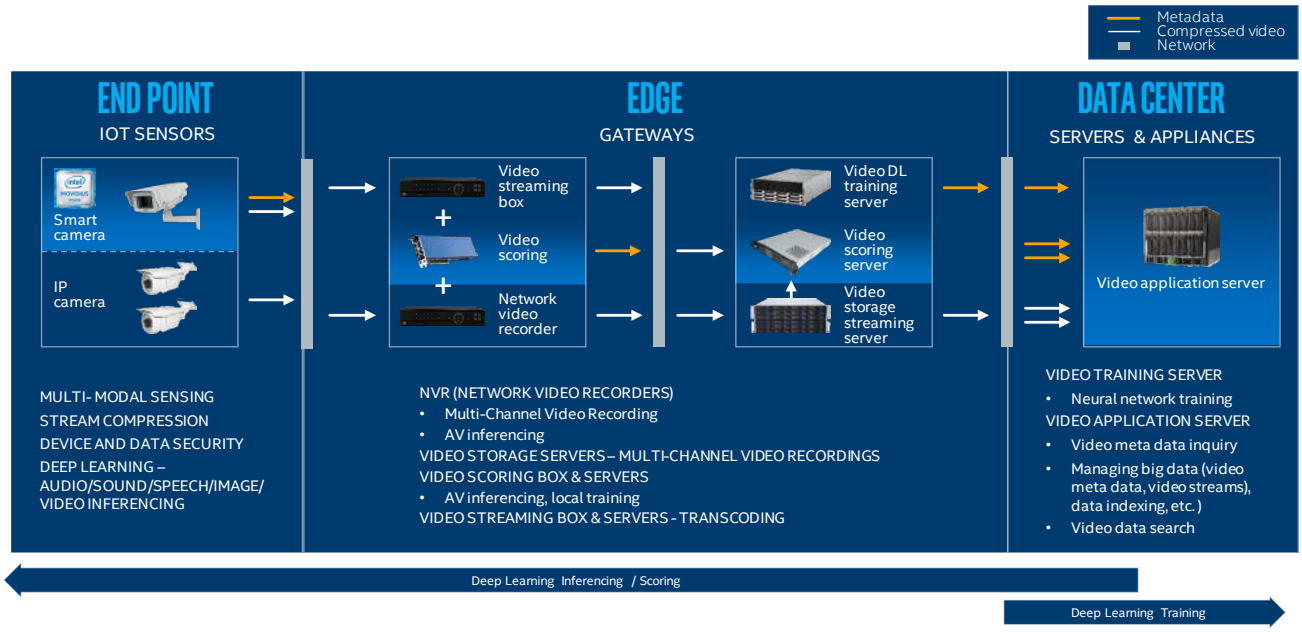
Intel: Taking AI to the Network Edge

As Smart Cities connect more devices to the internet and the need for real-time intelligence grows, more AI inference will move to the Edge of the network to avoid the need for data transfer to the cloud. One of the most important ways to move AI to the Edge is with federated learning. This process enables Edge devices to collaboratively learn a shared prediction model while keeping all the training data on the device, decoupling the ability to enhance models from the need to store data in the cloud. This also enables devices to be used for model training. The device downloads the latest model, improves it by learning from data on the device, and then summarizes the changes as a small, focused update. Only this update is sent to the cloud, using encrypted communication, where it is immediately averaged with other user updates to improve the shared model. All training data remains on the Edge device, and no individual updates are stored in the cloud.

Intel offers hardware and software tools to help Smart Cities deploy AI on Edge devices, including:

- **Intel® Distribution of OpenVINO™ Toolkit** is software designed for deploying neural networks for video across multiple types of Intel® hardware, from data centers to devices at the Edge.
- **Intel® Movidius™ VPU** push the boundaries of what's possible with AI at the Edge with extreme low-power deep neural network (DNN) inferencing on the device.

For more information on solutions for AI at the Edge, visit Intel® AI in Production.



Intel 5G

From device to network to cloud, Intel is leading the way in developing 5G technology that will shape the future of connectivity. The next generation of wireless, 5G is a complete revolution in the way data and services will be consumed on a network, offering higher speeds, more capacity, and lower latency.

With the move to 5G, Intel-powered networks help Smart Cities become AI ready– with the compute power to handle networking, cloud, and AI workloads. Transformed networks with powerful computing resources at the edge enable operators and cloud providers to intelligently deliver highly personalized services for Smart Cities today and in the 5G future.



Intel is driving network transformation and enabling edge compute that's needed to bring 5G to life. Intel is transforming purpose-built networks to become more agile, flexible, and scalable with Software Defined Networking (SDN) and Network Function Virtualization (NFV)—setting the stage for 5G.

For Intel's communications service provider customers, the work is already underway as they lay the foundation for 5G and transform their communications infrastructure to SDN. This enables more seamlessly connected, powerful, and intelligent 5G-ready networks in comparison to previous networks that were hardware-based. Leading service providers around the globe have made incredible progress in advancing SDN and NFV with solutions across the core network.

For up-to-date information on the latest trends in Smart City design ideas and solutions, visit insight.tech.



AHMEDABAD, GUJARAT, INDIA

SOLUTION SPOTLIGHT

Ahmedabad, Gujarat, India

Challenge: India's cities are growing rapidly. Of those cities, one of the biggest in the state of Gujarat is Ahmedabad, with a current population of 6.3 million. Ahmedabad wanted to significantly extend a network of security cameras across its confines as part of a broader Smart City project. City leaders also hope to build up a store of data that the city authority can use when planning developments to city infrastructure such as roads and rail networks. The city planned to extend its existing network of 300-plus web-enabled cameras to about 7,000. Many of them would capture footage in high definition.

Solution: Qognify and Dell EMC OEM collaborated on the video management solution (VMS) that can accommodate thousands of additional security cameras. The VMS solution comes with significant video recording and storage capacity, scalability and security, as well as centralized control. Tested and validated at the Dell EMC OEM Video Surveillance Global Lab in Bangalore, the solution includes Dell EMC PowerEdge blade servers powered by the Intel® Xeon® processor E5-2600 v4 family, with 10-gigabit Dell EMC Networking MXL switches inside the blade server chassis. Storage platforms included Dell EMC SC5020 for structured data and Dell EMC Isilon NL-Series for unstructured data.

Result: The solution helped transform its video management technology to handle thousands of high-definition cameras. With its pre-deployment certification, the VMS ultimately lowered costs for the city by 15% and enabled 25% faster deployment time while enhancing safety and security capabilities for the city.

For more information, see Dell Technologies customer story and Qognify's website.

Dell Technologies Edge and IoT Soutions for Safety and Security

The **Dell Technologies IoT Solution for Safety and Security** is a hyper-converged solution purpose-built for demanding, multi-sense surveillance, such as video, sound, and barometric pressure, comprising both hardware and software. The enterprise-grade, end-to-end video surveillance solution uses the latest technology from Dell and Intel, taking a complex and challenging infrastructure and making it simple to test, validate, and deploy.

As a pre-integrated solution, the Dell Technologies IoT Solution for Safety and Security provides a consistent foundation from Edge to core to cloud, with a single management console for information technology and operational technology (IT/OT) convergence in an open, flexible architecture.

Dell EMC Elastic Cloud Storage (ECS) offers many capabilities appropriate for video evidence storage and helps meet the needs of law enforcement agencies for on-premises storage, as well as for service providers creating an evidence storage system on behalf of law enforcement agencies.

Dell EMC CIFS-ECS is a lightweight application that allows law enforcement customers to upload and download files to a Dell EMC ECS storage platform, providing applications and users efficient access to content in the cloud from a Windows platform.

Dell EMC PowerEdge™ servers are ideal for recording and managing terabytes of video from distributed locations. PowerEdge 1U servers are used where external network-attached storage (NAS) clusters or block arrays are planned for surveillance storage. PowerEdge 2U rack servers are used for local video storage where external surveillance storage is not used.

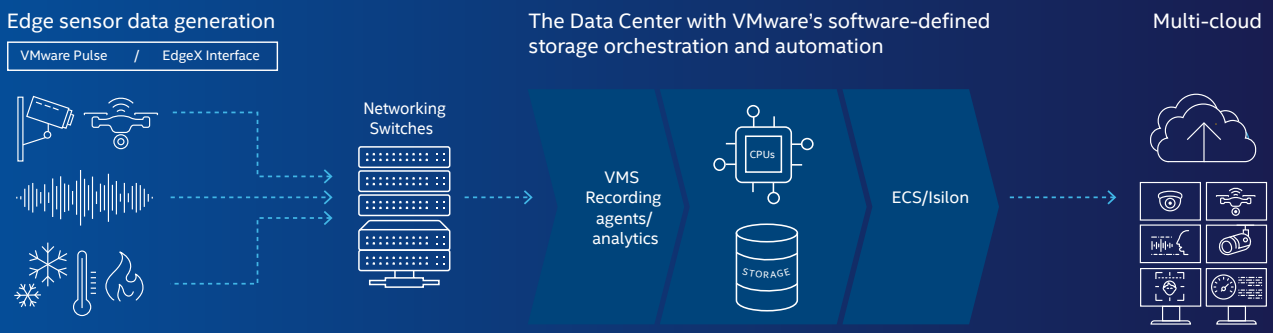
VMware vSphere is a virtualization platform that can transform or virtualize computer hardware resources, including CPU, RAM, hard disk, and network controller, to create a fully functional virtual machine (VM) that runs its own operating systems and applications like a physical computer.

VMware vSAN aggregates local or direct-attached data storage devices to create a single storage pool shared across all hosts in the vSAN cluster, helping to eliminate the need for external shared storage and simplify storage configuration and virtual machine provisioning.

VMware vRealize Operations Manager delivers intelligent operations management with application-to-storage visibility across physical, virtual, and cloud infrastructures.

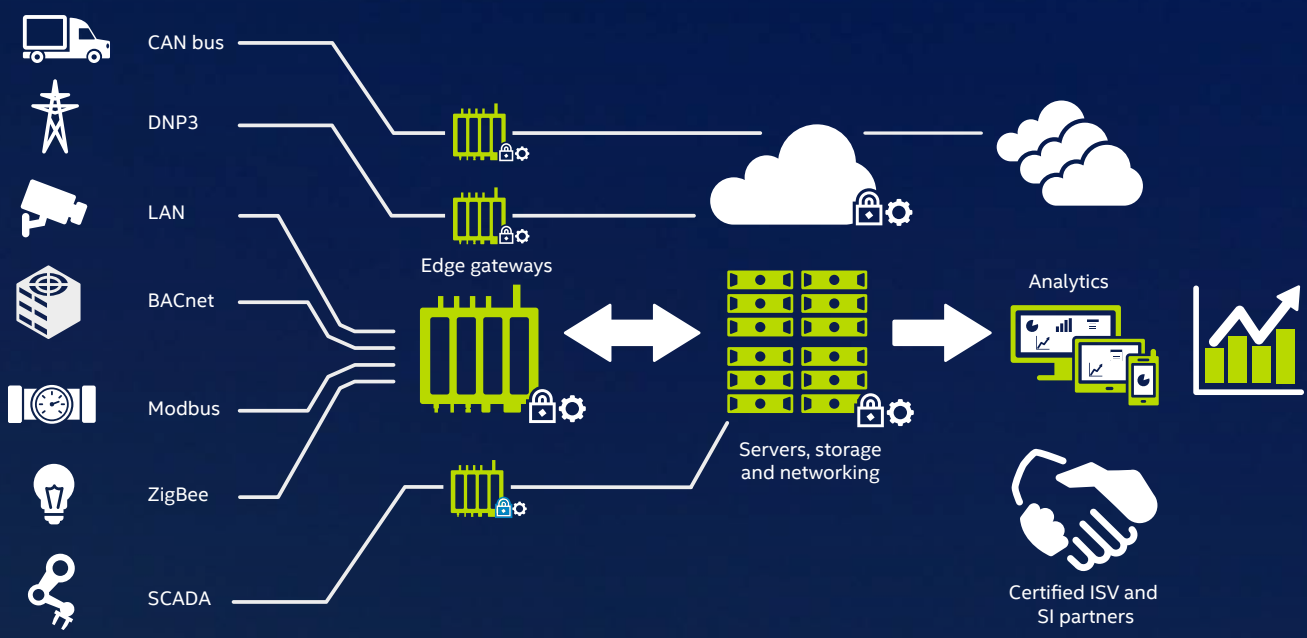
VMware Pulse IoT Center is a secure, enterprise-grade Edge and IoT device management and monitoring solution. Integrate, manage, monitor, and secure Edge and IoT use cases from the edge to the cloud, bridge the gap between Information Technology and Operational Technology organizations and simplify Edge and IoT device management with Pulse IoT Center.

Dell Technologies IoT Solution for Safety and Security



Dell Edge Gateways for Edge and IoT

Made to withstand harsh conditions, Dell Edge Gateways for Edge and IoT empower computer vision and surveillance networks to expand in new directions. Ruggedized, with a variety of input/output connections, they aggregate data and support analytics at the Edge of the network. With protection built in, Dell Edge Gateways include hardware features that help protect the network Edge and sensors from cyberattack, including a secure boot and BIOS-level control. Law enforcement agencies can minimize network cost while aggregating and securing Edge and IoT data at the Edge of the network. Dell Edge Gateways perform local analytics and real-time actions where network latency is a problem.



For more information on Edge and IoT solutions from Dell Technologies, go to www.delltechnologies.com/IoT

"Public Safety outcomes for the citizens in a city demand complex and a highly federated frameworks, which require efficient and effective coordination across multiple agencies, and hinge on three broad capabilities: real-time situational awareness, effective incident response solutions, and predictive outcome capabilities. Technology, with advancements in Edge and IoT, AI, computer vision, computing power, faster network speeds, and more, can act as critical enablers of these capabilities for a city. By harnessing the deluge of cross-domain/cross agency data in real-time, today's emerging trends are enabling law enforcement across the globe to build safer and smarter digital futures."

Amit Midha

PRESIDENT APJ, GLOBAL DIGITAL CITIES, DELL TECHNOLOGIES

GETTING STARTED

Smart people transform cities into smarter, safer cities. In order to hear and meet the needs of its citizens, a Smart City of the future must transcend silos in order to provide a cohesive view of infrastructure, surroundings and personnel.

The benefits of planning for a smarter, safer city are clear, and there are numerous technologies to help pave the way. But how do you get started? And how can you know which city services offer the greatest potential for the most valuable outcomes and benefits? How do you build support for your vision of the future amongst citizens, colleagues and investors?

The journey to a smarter, safer city can begin with small steps. For example, reaching out to like-minded leaders in your city and identifying common goals is one way to get started. Another way to begin is by evaluating planned infrastructure projects and identify ways to incorporate elements that will move your city forward; leveraging Smart City solutions.

Transforming your city can open a number of decisions, opportunities, and issues to work through as you leverage new technologies to optimize city services and improve citizen quality of life. That's why Intel and Dell Technologies have established collaboration spaces to help you investigate your options, learn from other city examples and apply best practices. We work with customers like you to explore, test and deploy your IoT solutions and devices. In our labs, you can use our active bench space to demonstrate large workloads, connectivity and data modeling and extraction on our end-to-end solutions – including storage, servers and software solutions. Further information is supplied in the Resources section on how to take advantage of these collaborative spaces and programs.

In addition to collaboration spaces, your City's transformation can benefit from leveraging the experience of the emerging community of civic leaders, data scientists, technologists, and companies are joining forces to build Smart Cities. In support of innovation and gathering best practices, Intel and Dell Technologies are participating members of the Smart Cities Council, the world's largest Smart Cities network. The Smart Cities Council envisions a world where digital technology and intelligent design are harnessed to create smart, sustainable cities with high-quality living and high-quality jobs. As a leader in Smart Cities education, the Smart Cities Council is comprised of more than 120 partners and advisors who have contributed to more than 11,000 Smart Cities projects.

The Smart Cities Council helps cities become smarter through a combination of advocacy and action. They offer a number of practical guides and resources to support cities in developing a plan for transformation to a Smart City. For example, consider these **four areas to focus on** when building a Smart City project:



Assess and identify citywide needs

Conducting a citywide assessment will help create the big picture necessary to make optimal choices and set priorities. A citywide assessment captures all the synergies and opportunities to share infrastructure, data and costs. It also identifies the problems that need to be solved, not just the technologies people hope to use.

For example, an assessment that lists the desire for video sensors is incomplete unless it also describes the problem that video sensor data is meant to solve. If the goal is to reduce crime in a neighborhood, that goal might be better achieved with a different technology, such as gunshot detection or smart policing or achieved more quickly and cost-effectively by sharing video infrastructure with another agency.

As you perform your assessment, this is a great time to consult fellow City and Public Safety Leaders about the issues they are trying to solve. During this discovery process you can identify key stakeholders whom you should be aligning with.

There's no magic to defining a desired future state. It can be as simple as taking a broader view of the desired benefits, including social, environmental and other "soft" issues. Often, it's just creating a linkage with goals already in place. Many cities have already identified long-term outcomes in their comprehensive plans, which can be referenced in Smart City initiatives.

Pick a suitable project and consider its potential

By aligning stakeholders and prioritizing needs, cities can benefit from two concepts that are simple to understand but sometimes hard to accomplish. The first is to cluster projects (or use cases) so they can share infrastructure and costs, creating an enduring solution. The second is to find one or more "quick wins" with immediate citizen benefits.

At this stage, cities should be looking to bundle together projects that combine three characteristics:

1. **High priority.** Addressing one or more of the top needs uncovered in the citywide assessment
2. **Sharing potential.** Sharing infrastructure and data with other projects/departments, immediately or in the future
3. **Visible short-term citizen benefits.** Helping communities immediately see and tap into the benefits.

To find these opportunities, an individual or a small group will need to take responsibility for scanning across the "vertical" departments to look for "horizontal" opportunities – chances to work across different departments and asset classes to capture synergies and efficiencies. This is not always easy to do. Organizations operating in silos have experts who have tremendous knowledge about that organization but are not necessarily aware of, let alone experts on solutions that drives benefits across multiple areas.

Begin stakeholder engagement as early as possible

It may be tempting to launch a Smart City project by taking a few early steps before bringing in others. Experience has shown, however, that cities benefit by involving all stakeholder groups (both personnel and citizens) early in the process. They gain:

- **Better ideas** due to a larger, more diverse brain trust
- **Better buy-in** through a sense of ownership by stakeholders
- **Better community support** for the project and for elected officials
- **Better warning** of potential protests and pushbacks.

Great projects start with a great vision. But that vision is incomplete if it doesn't include the people it will affect and the people it will serve.

In the early stages, stakeholder engagement should focus on two things. The first is communicating the government's firm commitment to using smart technology to improve community life. The second is listening to get a clear sense of the issues that are top of mind. To accomplish these goals, many cities use a combination of "traditional" town hall meetings along with advisory councils, working committees, online surveys, and social media. Later engagement efforts should include progress reports and course corrections.

In the example of the **City of Las Vegas' Smart City solution by NTT,** it was designed initially to reduce response times for first responders during public safety events, earning the 'Smart 50 Award' as a transformative smart project. Additionally, the initiative was honored as a 'Safe City' for helping improve situational awareness and provide insights for public safety decision makers via early notification of potential and active incidents. Now that the solution has been implemented, additional use cases are surfacing with potential benefits including leveraging the data for economic development initiatives such as curb monetization and enhancing the visitor and citizen experience.

Finally, leveraging existing assets is another way to approach Smart City planning. Once your City and Public Safety Leaders have a sense of the projects to pursue, the team should identify assets that can benefit those projects. Such assets can lower the cost, speed the delivery and enhance the appeal to funding and financing sources.

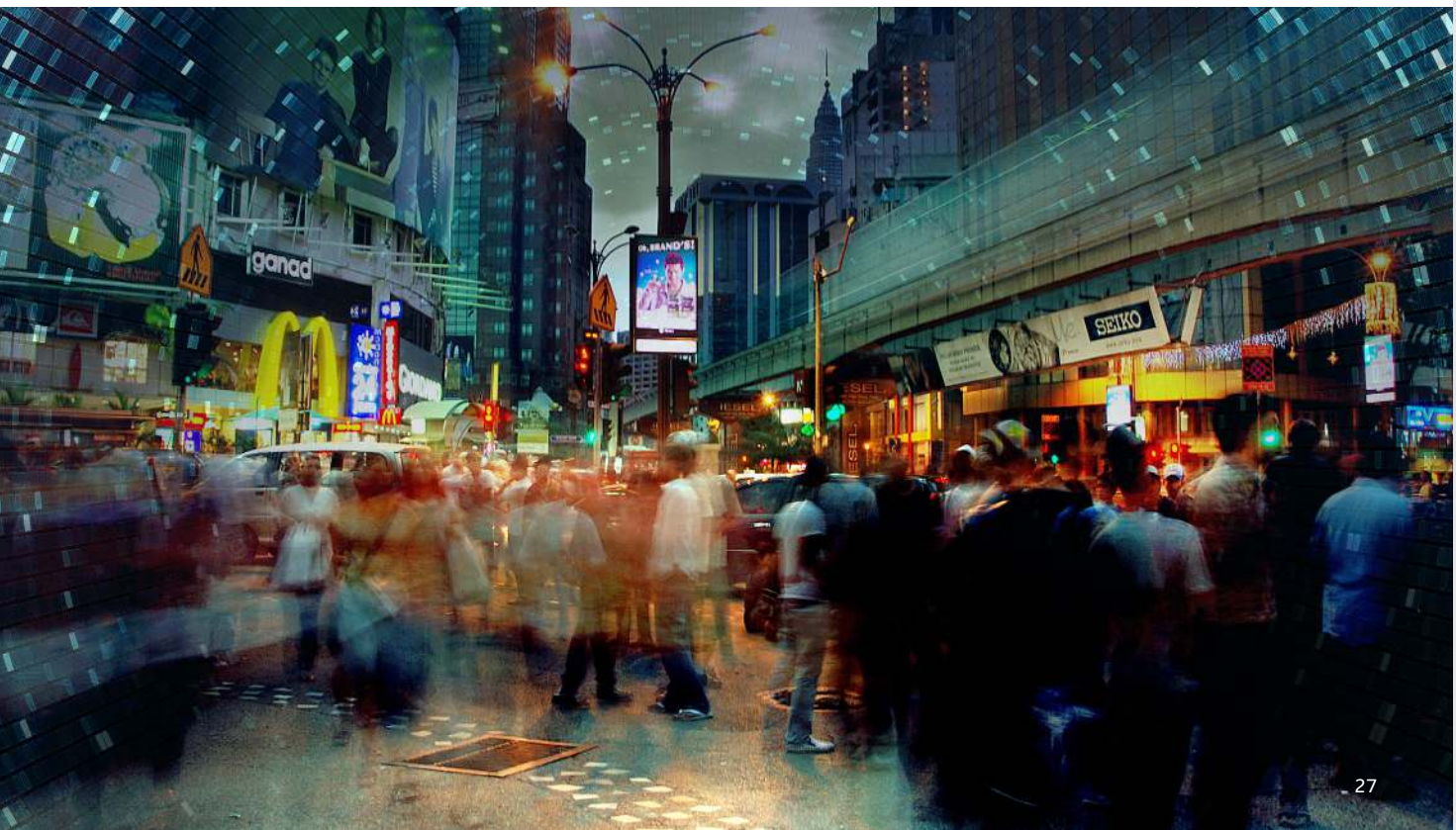
Establish a governance structure

Strong governance is arguably the most important element to Smart City success. With stakeholders aligned, governance helps drive collaboration and standardization, which are critical elements in a Smart City. For example, an AI solution's ability to enable awareness and insights can help improve public safety decision-making. However, these technology solutions need to work in tandem with the city's evolving policy framework for data privacy and security to build public trust and cooperation.

Technology solutions are not a replacement for humans, but rather serve as a tool to provide insights for Public Safety and City Leaders. Expertise from Public Safety officials as well as common sense can guide how to apply the technology while building trust in the system for the community. A collaborative community approach, where municipalities work hand-in-hand with the public to leverage technology solutions, will go a long way in making the city smarter and safer.

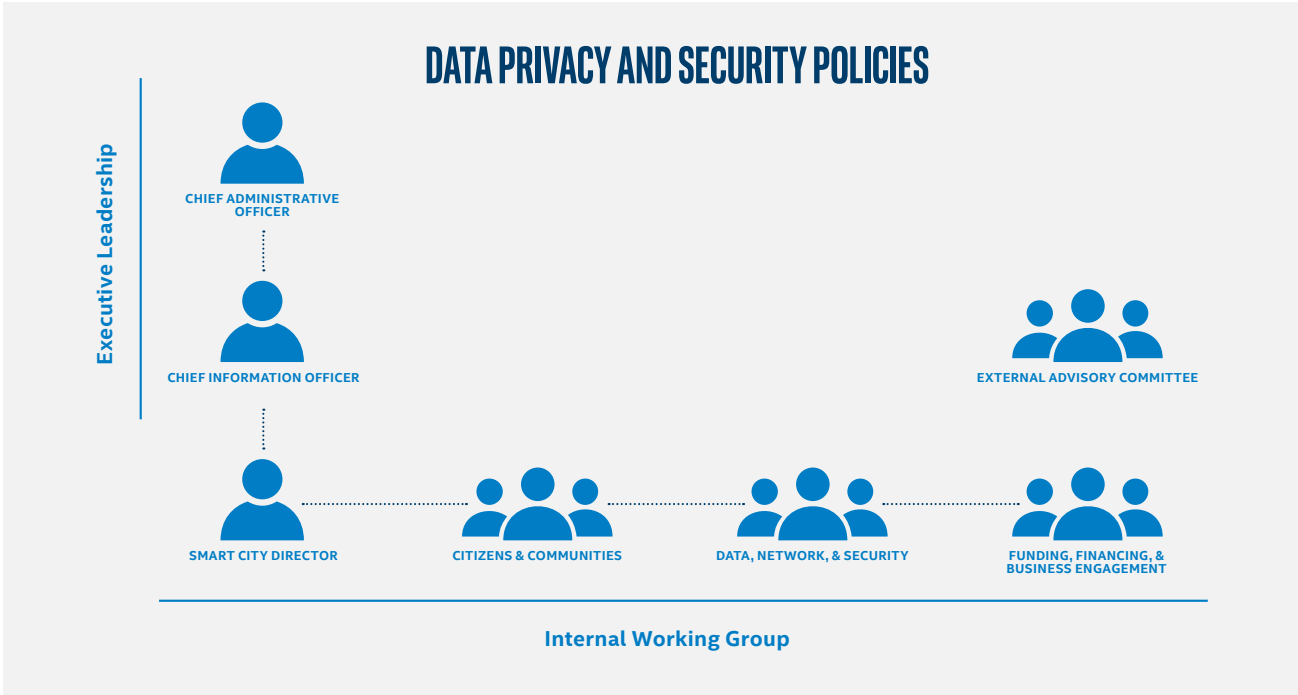
> *"Public Safety in cities is on the cusp of quantum improvement with the support of disruptive new digital technologies; Dell & Intel have the cutting edge toolkit to support the effort to improve the safety and security of citizens across the globe."*
>
> SmartCityPHL Roadmap
> **CITY OF PHILADELPHIA**

An established governance model will solidify the city's decision-making process, reporting structures, and roles and responsibilities of participating members.



Best practices for governance models include establishing:

- **Executive Leadership,** which sets vision and direction
- **A Smart City Director** to identify strategic opportunities, drives collaboration and carries out the vision
- **An Internal Working Group** to collaborate and partners to inform and implement activities
- **An External Advisory Committee** for advisory services, research funding, solutions and workforce capacity
- **Metrics** that measure what worked and what still needs work
- **Data Privacy and Security Policies** to ensure that cybersecurity risks are mitigated, and privacy is protected through a centralized security approach.



City agencies, transit authorities and Public Safety organizations may all be collecting and analyzing data from the Edge, to the Core and to the Cloud in Smart City implementations. Sharing of data can yield operational efficiencies, improve response times, and better protect the safety of citizens, however, this data can be compromised without appropriate measures in place. Essential to successful management of the immense magnitude of data in a Smart City is establishing a Master Data Management (MDM) approach. With MDM, cities can create a single, trusted source of data across city services and infrastructure. As you plan for your city's transformation to a Smarter, Safer City, Dell Technologies and Intel can help guide your city during planning and implementation to prioritize Data Privacy and Security and apply industry best practices to safeguard your city's (and citizens') data.

Explore funding options

Finding the money to pay for a new project is a key challenge for Public Safety and City Leaders but can be accomplished through creativity and resourcefulness. Today, no city can hope to pay for its transformation to a smarter, safer city solely by raising taxes or by waiting for the central government to step in and provide funding. City and Public Safety Leaders must learn to tap into additional revenue streams and build a compelling case for innovative financing.

*"The world is facing a **$15 trillion gap** between projected investment and the amount needed to provide adequate global infrastructure by 2040"*

World Economic Forum

Principles for cost-effective Smart City Initiatives

Taking stock of current assets and how they may contribute to your Smart City Project is the first step to building a picture of potential costs and potential revenue that your project can generate. The below principles can help guide your investigation:

- **Sharing smart infrastructure.** It's not enough to have a smart infrastructure. It should also be shared. At the very least, shared with other city departments. And, when practical, shared with regional partners such as utilities, universities, counties, transportation authorities, and neighboring cities.
- **The importance of self-sustaining.** It doesn't matter if a city seeks smart, shared infrastructure if it can't afford to pay for it. Historically, cities have relied on grants, subsidies, and taxes. In most parts of the world, however, cities can no longer count on federal and state governments to pay for any and every big project. Nor do cities have the money on their own.
- **Taking advantage of available capital.** There is plenty of money available for smart projects that meet certain criteria. Development banks, for instance, are eager to fund Smart City projects that align with the UN Sustainable Development Goals. Likewise, the private sector has an unprecedented appetite for infrastructure projects and for "green" projects that contribute to sustainability.

With your needs and projects in mind, you can now look for assets the city can contribute to projects to make them more investable. Asset management (also known as asset governance) is well understood by the private sector, and by public institutions such as universities, who constantly fine-tune their assets to wring out the most value, however it is often overlooked by cities.

In this era, therefore, cities must strive for projects that pay for themselves over time. And City Leaders must learn where to find upfront financing to get those projects underway. Some cities achieve this goal through a "capital stack" or "capital bundle" that combines multiple sources. Not just grants and municipal bonds, but also innovative sources such as impact bonds, value capture and public-private partnerships. Much of this financing will need to come from the private sector.

Visionary City Leaders agree that investing in digital infrastructure can pay dividends for decades to come. This is important as demand for more housing, faster commutes, and constant mobility continue to surge. To that end, cities worldwide are adopting Smart City initiatives. In fact, overall spending on such initiatives is estimated to reach $158B by 2022.[16] Cities across the globe are recognizing opportunities to begin the journey to a safer, more sustainable future.

Identifying sources of Revenue or Cost Savings

Now it's time to consider additional revenue streams that can make the project financially sustainable. Once a city understands the assets at its disposal, it is ready to consider ways that Smart City project(s) can generate revenue to help offset the costs. Even cities in a strong financial position will benefit from additional money to help pay for the first project or contribute to the next ones.

When considering ways to offset the costs of a Smart City initiative, consider finding revenue opportunities that will work in your city's political and financial realities. For example, the below sources have generated revenue for leading Smart Cities around the world:

Generate Revenue from Advertising: Selling advertising is the low-hanging fruit for many cities, since digital advertising is an extension of existing business models.

Lease Space for Mounting Platforms: Cities can also generate revenue by leasing space for sensors and communications nodes, provided they plan ahead. Anything that has both power and communications is a great candidate, including streetlights, kiosks, digital signage, WIFI hotspots, rooftops, and transit infrastructure.

16 https://www.idc.com/getdoc.jsp?containerId=prUS44159418

Generate Revenue from Real Estate: The most straightforward example is a simple sale. The city sells under-used land or buildings, then puts all or part of the funds towards the new project.

Generate Revenue from Curb Space: The wise use of curb space can increase walkability, improve transit access, and reduce congestion from deliveries and ridesharing. It can also create a revenue stream.

Generate Revenue from Data: Some cities swap traffic information with payment processors and other private sector firms. When a city knows where people go, when they go, what they spend, and where they spend it, they have a powerful tool for luring retailers, planning future infrastructure, and other economic development activities.

Utilize General Taxes: Although it can be a political challenge to raise general taxes, in the interest of completeness this option should be on your list of options. Property taxes, for instance, already fund a big percentage of city activities and competition is fierce for those funds.

Utilize Value Capture: Value capture recovers some of the future benefits of a Smart City project to help with present-day financing. Infrastructure increases the value of adjacent properties. Capturing a portion of those value increases upfront can help fund smart infrastructure.

Consider User Fees: Not to be confused with taxes, user fees are paid by choice and only by those using the service – for example, paying a toll to drive in express lanes.

Find Cost Savings: Almost all Smart City projects generate cost savings that can be treated as a new revenue stream. Smart buildings typically save 10-30% on energy. Smart water systems can reduce water use by 10-30%. Smart LED streetlights can save 20-50% on energy bills. Smart meters save on repairs, outages, and connecting and disconnecting customers. Open Data systems and digital city services can greatly reduce phone calls to city hall and 311 services. Smart fleet management can reduce the number of vehicles and their cost of operation.

Use/Repurpose Existing Budgets: Cities may also want to look at existing budgets for contributions to capital costs or even to ongoing operations and maintenance.

Explore Innovative Financing Options

Financing creates a bridge from the present to a better future. Most infrastructure projects require a large up-front investment. Financing enables cities to make an initial investment right away, then pay it back over time. In this sense, it resembles home mortgages, which let consumers buy houses that would be unaffordable on a single year's salary.

Now that you have reviewed potential cost saving and revenue opportunities, it's time to review your available funding versus potential financing options. Smart Cities come in all shapes and sizes, and so does the available financing options. Assuming that you do not have line of sight on 100% of the funds required for your Smart Cities project, one or many innovative financing approaches may work best. You can construct a 'capital stack' which combines multiple financing methods. Some of these methods are shown below:

- **Municipal Bonds**
  A traditional financing option for cities, the bonds represent the city's promise to pay a specific amount of interest over a preset period of time in exchange for an up-front loan. Sub-category includes Green Bonds.
- **Impact Bonds**
  Also known as "social innovation financing" or "pay for success"—a results-based public-private contract undertaken to solve a specific social problem. Before the project is carried out, the government details measurable outcomes to be monitored by an independent evaluator. Types include Environmental Impact Bonds.

- **Grants**
  Often considered a 'public' funding source, grants may be earmarked by a federal or local government (e.g. state or province) for specific project types/outcomes.
- **Public Private Partnership (PPP)**
  Government and enterprise set up a joint company, seeking financing from banks, or financing organization to support the project. This model provides financial, operational, and technical support.
- **Other Sources**
  Green banks, general taxes, vendor financing, infrastructure funds, joint ventures and project pooling.

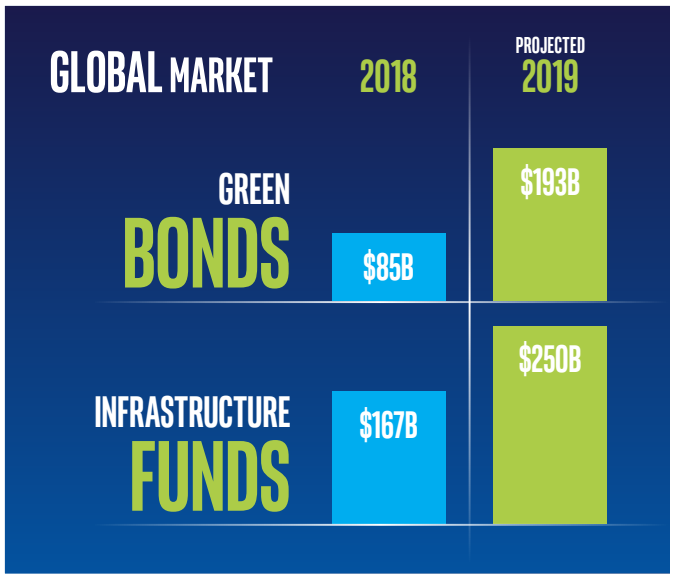
The resulting capital stack could be:



Consulting with trusted advisors can also help build your capital stack. For example, large technology companies work with dozens or hundreds of cities and can offer vendor financing. Systems integrators, who pull together multiple technologies, may have ideas on how to combine multiple financing alternatives. Infrastructure funds and impact fund managers can make suggestions on qualifying for their programs. Development banks are also a great source of assistance in certain countries. And some consulting firms have specialists devoted to helping cities assemble the best possible financing package.

It should be emphasized that cities will need expert advice to navigate the complexities of financing. Many cities have long-standing relationships with traditional financiers that they should consult. But cities should also get input from companies that offer different types of financing and that have the experience of working with many cities on new approaches. Dell Technologies and Intel can provide strategic guidance and practical capabilities to help you accelerate time to value for your transformation to a smarter, safer city.

Likewise, the private sector has an unprecedented appetite for infrastructure projects and for green projects that contribute to sustainability. Prequin Insights expects infrastructure funds to raise $193 billion in 2019, more than twice as much as in 2018's record $85 billion. And the global market for green bonds hit $167 billion in 2018, according to Climate Bonds Initiative, and is on pace to reach a record $250 billion in 2019.[17]



17 https://www.preqin.com/insights/global-alternatives-reports/2019-preqin-global-infrastructure-report/24900

CONCLUSION

Leading a city through strategic innovation and transformation is a continual journey and critical to the future of economic growth, citizen engagement, and effective delivery of city services. Defining and executing a Smart City strategy is neither straightforward nor without risks. However, City and Public Safety Leaders can realize significant benefits by transforming an urban community into a smarter, safer city.

Using experience working with many governments and cities worldwide, Intel and Dell Technologies are bringing together the right organizations and companies to create the necessary building blocks that City and Public Safety Leaders can use to initiate Smart Cities planning. Stakeholder participation and clear priorities are essential starting points for building your Smart Cities plan. But to succeed in driving economic growth, improving environmental management, and providing a better quality of life for citizens, you will also need a well-supported set of policies, good governance, and effective methods for implementing smart programs, assessing performance, and ensuring continuous improvement.

This is only a starting point for a transformative city journey. At Intel and Dell Technologies, we believe city leaders can successfully transform their cities by establishing clear priorities, encouraging active stakeholder participation, ensuring methodical technology infrastructure planning, while enabling the right policy and governance. With our Edge to Core to Cloud solutions and strong partner ecosystem, Intel and Dell Technologies can help bring your Smart City vision to life.




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RESOURCES

Dell Technologies Solution Centers

Dell Technologies Solution Centers are a global network of state-of-the-art technical labs constructed just for customers. Launched in 2011, they are places where customers can explore and test solutions, enabling them to select the best technologies that will truly work for them and meet their business objectives.

Solution Centers are built and run on Dell platforms, representing a "living lab" to showcase real-world deployment of Dell technologies and capabilities. Dedicated experts work with customers in the centers to share best practices and knowledge. This combination allows customers to "try before they buy," proving out and optimizing their architectures on Dell infrastructure before committing to a production environment or services contract.

Solution Centers also provide customers with technical briefings, architectural design sessions and independent software vendor certification. With 12 centers now open globally, the most recent in Silicon Valley, Dell has connected with thousands of customers, enabling them to get hands-on with Dell solutions.

Dell Executive Briefing Program (and Centers)

Strategize, plan and learn with the Dell Technologies Executive Briefing Program. The Executive Briefing is a collaborative experience, designed for engaging, consultative conversations that help bring your visions to reality.

Dell Technologies Ignition Labs

Dell Technologies Ignition Labs have a dedicated space for the Intel IoT Lab Ignition Labs where customers can engage in a number of activities including a briefing, a workshop, or running fully supported proofs-of-concept using their data.

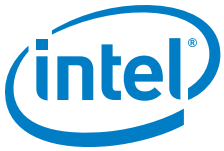
Dell Technologies Services, Payment Solutions

Dell Financial Services helps you acquire the essential hardware, software and services you need to run your city. Our portfolio of industry-leading payment solutions includes traditional leasing and financing options, as well as advanced flexible consumption products. Maximize your IT budget and get the technology you need today.

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