

Digital Cities: Building the New Public Infrastructure

Cities show proven results through digital transformation

By Joel Barbier, Kevin Delaney, and Nicole France



“A 21st-century citizen expects that the road will get them from point A to point B, but they also expect to be connected digitally. And to do that, you have to have digital infrastructure.”

— **Bob Bennett**
Chief Innovation Officer
Kansas City, Missouri

Digital Cities: Building the New Public Infrastructure

From smart lighting to digital crime-fighting to connected transportation and beyond, cities are poised for a radical makeover.

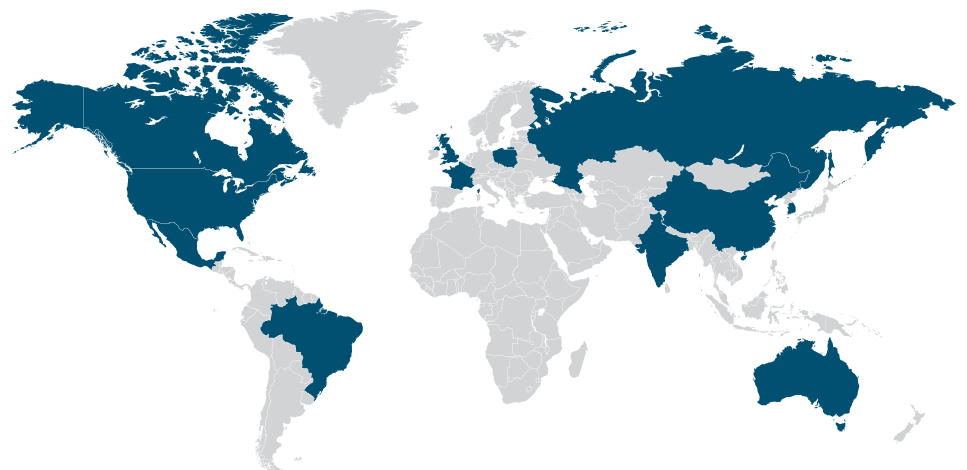
This technology-driven transformation is redefining the business of running a city. It has as much influence on how cities generate revenue as on the assets they own and how they manage them.

In the private sector, digital capabilities are disrupting established industries and giving rise to entirely new kinds of competitors. These shifts—what Cisco describes as the [Digital Vortex](#)—are driving equally profound changes in the public sector.

Take ride-sharing apps as an example. We all know how they’re eroding the taxi business and reshaping the automotive industry. They’re cutting into revenue from parking fines and municipal taxi licenses. But they’re also reducing traffic, limiting demand for parking, and alleviating the burden on crowded public transit systems.

Adding digital capabilities can bring great benefits to our cities. They can reshape public services and how they’re delivered—making it possible to do more with the same available resources. But there will be challenges too. City leaders and workers will have to adapt to new business models. Changing regulations and new mandates will force the issue for many cities.

Even so, the real push for digital transformation may come from residents themselves. In a 2017 Cisco survey of 3619 consumers in 12 countries, just under half of all their interactions with the public sector (49 percent) were digital. However, respondents anticipated increasing this by 20 percent within just two years. Simply put, citizens expect to engage and interact digitally.



Less than half of the interactions by consumers in 12 countries with the public sector were digital. They expect that to grow significantly in the next two years.



“The railroad, in the old days...was the economic engine, no pun intended. Broadband’s the same thing today.”

— **Lou Zacharilla**
Intelligent Communities
Forum

Getting Digital Investment Right

For most city leaders, the question isn’t whether to embark on a digital transformation, but how. This requires clear vision and sustained, long-term investment. To maximize your chances of success, we suggest three critical components to any digital transformation initiative:

- Municipal, modernized broadband and Wi-Fi networks
- An effective cybersecurity approach that underpins everything
- An investment plan that allows you to take the savings or revenue generated by each project to reinvest in the next one

No two cities will have the same digital transformation journey. Where you start and what generates the most value for your city depend entirely on its unique circumstances.

For every city, investments in digital infrastructure and capabilities are interdependent. The more you connect and build on existing investments, the greater your benefits. The better you are able to integrate and plan those investments, the more efficient they will be.

Our experience with customers strongly suggests that, regardless of your starting point, getting municipal networks and cybersecurity right must be done as early as possible. These two areas form the literal and figurative backbone of any digital capabilities. Without broadband and Wi-Fi networks, installing remote sensors of any kind can be cost prohibitive. Avoiding appropriate investments in cybersecurity puts all of your data at risk—and slows new development.

With these two elements in place, even as part of a wider initiative, you are ready to make the most of any other capabilities you prioritize.



Defining Digital Value at Stake

The potential benefits of digital transformation in cities are huge: \$2.3 trillion worldwide through 2024.

This is what we term Digital Value at Stake—the net value of cost savings, cost avoidance, efficiencies, and revenue generation that investment in digital capabilities makes possible.

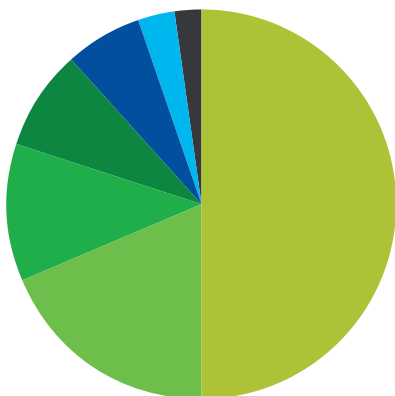
Digital Value at Stake is Cisco’s in-depth economic analysis model. It includes more than **400 use cases across 16 sectors, including 39 specific to cities.** Based on data from our work with customers and extensive secondary research, Digital Value at Stake quantifies:

1. Entirely new sources of value emanating from digital investments and innovations
2. Value shifting among companies and industries based on their ability (or inability) to harness digital capabilities (in essence, value moving from “losers” to “winners”)

Identifying Potential Big Wins

According to our analysis, there are seven key areas of Digital Value at Stake, in addition to municipal networks and cybersecurity:

- Next-Generation Worker, 48 percent (\$1.1 trillion through 2024)
- City Utilities & Smart Metering, 18 percent (\$401 billion through 2024)
- Safety & Security, 11 percent (\$240 billion)
- Transportation & Urban Mobility, 8 percent (\$190 billion)
- Citizen Experience, 6 percent (\$147 billion)
- City Infrastructure Management, 3 percent (\$66 billion)
- Open Data, 2 percent (\$51 billion)



These benefits aren’t just theoretical. We also offer the experience of cities around the world that have adopted a variety of digital capabilities. We hope their lessons help inform your priorities.



“A lot more work has to be done than is being done...the same number of workers will now be able to achieve a lot more.”

— **Dr. Sumit D. Chowdhury**
Gaia Smart Cities

From City Employees to Next-Generation Workers

When most cities begin their digital transformation journeys, they tend to focus on functional areas, like transportation or utilities, for example. So it may come as some surprise that by far the biggest source of Digital Value at Stake is in equipping city workers—all city workers—with tools and policies that make it easier for them to do their jobs.

Workers are used to a seamless digital experience in online retail and other areas. They expect a better workplace experience, one that moves beyond slow paper-based processes and offers them the real-time information they need to be more effective.

Mobile apps, secure video conferencing, data sharing, and remote access to expert support all make an impact. Taken together, the combined value of digitally enabling city workforces is 48 percent, or \$1.1 trillion, of Digital Value at Stake worldwide from 2015 to 2024.

Mobile collaboration tools and BYOD policies equip staff to work more productively. That’s especially true of employees in the field, such as social workers, building inspectors, and maintenance crews. Cities, such as Los Angeles, are making collaboration tools a key element of their digital strategies. GeoHub, an interactive digital mapping service, helps L.A. city workers locate everything from fire hydrants to homeless encampments.¹

These new ways of working can improve productivity by two to three hours per employee per day.² Even bigger gains come through using mobile collaboration to solve specific challenges.

Houston had a problem. Its fire department was responding to far too many ambulance calls that didn’t require acute or emergency care. Now, fire fighters connect to local hospitals via tablets, giving them secure access to patient records and expert advice from nurses and doctors by video. They help non-critical patients get to a clinic appointment or pharmacy by taxi, reducing unnecessary ambulance rides and emergency room visits by 80 percent. The city estimates it saves \$928,000 annually.³

Much of the value in creating collaborative work environments comes from making it easier for city employees to work together across departments. Philadelphia and Atlanta have implemented what they call co-working spaces and “innovation labs.” The goal is to foster open sharing of ideas across diverse government agencies.

Sources

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From City Employees to Next-Generation Workers (continued)

Similar ideas made a big impact in Buenos Aires. Siloed government ministries were buried in complex, paper-based processes. By integrating all administrative, maintenance, and back-office functions into one platform, the city has eliminated bottlenecks across agencies, from inspections and permits to pothole repairs and water main breaks. User-friendly dashboards and mobile apps enabled the Environment and Public Spaces Ministry to double its productivity.¹ That amounts to doubling its ability to provide services without the need for additional staff.

Sometimes the biggest inefficiencies come down to being in the same place at the same time. San Antonio is using video collaboration to streamline public safety. Detectives can connect rapidly with a judge to obtain a needed search warrant. Prisoners can be arraigned remotely, without the high cost of transporting them securely.²

Introducing simple technology tools to long-established processes can produce unexpected benefits. One of the largest school districts in the United States is using tablets to take daily attendance in class. This has significantly reduced the amount of paper, duplicative data entry, and time required. In addition, the digital roll allows the school system to send an automated phone alert to parents to confirm whether or not a child is out sick. It also means that the district has an extremely accurate record of who is in school in case of an emergency situation.

Transforming city employees into next-generation workers requires culture change as well as technology investment. Most public workers are eager to take on the challenge. A 2017 survey from the Thornton Review found that while 90 percent of government workers are looking to improve their productivity, only 55 percent feel empowered with the right support and resources.³

The benefits of a digitally equipped workforce are enormous. Such investments improve the ability of city employees to do their jobs and increase public satisfaction. They make it possible to deliver better services with the same staff. Just as importantly, the opportunity to break new ground with modern technology tools also makes it easier to attract and retain talent.

Sources

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Smarter Utilities, from Homes to Public Spaces

Cities and individual households alike are realizing major savings by replacing older electricity, water, and gas meters with digital versions. Smart meters, when combined with data analytics and demand-response monitoring systems, provide deep insight into how energy or water is being used. These insights influence the behavior of both consumers and utilities.

By applying digital technologies to monitor water usage in parks and other public places—along with efficient waste management through the use of sensors and network technologies—cities are capturing additional savings.

Cisco estimates that, combined, these digital utilities solutions will generate 18 percent or \$401 billion of Digital Value at Stake globally from 2015 to 2024. This value stems from more efficient use of energy and water by consumers, lower labor costs as meters are read remotely, and reduced leakage. Smart meters also enable dynamic pricing. Consumers who use less energy during peak hours can be rewarded with lower charges, and help avoid brownouts.

Given California’s drought challenges in recent years, cities, such as Burbank, Long Beach, and Glendale, adopted smart meters to monitor water usage. Long Beach saw water usage decrease in one single-family home by 70 percent after the smart meter identified an irrigation problem.¹

By deploying smart meters and other technologies to monitor electricity and gas, Houston offered flexible billing and avoided 100 million minutes of customer power outages from 2011 to 2016. This was partly the result of faster response times to outages during and after storms.² The meters are part of an intelligent grid that includes sensors on power lines and automated switches.

Kansas City, Missouri, integrates smart meters into a much larger smart utilities initiative. The goal is to gain visibility into every aspect of its utilities, from pipes and power plants to household consumers.³ The city also deployed sensors in dumpsters, which led to more efficient scheduling of waste collection.

Similarly, Copenhagen determined that only about 30 percent of its scheduled waste pickups were met with full garbage bins.⁴ Its SmartBin solutions enable “on-demand” waste collection, which cuts fuel costs and allows for more effective use of sanitation crews.⁵

Sources

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“There’s a correlation between public safety and economic activity. It’s largely been public safety that was the first mover in the investor confidence that came back.”

— **Lou Zacharilla**
Intelligent Communities
Forum

Safety and Security: Protecting People Better

To grow and thrive, cities must lessen threats and respond quickly to emergencies. But dealing with everything from crime and terrorism to storms and wildfires is expensive and complicated.

Digital solutions dramatically reduce costs, better protect citizens, and increase the efficiency of public-safety workers. These solutions can include smart lighting, video surveillance, and emergency texting, along with better use of snow plows and sensor-based wildfire suppression. **Together they account for 11 percent, \$240 billion, of Digital Value at Stake.**

Smart lighting is a low-cost tool that increases public safety and reduces crime. It also provides a platform for video surveillance, public Wi-Fi, traffic and air monitoring, and other sensors. Street lights can account for up to 40 percent of a city’s municipal electric bill.¹ But by combining LED bulbs with sensors and network technologies, those costs can be cut by more than 60 percent.² Street lights automatically respond to pedestrians or vehicles, dimming during periods of low activity, all the while lessening the potential for crimes to occur.

With its network of connected streetlights, Oslo is saving \$1.3 million annually, or about 20 percent of the cost of its previous system. Maintenance is also easier and cheaper, since remote monitoring identifies malfunctioning streetlights.³ Barcelona’s smart lighting system saves the city \$37 million each year.⁴

Sources

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Safety and Security: Protecting People Better (continued)

Adelaide's smart lighting is considered a key element of that city's carbon-neutral strategy.⁵ Similarly, connected lighting and other energy-saving solutions are reducing Hamburg's annual carbon emissions by 12,000 tons.⁶

A network of outdoor smart lights creates an excellent platform for sensors to gather data on traffic, air quality, and crime, while also providing public Wi-Fi. Kansas City, for example, is installing multiple sensors along with its Light Sensory Network.⁷ One upshot is better use of police assets to respond to real-time situations.

Like smart street lights, network-based video surveillance can improve the effectiveness of police forces, which are often burdened by labor-intensive surveillance operations with little ability to predict where actual crimes will occur. In addition to better police productivity and reductions in crime, network-based video surveillance provides important evidence to help apprehend and sentence perpetrators.

Atlanta's digital infrastructure includes 300 miles of fiber optic cable throughout the city. This supports large data flows from an array of sensors, including video cameras on smart lighting poles designed to fight crime and thwart terror attacks.⁸

Through its Safe City initiative, Pune deployed more than 1200 video cameras along with a state-of-the-art command and control center. The system has thwarted car thefts and other crimes, while speeding response times following traffic accidents and fires.⁹ In areas where the cameras have been deployed, crime has dropped 27 percent.¹⁰

Sources

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Connected Transportation and Urban Mobility: Getting Around the City, Intelligently

Transforming urban mobility takes a holistic approach. Everything from traffic and parking to public transport and pedestrians must be addressed. The city must have a clear picture of how its citizens are traveling, where bottlenecks occur, and how pedestrian zones and cycling lanes can best serve citizens.

Connected transportation combines intelligent sensors, advanced analytics, and remote monitoring to dramatically raise the efficiency of public transportation and cars. As pilot programs in cities, such as Pittsburgh, are showing, these solutions could eventually include self-driving vehicles.¹

Cisco projects 8 percent, or \$190 billion, of Digital Value at Stake from combined capabilities such as traffic management, congestion charging (imposing vehicle taxes to reduce traffic and carbon emissions), local metro and connected buses (digital solutions that monitor and manage public transit), smart parking (using sensors and smartphone apps to ease parking challenges), and pedestrian monitoring. Cities that create new opportunities for cyclists and pedestrians further impact energy usage, air quality, and mental well-being.

By implementing congestion charging, Stockholm decreased traffic by 20 percent in designated areas, cut CO₂ emissions by 2 to 3 percent, and increased public transportation usage by 2 to 3 percent. The system combines video, road sensors, wireless RFID, and other technologies to monitor vehicles, while also providing detailed data on traffic patterns.²

London, a pioneer in congestion charging, plans to add an additional charge in October of 2017 for vehicles that fail to meet minimum emissions standards.³

Cities, such as Copenhagen and Jaipur, use a combined network of roadway sensors as part of a larger network-based effort to improve traffic, streamline parking, and monitor air quality.⁴ Barcelona has boosted revenues by \$50 million annually through smart parking solutions, which include sensors embedded in asphalt and apps that guide drivers to open spaces.⁵

Kansas City is adding smart lighting, video cameras, and public Wi-Fi to its streetcar line, enabling rapid response if, for example, a stalled vehicle blocks a streetcar.⁶ According to Bob Bennet, Kansas City's chief innovation officer, in the streetcar's first year, the city has seen an upsurge in development and investment along the light rail corridor, resulting in a 58 percent increase in sales-tax revenue.

Sources

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6. [*Kansas City Gets Smart Lights that Watch You*](#), Kansas City Business Journal, May 4, 2016.



Citizen Experience: Making Cities Livable, Clean, and Fun

Citizen experience means delivering benefits for both residents and visitors. Those benefits come from improving the city's ability to monitor what's happening and adjust accordingly. For example, sensors can monitor air quality, noise, and allergens. Remote street kiosks share those and other real-time insights on traffic, transportation, restaurants, and events. Connected sports [stadiums](#) attract tourists and locals alike. **Together, such digital solutions add up to 6 percent, \$147 billion, of Digital Value at Stake.**

User-friendly and interactive, digital kiosks play a dual role. They provide all kinds of information, including directions, restaurant tips, and train and bus updates. Some even charge smart devices. Kiosks also collect data about pedestrian and vehicle traffic, air quality, street noise, and public safety. New York expects to install 7500 LinkNYC kiosks by 2020.

In Barcelona, the kiosks offer two-way interactions. Citizens access information and services, while sharing feedback and complaints with city government.¹ Dubai residents use kiosks to pay their bills.² And in Kansas City, users download information, like restaurant ads, from the kiosks directly onto their smart devices.³

Meanwhile, Copenhagen has implemented an array of sensors along its dirtiest, noisiest roads, to capture insights on noise and carbon emissions. One result? The city discovered that a high percentage of carbon emissions came from cars searching for parking spots. That led to additional initiatives to manage parking.⁴

Sources

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4. [*Future Cities: Copenhagen*](#), Future Cities, December 29, 2016.



City Infrastructure Management: Built-In Intelligence for Buildings and Vehicles

Cities that manage their public infrastructure more efficiently—for example, city buildings and vehicles—are tapping a source of unrealized value. **That's why city infrastructure management accounts for 3 percent, \$66 billion of Digital Value at Stake.**

Smart systems that manage heating, cooling, and lighting can cut a building's energy costs by 15 percent.¹ Remote collaboration and connectivity streamline maintenance and building management. The key is integrating sensors and building systems into the network. Such sensors can also monitor water usage and convey insights about leaks and other inefficiencies to building managers.

By implementing smart lighting systems in public school buildings, Miami-Dade saved 50 percent in electricity costs.² Additional sensors in the buildings track students, eliminating the need for teachers to take roll-calls. The system aligns temperature and lighting with real-time activity levels in the classrooms.

Searing heat posed a major challenge for Dubai's Mohammed Bin Rashid School of Government. Drawing the curtains wasn't an effective way of avoiding high energy costs—it affected learning and attention spans. By connecting lighting, ambient sensors, and environmental systems under one network, LED bulbs designed to mimic natural sunlight could be dynamically controlled. As a result, energy bills have decreased, while test scores have risen.³

The same principles apply to managing city vehicles. In 2012, Copenhagen ruled that all cars purchased by the government would be electrically powered, and ever since its growing fleet has been saving money and cutting air pollution.⁴ Electric buses are another cornerstone of the city's effort to become carbon neutral by 2025.⁵

Sources

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“Apps are being rolled out where they are empowering the citizen, as well as empowering the city workers. You’ve got apps for reporting faulty lights, faulty roads, faulty water, water leakage. All of those things are being reported today.”

— **Dr. Sumit D. Chowdhury**
Gaia Smart Cities

Open Data: Transparency for All

As citizen interactions rise and Internet of Things connections explode, digital infrastructure generates an ever-expanding wealth of data. But much of that rich trove of information remains untapped. **Making this data publicly available is not a new concept, but one that still has significant unrealized value—representing 2 percent, \$51 billion, of Digital Value at Stake.**

With so much data being generated on traffic patterns, employment, public health, crime, energy usage, waste management, and more, there are great opportunities for app developers to create new solutions. But it has to be smart data, not just big data.

When Chicago Mayor Rahm Emanuel announced his city’s open data portal, he summed up the opportunity: “An open and transparent administration makes it easier for residents to hold their government accountable, but it also serves as a platform for innovative tools that improve the lives of all residents.”¹ Chicago encourages and highlights the work of developers in hackathons and on its [digital hub](#) website.

Similarly, Santander, Spain’s open data portal has encouraged local developers and startups to create a wide range of apps. These have shared information on business opportunities, taxis, sustainability, and cultural events.² Los Angeles claims its open data portal helped launch 34,000 new businesses.³

Sources

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2. [Four New Apps Developed with Open Data in City of Santander](#), European Data Portal, 2017.
3. [Digital Cities Survey—2016 Winner Announced](#), Digital Communities, Nov. 9, 2016.



“As I talk to mayors and city leaders, I take my shoe off and pound on the table, trying to get them to be sure that they have that broadband foundation. You have to have citywide connectivity, not just for your people, not just for your smartphones, but for your sensors and other devices. And that’s what then unleashes all these other opportunities.”

— **Jesse Berst**
Smart Cities Council

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Laying the Foundation: Public Wi-Fi and Next-Gen Broadband

At just 3 percent or, \$59 billion, of Digital Value at Stake, public Wi-Fi and broadband offer modest direct value for cities. But that low percentage belies far more significant indirect benefits, which is why public Wi-Fi and broadband underpin our discussion of digital capabilities.

Direct benefits of municipal networks come mainly through avoiding the high costs of leased lines and carrier-provided network services. In some cases, such as the City of Santa Monica’s, the city itself acts as an Internet service provider to residents and local businesses, drawing in additional revenue.

Barcelona’s more than 300 miles of fiber optic cable, for example, enable its many smart services, including water, energy, waste, and transportation management, as well as open government. This network is critical to smart lighting, public Wi-Fi, and the city’s nearly 20,000 smart utility meters.¹

Santa Monica’s mayor, Tony Vazquez, stresses that the city’s extensive investment in fast broadband “returned significant benefits for our community health, safety, education, and wellbeing as well as for stimulating and sustaining our local economy.” He cites CityNet as the catalyst for a vibrant startup community that has been dubbed “Silicon Beach.”²

Virginia Beach, Virginia, is laying hundreds of miles of fiber optic cable to link almost 100 municipal buildings with high-speed broadband. City officials anticipate that the network will promote economic and educational opportunities, while speeding emergency response times and enabling traffic management. It also supports their strategy of bridging the “digital divide” to fight inequality.³

As of 2017, Seoul is offering free Wi-Fi in every public place, including subway cars and buses. The city sees public Wi-Fi as a cornerstone of its Open Data Plaza, an online channel where information is shared on everything from economic opportunities to available parking spaces.⁴

Guayaquil is expanding its fiber-optic network and will soon provide free Wi-Fi to the entire city. One of the many benefits has been a telemedicine capability that allows patients in local clinics to receive expert diagnoses from major hospitals.⁵



“You have to reel in cybersecurity at every level. And specify products and specify vendors that have the security baked in, but also who follow the right processes...because cybersecurity is a process as much as it’s a technology.”

— **Jesse Berst**
Smart Cities Council

Cybersecurity: Critical Enabler for Growth

All of these exciting digital solutions won’t mean anything if the city’s network can’t be secured. Cybersecurity is critical to the success and growth of digital cities. Especially considering that government networks, with their wealth of public data and complex systems, are a prime target of hackers and terrorists alike.¹

In Cisco’s economic analysis, cybersecurity accounts for 1 percent of Digital Value at Stake through 2024. But as with public Wi-Fi and broadband, that is direct value. The wider impact of network-based cybersecurity is harder to measure. Cybersecurity is a [growth enabler](#) that ensures confidence among city workers and citizens alike, and allows for innovation and bold thinking to thrive.

A fast-evolving digital city, San Diego, found that an upsurge in endpoints left it vulnerable to cyber threats. By one estimate, city networks were facing up to 500,000 cyberattacks per day, some of which went undetected for weeks. However, with greatly expanded and user-friendly visibility into its networks, along with automated attack-response capabilities, the city estimates it is saving \$1.3 billion per year in lost productivity.²

Sources

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“Partners, partners, partners. The partnerships are the key to make any Smart City work. The Wi-Fi and fiber backbone allow you to do what you need to do and data is the heart of the system. When you combine and you apply them to people problems, your Smart City works.”

— **Bob Bennett**
Chief Innovation Officer
Kansas City, Missouri

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Digital Infrastructure: The Key to the Digital City

There is a common thread for all of the cities referenced here: they started with a strong foundation of digital infrastructure. They have the network and core capabilities to connect employees, citizens, sensors, and even cars. From this base, they can continue to innovate and grow. Their success shows in their ongoing digital transformations.

Implementing digital capabilities requires vision and political will. For cities in particular, the costs of adoption tend to be concentrated, but the benefits are often dispersed. While funding is likely to come from the city budget, the biggest benefits may flow to other agencies or even private businesses. That requires careful cultivation of public and private investments and management of disparate government agencies, all of which stand to benefit.

Cisco’s analysis of top value-driving digital capabilities is a guide for investment, not necessarily a roadmap. Though we rank these capabilities in terms of Digital Value at Stake, each city is unique. Only you and your community can determine which technology initiatives will drive the greatest impact.

Regardless of your priorities, take a portfolio approach. Individual capabilities may only offer a mediocre return as standalone investments. Combining a portfolio of initiatives will deliver higher marginal returns. The core infrastructure platform will scale—physical security, smart lighting, smart meters, traffic sensors, air quality sensors, and city Wi-Fi may share the same connectivity infrastructure.

The Digital Vortex poses distinct challenges for cities. It brings disruption and opportunity in equal measure, for both city operations as well as the businesses and employers that form your local economic base.

With a solid foundation of digital infrastructure, you’re well positioned to make the most of digital disruption—for city and community alike.

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