SMART CITIES READINESS GUIDE

The planning manual for building tomorrow's cities today

SmartCitiesCouncil

LIVABILITY | WORKABILITY | SUSTAINABILITY

Smart Cities Council

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Authors and Key Contributors:
This Guide was written by Smart Cities Council Chairman Jesse Berst, Editorial Director Liz Enbysk and Research Director Christopher Williams. It was conceptualized by Chris Caine, President and CEO of Mercator XXI; researched by Christopher Williams; illustrated by Scott Dunn, and designed and produced by Tahne Davis and Anne Schoenecker of Davis Design, Seattle.

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CHAPTER 1

INTRODUCTION TO SMART CITIES

Welcome to the Readiness Guide. This document was assembled with input from many of the world's leading smart city practitioners – the members and advisors of the Smart Cities Council. Its mission is two-fold.

First is to give you a "vision" of a smart city, to help you understand how technology will transform the cities of tomorrow.

Second is to help you construct your own roadmap to that future. It suggests the goals to which you should aspire, the features and functions you should specify, the best practices that will gain you the maximum benefits for the minimum cost, at reduced risk.

The Readiness Guide is intended for mayors, city managers, city planners and their staff. It helps cities help themselves by providing objective, vendor-neutral information to make confident, educated choices about the technologies that can transform a city.

Cities around the world are already making tremendous progress in achieving economic, environmental and social sustainability, in export-based initiatives and in the creation of 21st century jobs. All of these are excellent ways to improve city living standards and economies. The concept of smart cities doesn't compete with these efforts. Instead, smart city technologies can support and enhance work already underway. You'll see how in the chapters to come.

In this chapter, we will define the smart city, explore its benefits and introduce the framework that underlies this Readiness Guide.

Taking a holistic view of 'city'

This introductory section defines smart cities and explores the trends that are driving this global phenomenon. It also discusses some of the barriers cities may face and strategies to overcome them.

Before we define the "smart" piece, however, we should first deal with the word "city." Real-world smart city examples are rarely a city in the strictest term. Many are more than a single city, such as a metropolitan region, a cluster of cities, counties and groups of counties, a collection of nearby towns or a regional coalition. Other examples are less than a full-scale city, such as districts, neighborhoods, townships, villages, campuses and military bases. Indeed, many municipalities are taking a neighborhood-by-neighborhood approach to modernization. This Guide is designed to address all of these human ecosystems.

Because it is in common use, we will continue to use "city" throughout this Guide. But we use it to mean all relevant examples big and small. Regardless of size, we are taking a comprehensive, holistic view that includes the entirety of human activity in an area, including city governments, schools, hospitals, infrastructure, resources, businesses and people. As you'll read, smart technologies have matured to the point that cities of all sizes can afford and benefit from their implementation. For example, new cloud computing offerings allow even the smallest city to affordably tap into enormous computing power. So the lessons of this Guide apply regardless of size – and you'll see real-world examples in the case studies featured throughout.

The definition of a smart city

A smart city uses information and communications technology (ICT) to enhance its livability, workability and sustainability. In simplest terms, there are three parts to that job: collecting, communicating and "crunching." First, a smart city ***collects*** information about itself through sensors, other devices and existing systems. Next, it ***communicates*** that data using wired or wireless networks. Third, it ***"crunches"*** (analyzes) that data to understand what's happening now and what's likely to happen next.

Collecting data. Smart devices are logically located throughout the city to measure and monitor conditions. For instance, smart meters can measure electricity, gas and water usage

THE THREE CORE FUNCTIONS OF A SMART CITY

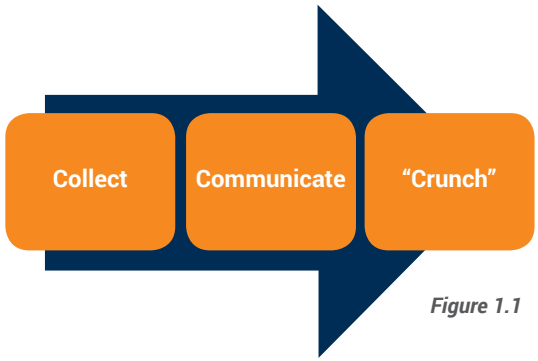


Figure 1.1

1. **Collect**
   information about current conditions across all responsibility areas (power, water, traffic, weather, buildings, etc.).

2. **Communicate**
   information, sometimes to other devices, sometimes to a control center and sometimes to servers running powerful software.

3. **Crunch**
   data, analyzing it to present information, to perfect (optimize) operations and to predict what might happen next.

with great accuracy. Smart traffic sensors can report on road conditions and congestion. Smart GPS gear can pinpoint the exact locations of the city's buses or the whereabouts of emergency crews. Automated weather stations can report conditions. And the smartphones carried by many city dwellers are also sensors that can – when specifically authorized by their users to do so – collect their position, speed, where they cluster at different times of the day and the environmental conditions around them.

A smart city, then, is one that knows about itself and makes itself more known to its populace. No longer do we have to wonder if a street is congested – the street reports its condition. No longer do we have to wonder if we're losing water to leaks – the smart water network detects and reports leaks as soon as they occur. No longer do we have to guess the progress of the city's garbage trucks – the trucks report where they've been already and where they are headed next.

Communicating data. Once you've collected the data, you need to send it along. Smart cities typically mix and match a variety of wired and wireless communications pathways, from fiber-optic to cellular to cable. The ultimate goal is to have connectivity everywhere, to every person and every device.

Crunching data. After collecting and communicating the data, you analyze it for one of three purposes: 1) presenting, 2) perfecting or 3) predicting. If you've read about "analytics" or "Big Data," then you may already know about the astonishing things that become possible by crunching large amounts of data. Importantly, crunching data turns information into intelligence that helps people and machines to act and make better decisions. This begins a virtuous cycle wherein data is made useful, people make use of that data to improve decisions and behavior, which in turn means more and better data is collected, thereby further improving decisions and behavior.

Presenting information tells us what's going on right now. In the aerospace and defense industries, they call this "situational awareness." Software monitors the huge flow of incoming data, then summarizes and visualizes it in a way that makes it easy for human operators to understand. For instance, a smart operations center can monitor all aspects of an emergency situation, including the actions and locations of police, fire, ambulances, traffic, downed power lines, closed streets and much more.

Perfecting operations uses the power of computers to optimize complex systems. For instance, balancing the supply and demand on an electricity network; or synchronizing traffic signals to minimize congestion; or selecting the ideal routes for a delivery fleet to minimize time and fuel costs; or optimizing the energy usage of an entire high-rise to achieve maximum comfort at minimum cost.

Predicting what's next is perhaps the most exciting part of analytics. Cities such as Singapore already crunch data to predict traffic jams while there is still time to minimize their effects. Cities such as Rio de Janeiro already predict just where flooding will occur from a particular storm, so emergency crews and evacuation teams know just where to go.

Cities can derive benefit by collecting, communicating and crunching information from a single department. But the greatest benefits come when data is connected with multiple departments and third parties. Many cities combine historic traffic data with information about population growth and business expansion to know when and where to add or subtract bus and train routes. Other cities correlate multiple data sources to predict crime the way we predict weather. Or predict which expensive transformers are about to fail on the power grid and which will still be good for years to come.

As we'll see in more detail, a smart city is a system of systems – water, power, transportation, emergency response, built environment, etc.– with each one affecting all the others. In the last few years, we've refined our ability to merge multiple data streams and mine them for amazing insights. It is those insights – presenting, perfecting and predicting – that enhance the livability, workability and sustainability of a smart city.

> ***Smart cities collect, communicate and crunch data.***
> *The city of Rio de Janeiro collects information from 30 different city departments about transportation, water, energy, weather and other conditions. Then it communicates those conditions to powerful computers, which crunch the data and present it in a unified control center the city developed with IBM. Not only does the city gain full situational awareness, it can even predict some conditions in advance, such as where floods will occur during severe storms. It can also develop actionable tasks based on modeled patterns, creating a competitive advantage for smart cities.*
>
> ***Figure 1.2***

OTHER SMART CITY DEFINITIONS

The Council defines a smart city as one that "uses information and communications technology (ICT) to enhance its livability, workability and sustainability." Other organizations have their own definitions.

For instance, Forrester Research emphasizes the use of computing to monitor infrastructure and improve services: "The use of smart computing technologies to make the critical infrastructure components and services of a city – which include city administration, education, healthcare, public safety, real estate, transportation and utilities – more intelligent, interconnected and efficient."

The U.S. Office of Scientific and Technical Information also stresses infrastructure, explaining that "a city that monitors and integrates conditions of all of its critical infrastructures – including roads, bridges, tunnels, rails, subways, airports, seaports, communications, water, power, even major buildings – can better optimize its resources, plan its preventive maintenance activities, and monitor security aspects while maximizing services to its citizens."

Meanwhile, in 2010 IBM's Journal of Research and Development paid particular attention to the wide range of smart devices that collect information, calling it "an instrumented, interconnected and intelligent city."

These and other definitions are valid and helpful understandings of what smart cities are. The Council stands behind its comprehensive definition. But we mention these others so that cities that have planned and invested under these and other models will understand that we share complementary, not competitive, views of the smart city

> ***Livability, workability and sustainability are the goals.*** *Smart cities use information and communications technologies to achieve them. Seoul, South Korea – pictured here – is often cited as one of the world's most vibrant, sustainable cities.*
>
> ***Figure 1.3***

The drivers of smart cities

Powerful forces are converging to make smart cities a growing trend all around the world. It is valuable for city leaders to understand what's behind this momentum and how it will play out in their region. Chances are some of the pain points described below will hit close to home.

Growing urbanization. Cities deliver many benefits – greater employment opportunities, greater access to healthcare and education, and greater access to entertainment, culture and the arts. As a result, people are moving to cities at an unprecedented rate. Over 700 million people will be added to urban populations over the next 10 years. The United Nations projects that the world's cities will need to accommodate an additional 3 billion residents by the middle of the century. A recent UN report suggests that 40,000 new cities will be needed worldwide.

Growing stress. Today's cities face significant challenges – increasing populations, environmental and regulatory requirements, declining tax bases and budgets and increased costs – at the same time many are experiencing difficult growing pains ranging from pollution, crowding and sprawl to inadequate housing, high unemployment and rising crime rates.

Inadequate infrastructure. Urbanization is putting significant strain on city infrastructures that were, in most cases, built for populations a fraction of their current size. Much of the developed world has infrastructure that is near or past its design life, requiring massive upgrades. For instance, in 2013 the American Society of Civil Engineers gave the United States an overall grade of D+ for its infrastructure. Meanwhile, much of the developing world has missing or inadequate infrastructure, requiring massive build-outs. The 2012 blackout in India that left more than 600 million people without electricity is a prime example; the country has inadequate power generation to meet ever-increasing demand. The bottom line? McKinsey & Company estimates that cities will need to double their capital investment by 2025, to $20 trillion from today's $10 trillion per year.

Growing economic competition. The world has seen a rapid rise in competition between cities to secure the investments, jobs, businesses and talent for economic success. Increasingly, both businesses and individuals evaluate a city's "technology quotient" in deciding where to locate. A real challenge for cities with economies based on heavy industry is

Growing urbanization drives change.
Over 700 million people will be added to urban populations over the next 10 years. The United Nations projects that the world's cities will need to accommodate an additional 3 billion residents by the middle of the century. A recent UN report suggests that 40,000 new cities will be needed worldwide.

Figure 1.4

creating job opportunities that appeal to recent university graduates so they will stay and help build the kind of high-quality workforce that new industries, for instance those in technology, demand.

Growing expectations. Citizens are increasingly getting instant, anywhere, anytime, personalized access to information and services via mobile devices and computers. And they increasingly expect that same kind of access to city services. In fact, a May 2013 United Nations survey of over 560,000 citizens from 194 countries revealed their top priorities are a good education, better healthcare and an honest and responsive government. We also know that people want to live in cities that can provide efficient transportation, high-bandwidth communications and healthy job markets.

Growing environmental challenges. Cities house half of the world's population but use two-thirds of the world's energy and generate three-fourths of the world's CO_2 emissions. If we are going to mitigate climate change, it will have to happen in cities. Many regions and cities have aggressive climate and environmental goals – goals that cannot be reached without the help of smart technologies.

Rapidly improving technology capabilities. Many of the smart city drivers listed above are negatives – problems that demand solutions.

> ***One-stop shopping for city services.***
> *Citizens increasingly expect instant, anywhere, anytime personalized access to information. The web portal pictured here is from the province of Quebec, Canada and uses technology from Council member Alphinat. Its goal is to give businesses "one-stop shopping" for virtually all of their needs – permits, licensing, taxes, etc. In many cities taking care of business needs requires dealing individually with numerous different city departments.*

Figure 1.5

There are positive drivers as well, especially the rapid progress in technology. The costs of collecting, communicating and crunching data have plunged. What's more, much of the needed technology is already in place:

- Over the last decade, many regions have begun to modernize their electric power grids and, to a lesser extent, their water and gas networks. Hundreds of millions of smart meters and smart sensors are now in place, producing data of value to a smart city.

- With the arrival of smart thermostats and building management systems, there are now millions of buildings with some of the pieces needed to be smart, on the cusp of being able to 'talk' and 'listen.'

- On the health and human services front, we're seeing better access to healthcare with in-home consultations via computer. Meanwhile most agencies are switching to electronic records and many are using analytics to improve results.

- Our highways and byways are becoming smarter thanks to intelligent transportation management software, roadway sensors and smart parking apps. Navigation apps and equipment display real-time traffic so users can find – and even be automatically pointed to – less congested alternatives.

Rapid progress in technology.
An increasing number of cities are starting to benefit from technology that allows merchants to accept payments via smartphones and wallets.

Figure 1.6

And we are seeing more electric vehicles on our roads which help reduce pollution.

- Over the last two decades, we have deployed high-bandwidth networks worldwide that connect one billion computers and four billion cell phones. These networks are already in place in almost all major cities and can be leveraged for smart city applications.

- An increasing number of cities are starting to benefit from a large network of Near-field Communication (NFC) equipped point of sales with the roll-out of contactless cards technology. It means hundreds of merchants are already capable of accepting mobile payments and wallets for seamless consumer experience and value added services, but also cashless cities are able to reduce frauds and benefiting from better insights on their citizen purchasing journeys.

Let's consider that final example in more detail. It's important to realize that today's ubiquitous smartphones are becoming both a "delivery platform" and a "sensor network" for smart city applications. The delivery platform is obvious – a smartphone is a great place for a resident to receive alerts and access city services. But today's smartphones can also be leveraged to collect information when the user agrees to share data. For instance, one launched in 2013 has the following sensors: a GPS locator, a microphone, a gyroscope, a light sensor, a camera, an accelerometer, a barometer, a thermometer, a magnetometer and a hygrometer.

"By the end of the decade, many infrastructure technologies – smart meters, intelligent traffic systems, building energy management – will be deployed across North America and Europe and, increasingly, in the rest of the world," says Navigant Research analyst Eric Woods. Once

in place, that technology provides the basis for a wide range of innovative smart city applications and services.

Rapidly declining technology costs. Even as capabilities are climbing, technology costs are plummeting. Hardware costs are declining at a steady pace. But it is software costs that have plunged the most, thanks to four trends.

The first trend is the advent of inexpensive mobile apps and information services viewable by mobile phones. Those phones are so popular that millions of developers have turned their attention to building applications, many of which cost only a few dollars.

The second trend is the arrival of social media. Applications such as Facebook and Twitter act as free "platforms" to deliver alerts, updates or even small-scale apps. They also act as "listening posts" that help cities monitor citizen needs and preferences. In fact, companies such as IBM and Microsoft now have the capability to use machine intelligence to monitor social media and derive trends.

The third trend is the maturation of cloud computing. Cloud computing delivers powerful solutions via the Internet. Suppliers save money because they can build one solution and sell it to many different users, gaining tremendous economies of scale. Users save money because they don't have to buy and maintain giant data centers or hire and train large IT staffs. Only a few years ago, advanced applications were available only to the very biggest agencies and corporations. Today – thanks to cloud computing – they are not out of reach for even the smallest township. And they are available without a giant upfront investment, simply by paying a monthly fee.

The fourth trend is about the data. From an analytics perspective, we can now cost effectively handle the high volume, velocity and variety of data – e.g. Big Data.

And there's much more to come. The smart city is part of an even larger trend – the "Internet of Things." Technology provider Cisco estimates there were 200 million devices connected to the Internet in the year 2000. By 2012, that number had increased to 10 billion. There are approximately 200 connectable "things" per person today, or 1.5 trillion things globally, Cisco estimates.

Clearly we are entering a remarkable new phase. Research firm IDC predicted in 2012 that the smart city market would grow by 27% year over year. Meanwhile, Navigant Research said it would hit $20 billion in worldwide sales by 2020. And Cisco in early 2013 predicted the overall Internet of Things market will create an astonishing $14.4 trillion in additional net profit for the world's industries in the next decade.

The "Internet of Things." *Cisco estimates there were 200 million devices connected to the Internet in the year 2000. By 2012, that number had increased to 10 billion.*

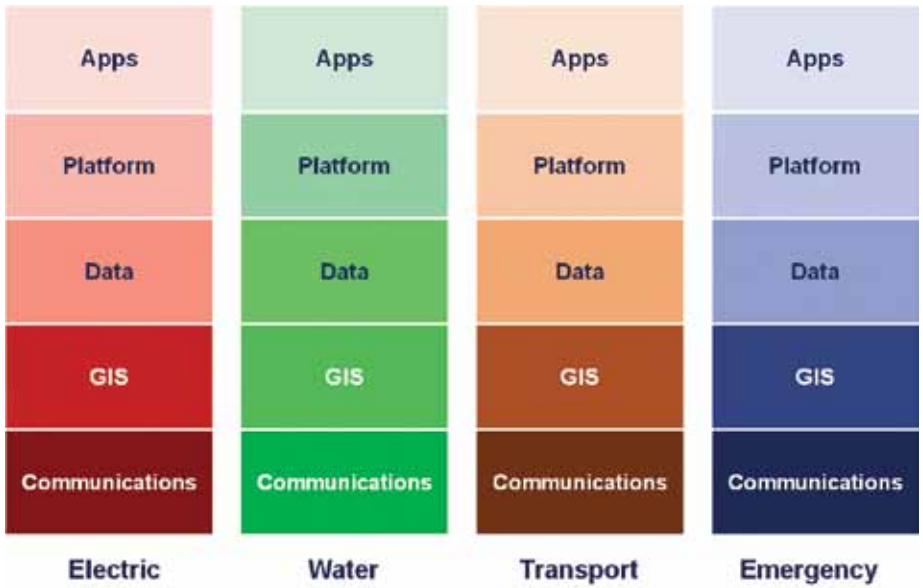
Figure 1.7

The barriers to smart cities

Despite the powerful drivers in favor, the path to smart cities has obstacles along the way. Members of the Smart Cities Council have worked on thousands of smart city projects all over the world. As they've collaborated with local governments certain barriers have emerged frequently.

Siloed, piecemeal implementations. Cities often tackle challenges in a piecemeal fashion, due to short-term financial constraints and long-term traditions that divide city functions into separate, "siloed" departments with little interaction. As a result, many projects are built to solve a single problem in a single department, creating "islands of automation" that duplicate expenses while making it difficult to share systems or data.

Building a smart city requires a system-wide view and an integrated approach. The bad news: holistic thinking and collaborative work are hard. The good news: done right, they can save time and enable new services that were not possible in an isolated, siloed model. For instance, a city department can drastically cut the development time for a new application by re-using data and software modules already created by other departments. A municipal water utility can drastically cut the cost of a communications network by using one already built out for an electric utility. And a city can sometimes reduce overall information technology (IT) costs by as much as 25% just by implementing a master IT architecture and technology roadmap. This is not to suggest that cities must finance and implement dozens of investments at one time. In fact, it is entirely fine to begin with just one or two projects. What is critical is that these projects all fall into a larger, integrated plan so that city investments are not redundant.



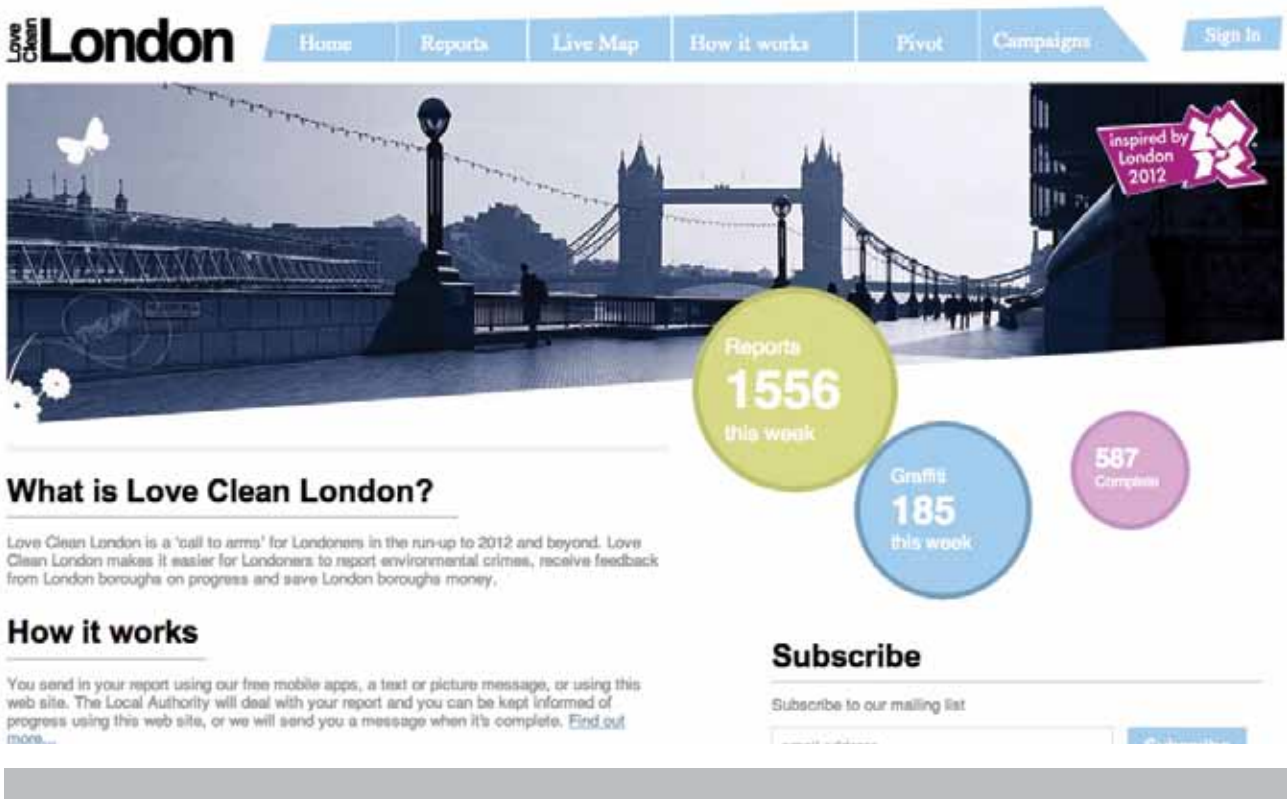
THE PROBLEM WITH "SILOED" CITIES

> ***Expensive redundancies.*** *Despite the fact that modern IT architectures make it possible to connect city departments and solutions today,, far too many cities still use a "siloed" approach to smart city applications. Individual departments build individual applications, with little regard to sharing costs, infrastructure and data. The result is expensive redundancies and unnecessary difficulties in coordinating between those isolated applications.*

Figure 1.8

Most experts agree that technology will not be the gating factor for the smart city transformation. Instead, we will be limited by our human ability to coordinate and collaborate between departmental and technology silos.

Lack of financing. Tax revenues are shrinking in many cities, making infrastructure projects increasingly difficult to finance. In fact, some cities have been forced to implement austerity measures – such as furloughing employees one day a month or cutting back on travel and discretionary expenses. Yet if those cities remain old-fashioned while others modernize, they will suffer even more, since cities must now compete globally. Fortunately, new financial models are emerging. And payment innovations like e-Procurement or electronic benefits can help cities reduce costs and free up money to invest in infrastructure and other improvements. Some of them require little or no upfront capital from the city. Instead, the city "rents" its solution as it goes. And performance contracts and shared revenue models between the city and solution vendors provide cities with attractive financing solutions. What's more, many smart city solutions have a rapid payback so that they save money over the long run. In many cases, the technology can actually improve the city's economic return.



> ***A new view of city apps.***
> *Early city applications were inward-facing and intended just for city employees. Today, more and more cities are producing outward-facing apps. For example, to get citizens involved in cleaning up London before the 2012 Summer Olympics, the city worked with Council member Microsoft on the Love Clean London portal (above) and companion mobile app that gave citizens an easy way to alert authorities to litter and graffiti by texting or uploading images. It's still being used today.*

Figure 1.9

The barriers to smart cities. *Despite the powerful drivers in favor, the path to smart cities has obstacles along the way. Sometimes it comes down to lack of a smart city visionary. Cities need a smart city champion — a mayor, a city manager, a planning director. Or it can come from outside city hall — civic or business leaders or a public-private partnership, for example.*

Figure 1.10

Lack of ICT know-how. Although industry has developed highly sophisticated ICT skills, few city governments have had the budget or the vision to push the state of the art. Since smart cities are essentially the injection of ICT into every phase of operations, this lack of ICT skills puts cities at a disadvantage. Fortunately, more and more applications are offered as a service. That is, they are hosted in the cloud (out on the Internet) where they have access to tremendous computing power, virtually unlimited storage and innovative software. Another plus is that the smart city sector has developed a large cadre of experienced global, regional and local consultants and service providers who are partnering with cities to deploy ICT solutions.

Lack of integrated services. To the extent cities applied ICT in the past, they applied it to their internal, siloed operations. The result has been a grab-bag of aging applications that only city employees can use. Although this was an acceptable practice in the last century, today we can and must allow citizen access and self-service. There is no reason that citizens who want, for instance, to open a restaurant should have to make multiple applications to multiple city departments. In a smart city, a single portal can gather all the data and parcel it out to the appropriate departments. Likewise, residents should have instant access to up-to-the-minute information about their energy and water usage, their taxes and fees, their social services programs and more. And ideas like Open Data not only improve transparency, they enforce a people-first perspective that is critical in smart cities

Lack of citizen engagement. The smart cities movement is often held back by a lack of clarity about what a smart city is and what it can do for citizens. As a result, many stakeholders are unaware of the smart city options that have found success already. Often, there is a communications issue. Cities should be wary of being too abstract with their smart city initiatives, recognize that citizens care about services that make their lives better, and adjust their engagement accordingly. Cities need to recognize when they need citizen and business awareness versus complete 'buy in.'

Remedying the citizen engagement challenge will require visionary leadership that paints a picture of the benefits technology can bring. In the U.S. in the late 2000s, several electric power utilities learned this lesson the hard way. They rolled out smart meters without explaining how customers would benefit. They suffered consumer backlash and resistance as a result.

Lack of a smart city visionary. Every parade needs a leader. Sometimes that leadership comes from an elected official – a mayor or council person who acts as the smart city champion. Smart city leadership can also come from elsewhere in the administration –

a city manager or a planning director, for instance. Or it can come from outside city hall altogether with involvement from business leaders, civic organizations or public-private partnerships.

The benefits of smart cities

Now let's look at why it is so worthwhile to overcome those barriers and take advantage of the technology advances described earlier that allow you to re-imagine your city. With the right planning and investment, government leaders can make our ciites more livable, more workable and more sustainable – both economically and environmentally. Let's examine those overall goals, which are the very purpose of becoming smart.

Enhanced livability means a better quality of life for city residents. In the smart city, people have access to a comfortable, clean, engaged, healthy and safe lifestyle. Some of the most highly valued aspects include inexpensive energy, convenient mass transit, good schools, faster emergency responses, clean water and air, low crime and access to diverse entertainment and cultural options.

Enhanced workability means accelerated economic development. Put another way, it means more jobs and better jobs and increased local GDP. In the smart city, people have access to the foundations of prosperity – the fundamental infrastructure services that let them compete in the world economy. Those services include broadband connectivity; clean, reliable, inexpensive energy; educational opportunities; affordable housing and commercial space; and efficient transportation.

Enhanced sustainability means giving people access to the resources they need without compromising the ability of future generations to meet their own needs. Merriam-Webster defines sustainability as a method of using a resource so that it is not depleted or permanently damaged. When the Council uses the term, it refers not only to the environment, but also to economic realities. Smart cities enable the efficient use of natural, human and economic resources and promote cost saving in times of austerity, and they are careful stewards of taxpayer dollars. It isn't about investing huge sums of money into new infrastructure, it's about making infrastructure do more and last longer for less.

Life is better in a smart city – better for people and better for businesses. In the chapters to come, we will discuss dozens of specific benefits that accrue to cities that embrace the smart city vision. But let's take a moment to summarize them by imagining a day in the life of a citizen in our smart city.

Smart cities enhance livability. *Residents have access to a comfortable, clean, engaged, healthy and safe lifestyle.*

Figure 1.11

A DAY IN YOUR NEW URBAN LIFE:

HOW SMART CITIES MAKE FOR HAPPIER CITIZENS

It's Monday morning, a rare day off for Josie. But when the alarm on her smart wristphone chirps, she doesn't reach for the snooze button. "Too much to do today," she reminds herself. Peeking around her bedroom's solar curtain, she's pleased to see the sun shining brightly.

"Perfect," she decides. "I can bike over to the mall, drop off the bike and pick up a car when I'm done."

Josie doesn't actually own a bike or a car; living in a city with abundant share programs means she doesn't have to. And since the café she runs is only 10 blocks from her condo, she typically walks to work – or if the weather is really lousy hops on a bus. She's proud that her city has a smart transportation system that uses advanced technologies to streamline traffic flow – and that it works.

Wandering into the kitchen, Josie pours herself a cup of coffee that started brewing when her alarm went off. Between her smart wristphone and her smart thermostat, pretty much every creature comfort in her condo is automated. She told the system her preferences, of course, but from then on it took care of the details. If it notices her overriding the original settings, it quickly adapts to her new wishes. Her shower is programmed to run at the same temperature every day and her refrigerator sends an alert to her phone when she's running low on items she typically has on hand. She just brings up the list when she's at the grocery store.

She knows she'll miss her condo when she and Miguel move into the loft they found. But the condo is on the small side for two people. Though the loft is small too, it has transformable spaces thanks to "robot walls" that can be moved to create different spaces for different needs. Josie is especially happy with the new TeleWall. The high-definition bigscreen will let Miguel telecommute much of the time and she plans to use it for the online courses she's taking.

> ***Sensors and digitization will change lives.*** *Day-to-day living will become much more convenient in tomorrow's smart cities, thanks to the digitization of just about everything.*
>
> ***Figure 1.12***

Continued on next page

Figure 1.13

After a quick trip to the roof to check on the garden she shares with the building's other tenants, she grabs her backpack and looks at a phone app to see the closest available bike-share. Turns out, there is one just around the corner. But if Josie had been running late or faced with rainy weather, she had only to enter her destination into her city transit app to get a route plan optimized for her preferences.

Jumping on her bike, she picks her destination from her favorites list and transfers her phone display to an overlay in her glasses. She instantly sees an alert from the city's traffic system warning of a downtown parade that threatens to jam up her usual route. She picks an alternate route calculated by the system and follows the directions as they appear in her glasses.

The purpose of her trip to the mall is to find something to wear to a party. But as she walks past the virtual city hall that occupies a small storefront near the mall entrance, she realizes she can take care of another item on her to-do list.

"This is pretty sweet," she says as she sits down in a private "closet" equipped with high-definition video equipment that allows her to interact with a remote city agent. She tells him she needs a permit for a street fair her cafe is going to participate in but doesn't know what it's called. The agent quickly finds the form she needs, transmits it to the touchscreen in front of her and Josie is able to fill it out and send it back within minutes. Before she leaves the agent mentions a new waste management system the city is testing at restaurants. It's "pay as you throw" – meaning the less they throw away and the more they recycle the lower their monthly bill. Josie likes the sound of that and signs up on the spot. She asks for daily updates. Since her bins are monitored by smart sensors, the city knows moment by moment how much trash Josie's cafe has accumulated. It can warn her when it looks like she'll exceed the goal she set for herself, while there is still time to improve.

She spends another hour trying on dresses suggested by the store's shopping service, which taps into a history of past purchases that Josie has rated and posted for just this purpose. Then glancing at her wrist, she realizes she has to get moving. She promised to take her grandmother to a medical appointment and doesn't want to be late. As she walks toward the mall exit, she passes a car-share wall display that has embedded smart tags. She waves her wristphone at the wall to find the nearest electric car– and sees there's one just two blocks away that's fully charged and ready to go.

During the medical appointment, Josie is relieved to see the specialist her grandmother is seeing for the first time pull up electronic records that provide a complete view of her medical history. She's heard stories about elderly patients suffering harmful drug interactions because one doctor doesn't know what the other is prescribing.

When she finally gets home that evening, it is dinnertime and Josie's hoping a robot will appear with a gourmet meal – but then she sees Miguel waiting for her with a pizza box and figures that's close enough.

AT A GLANCE: TRADITIONAL CITIES VS SMART CITIES

	The Problem	The Smart City Solution
Planning	• Ad hoc and decentralized • Cost savings aren't realized • Limited potential for scalability of investment	• Coordinated and holistic • Resources are shared • Cost savings are fully realized • Investments are scalable • Improved city planning and forecasting
Infrastructure	• Runs inefficiently • Costs more money and resources to run	• Optimized with cutting-edge technology • Saves money and resources • Improved service-level agreements
System operators	• Guess at infrastructure conditions • React to problems • Can't deploy resources efficiently to address problems	• Enjoy real-time reporting on infrastructure conditions • Predict and prevent problems • Deploy resources more efficiently • Automate maintenance • Save money
ICT investments	• Piecemeal and siloed • Deliver suboptimal benefit • Don't realize economies of scale	• Centrally planned • Deployed across city departments and projects • Deliver optimal benefit • Provide maximum value and savings
Citizen engagement	• Limited, scattered online connection to citizens • Citizens can't make optimal use of city services (or easily find them)	• Complete and singular online presence • Citizens can easily find and use services • Citizens can participate in smart city initiatives • Two-way communications between government and people • Specialized services focused on the individual citizen • Citizens can both contribute to and access real-time intelligent city data
Sharing data	• Departments and functions are siloed • Departments rarely share data and collaborate on initiatives	• Departments and functions are integrated and/or shared • Data is shared between departments and better correlated with other data services • Results are improved • Costs are cut

Figure 1.14

CHAPTER 2

HOW TO USE THE READINESS GUIDE

The role of the Readiness Guide is to help you transition to a smart city, at your own pace and on your own terms. This chapter explains the Smart Cities Framework that supports that mission. We think you will find it a useful mechanism to understand the totality of a smart city and how the pieces work together.

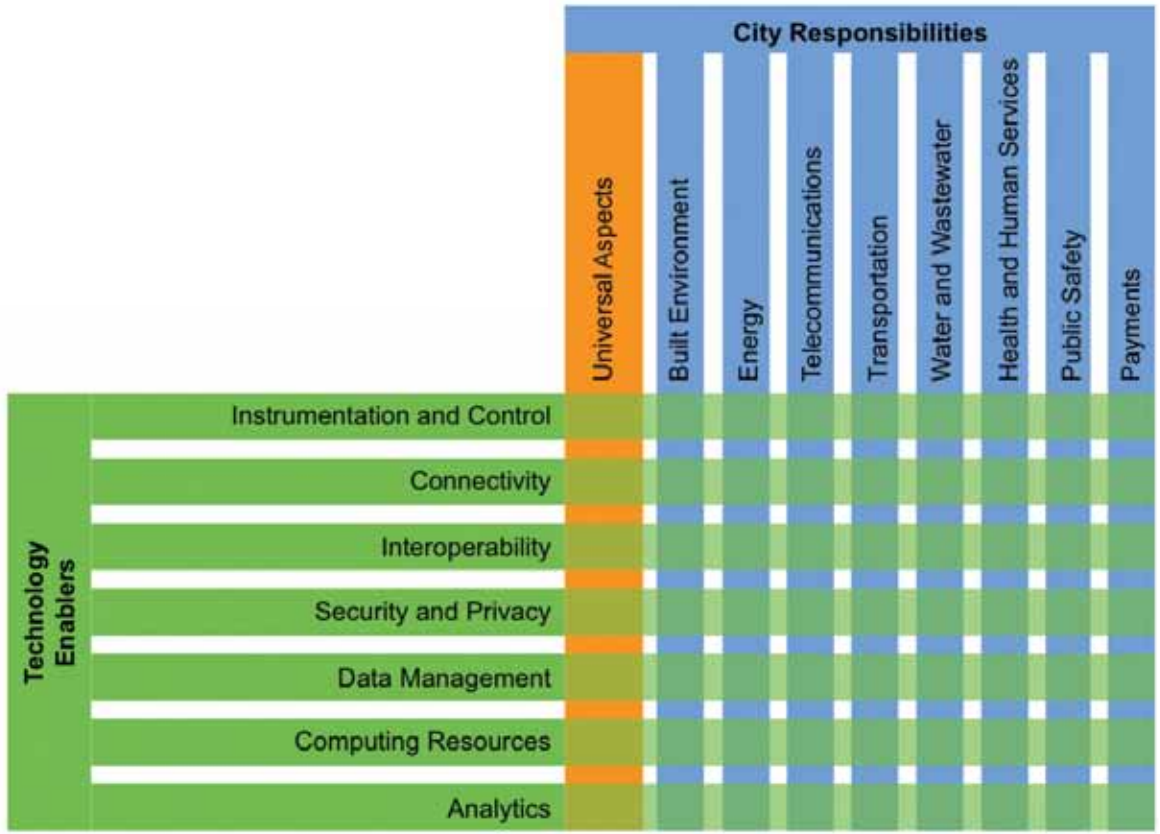
This chapter gives you what you need to construct a "target list" or "wish list" for your city. When you are ready to turn that list into an actual plan, you'll find guidance in Chapter 13, "Ideas to Action."

Our introduction defined the smart city as one that uses information and communications technology (ICT) to enhance livability, workability and sustainability. The Smart Cities Framework captures this relationship between a city's responsibilities (what it needs to accomplish for citizens) and its enablers (the smart technologies that can make those tasks easier).

THE SMART CITIES FRAMEWORK

Aligning responsibilities and enablers.
The vertical responsibilities denote essential services that cities require. The horizontal enablers are technology capabilities that improve those responsibilities.

Figure 2.1



Smart city responsibilities

Cities have essential functions and services that must be available every day. Homes must have water, businesses must have power, waste must be collected, children must be educated and so on. In the Readiness Guide, we refer to these vertical city functions as *responsibilities.* Although not all of them fall under a city's direct control, all of them are essential to everyday life and commerce. The eight city responsibilities are:

1. **Built environment.** In the Readiness Guide, built environment refers to all of a city's buildings, parks and public spaces. Certain components of the built environment – including streets and utility infrastructure – are not emphasized here because they are treated in other responsibilities (transportation and energy).

2. **Energy.** The infrastructure to produce and deliver energy, primarily electricity and gas.

3. **Telecommunications.** This term can have several different meanings. The Readiness Guide uses the telecommunications responsibility to refer to communications for people and businesses. We use connectivity to refer to communications for devices.

4. **Transportation.** A city's roads, streets, bike paths, trail systems, vehicles, railways, subways, buses, bicycles, streetcars, ferries, air and maritime ports – any and every system that relates to citizen mobility.

5. **Health and human services.** The essential human services for the provision of health care, education and social services.

6. **Water and wastewater.** The infrastructure responsible for water – from collection to distribution, to use and finally reuse and recycling. Pipes, distribution centers, catchment areas, treatment facilities, pump stations, plants and even the water meters at private homes are all essential components of this responsibility. Water purity and cleanliness are also addressed here.

7. **Public safety.** The infrastructure, agencies and personnel to keep citizens safe. Examples include police and fire departments, emergency and disaster prevention and management agencies, courts and corrections facilities.

8. **Payments.** Payments link a payer and a payee and refer to all the key contributors involved: merchants, consumers, businesses, banks, payment instruments providers, payment schemes. Payments sit at the heart of the economic activity in cities and form the core component of every economic flow including salaries, consumer spending, business procurement and taxes. They have become so systematic that they often go unnoticed.

Figure 2.2

Smart city enablers

Smart cities can radically improve all of the responsibilities through the power of ICT (information and communications technology). ICT can make buildings more efficient, water more affordable, transportation quicker and neighborhoods safer. In the Readiness Guide, we refer to these transformative technologies and capabilities as *enablers*.

They put the "smart" in smart cities. The seven technology enablers are listed below.

1. Instrumentation and control is how a smart city monitors and controls conditions. Instrumentation provides the eyes and ears of a smart city. Examples include smart meters for electricity, water and gas; air quality sensors; closed circuit TV and video monitors and roadway sensors. Control systems provide remote management capabilities. Examples include switches, breakers and other devices that let operators control from afar.

2. Connectivity is how the smart city's devices communicate with each other and with the control center. Connectivity ensures that data gets from where it is collected to where it is analyzed and used. Examples include citywide WiFi networks, RF mesh networks and cellular networks. (Note: When a cellular network communicates with devices, the Readiness Guide refers to it as connectivity. When it lets people communicate, the Guide uses the term telecommunications. These are arbitrary distinctions used only in the Guide to make it easier to distinguish between the two sides of communications – devices and people.)

3. Interoperability ensures that products and services from disparate providers can exchange information and work together seamlessly. Interoperability has many benefits. For one, it prevents the city from being "locked in" to just one proprietary supplier. For another, it gives the city more choice, since it can buy from any company that supports the city's chosen standards. For another, it lets the city build projects over time in phases, with confidence that all the pieces will work together in the end.

4. Security and privacy are technologies, policies and practices that safeguard data, privacy and physical assets. Examples include the publishing of clear privacy rules and the implementation of a cybersecurity system. Security and privacy play a critical role in enabling smart cities because they build trust with people. Without trust, a city may have difficulty adopting new technologies and practices.

5. Data management is the process of storing, protecting and processing data while guaranteeing its accuracy, accessibility, reliability and timeliness. Data is king in a smart city. Proper management is essential to maintain data integrity and value. A citywide data management, transparency and sharing policy – including proper policies around access, authentication and authorization – is one step toward proper data management, as explained below.

6. Computing resources include 1) the computer "brains" themselves, 2) storage of data and 3) special capabilities needed for smart cities. A geographic information system (GIS) is the most essential special capability, since it allows the smart city to know where everything is located. But it's worth noting that GIS is only as helpful as the data cities provide to it. All three computing resources are increasingly supplied via the "cloud" – remote servers connected to the Internet. Cities have options for deploying cloud services, including public, private and hybrid models.

7. Analytics create value from the data that instrumentation provides. Examples include: forecasting crime the way we already forecast weather; analyzing electric power usage to know when and where to expand; analyzing conditions to predict which equipment needs repair; automatically plotting the best route for a mass transit user, and creating personalized portals for every citizen by analyzing what they value most. And analytics that utilize data from across departments have tremendous potential to identify new insights and unique solutions to delivering services, thereby improving outcomes.

The role of dependencies in smart city planning

In the previous chapter we explored the dangers and pitfalls of siloed cities. Cities that don't coordinate their various departments at the technology planning level often end up with redundant investments in technologies, training and even personnel.

But there's an even deeper connection between smart city responsibilities that can't be overlooked. That's the matter of dependences. Since so many city systems, services and infrastructures are connected in one way or another, becoming smart in one area is often dependent on progress being made in another.

As cities develop long-term goals and plans, it is important to consider how desired improvements to the performance of a single responsibility may require improvements in a responsibility on which there is a dependency. For example, cities cannot expect to foster a healthy population if water systems cannot ensure water quality. Yet water systems rely heavily on energy systems to pump and move water through city infrastructure. So, as you plan projects to improve water infrastructure, be sure to examine any requirements that need to be addressed by electrical systems and the distribution grid. Think holistically to avoid having to make major system changes or unanticipated course corrections further into your smart city planning.

As you move through the chapters in this Guide, we will highlight dependencies that merit consideration. You'll come to realize that understanding dependencies is another reason to bring cross-departmental teams together early in your smart city planning process.

> ***The role of dependencies.*** *A healthy population is dependent in part on quality drinking water which, in turn, is dependent on energy systems that pump the water. Thinking holistically early in the smart city planning process will help avoid unexpected roadblocks later.*
>
> ***Figure 2.3***

LIVING PlanIT BUILT SMART FROM THE GROUND UP

Council member Cisco is one of the high-tech companies partnering with the government of Portugal to invent and build a state-of-the-art smart city from the ground up. Located in the town of Paredes about two hours north of Lisbon, Portugal, the project is spearheaded by Portuguese company Living PlanIT. Situated on more than 4,000 acres, the community will take at least four years to complete at an estimated cost of $10 billion. It will eventually house about 225,000 people, many of whom will work for Living PlanIT's technology partners at new research and commercialization centers.

The city is designed as a living laboratory for new technologies. Data collection sensors will be added to virtually everything, from refrigerators to trash containers to traffic lights. Those sensors will monitor every aspect of urban life, including traffic flow, energy consumption, water use, waste processing, even the temperature of individual rooms. All these sensors will be connected to Living PlanIT's Urban OS (UOS), a middleware platform that is embedded in the fabric of buildings and infrastructure.

> ***A consortium led by the Living PlanIT company is creating a smart city from the ground up in northern Portugal.*** *Data collection sensors will be added to virtually everything, from refrigerators to trash containers to traffic lights.*

Figure 2.4

Developing an intelligent city platform. *The city's digital control system will accommodate an expanding list of applications, from managing electricity demand to routing traffic to finding a parking spot, to name just a few.*

Figure 2.5

UOS will integrate with the Microsoft Devices & Services Platform to enable city governments to deliver a comprehensive set of services. Cisco is acting as the master planner for information technology and communications design and architecture. Cisco is also building a cutting-edge data center at an estimated cost of $38 million.

The city's digital control system will accommodate an expanding list of applications, from managing electricity demand to routing traffic to finding a parking spot, to name just a few. In the event of a fire, for instance, sensors can pinpoint the location, alert people nearby, notify the fire station and manage the traffic lights so fire engines can reach the building as quickly as possible.

Or the control system might notice that the interior of a building is getting too hot. With its knowledge of the outside temperature plus the building's equipment and orientation, it could relay a command to darken the smart glass on the building's sunward side to reduce the sun's warming effect.

The consortium hopes to ultimately create a platform to enable a new generation of intelligent cities. "Software has transformed industries – medicine, education, science, finance, manufacturing," explains Steve Lewis, Living PlanIT's co-founder and CEO. "And software will transform our cities to achieve their economic, social and environmental potential."

The Readiness Guide structure

The Readiness Guide is comprised of multiple chapters. One chapter examines "universal" principles – enablers common to all responsibilities. The chapters that follow detail how individual city responsibilities – power, transportation, public safety, payments, etc. – should use the technology enablers. Two final chapters cover how to translate the Guide's theories into a roadmap.

Each chapter has three sections. The first section envisions what each responsibility could look like by the year 2030. The second section examines the benefits that arise from each target. Targets are goals – end points or outcomes a city should work toward. A third section provides a checklist of the relevant targets for that responsibility. You can use these checklists (and the summary checklist in the final chapter) to create a "wish list" that can inform and improve your smart city roadmap.

Scattered throughout are brief examples to show how cities are applying these theories in real life.

What this guide does NOT do. We've talked about what the Guide wants to do, but it's also important to acknowledge the things that are outside its scope.

The Guide does NOT suggest what your city's overall goals should be. Smart city technologies are a means to an end. Every city should decide for itself what ends it hopes to achieve. But whatever you're after, the targets described in this guide represent the best technical foundation for pursuing those goals.

The Guide does NOT propose which responsibilities should be prioritized. Every city has its own unique strengths and weaknesses, its own unique history and resources, its own unique preferences and aspirations. Some cities may choose to tackle transportation first, for instance, while others may feel that energy is more urgent.

The Guide does NOT pretend that its targets are set in stone. Change is continuous, and technology advances are famously unpredictable. The targets shown here are the best recommendations we can make today, as informed by a large contingent of the world's top experts. They will put cities on the right path, but cities will still need to make periodic evaluations and course corrections as technology evolves.

Figure 2.6

Roadmapping is how a city translates the theories of the Readiness Guide into a plan of action.

MALTA: WHY NOT A SMART ISLAND?

Located in the heart of the Mediterranean and known for its stable economy and pro-business government, Malta is a group of small islands 50 miles to the south of Sicily. Home to roughly 400,000 people, it has the highest population density in Europe, putting a genuine strain on power, gas, waste management and other essential services.

In 2008, the national energy and water providers partnered with Smart Cities Council members IBM, Itron and other suppliers to gradually roll out smart meters for all electric and water customers. The utilities are saving money by not employing meter readers. What's more, the metering data is integrated into new back-office applications for billing. It is also used for analytics that locate problems and determine when and whether to expand the grid.

So far, results have been very successful. For instance, the new smart water grid has increased theft detection, while also introducing new pricing options for customers that reward conservation.

With those smart grids in place, Malta has the foundational elements for a smart island. And the government is taking things even further in one corner. It is transforming an industrial park into a state-of-the-art information technology and media city. The goal of SmartCity Malta is to put everything a high-tech company needs to succeed in one place, including state-of-the-art ICT infrastructure along with a host of IT, media and production services.

> ***The world's first smart island.*** *Thanks to its smart water and electricity networks, Malta is the world's first smart island. It is also the home of SmartCity Malta (shown here), a cutting edge development designed to attract high-tech industry.*

Figure 2.7

Conclusion

As you review the chapters that follow, you can use the checklists at the end of each one to note where your city is currently weak or strong. Once you've completed those assessments, you can transfer them to the summary checklist in the final chapter, Ideas to Action. With that summary in place, you'll be ready to build your smart city roadmap, using the tips and techniques provided in that last chapter.

The mission of the Smart Cities Council Readiness Guide is to set you on the path to becoming a city of the future – a smart city with enhanced livability, workability and sustainability. It will take patience to march through each chapter to compile your own "wish list" of essential features. And it will take leadership to build those features into a comprehensive smart city plan that has the support of the public.

But amazing advantages await those cities that make the effort. Their citizens will have a healthier, happier place to live along with better, higher-paying jobs. And all of that in a sustainable fashion that doesn't rob from the next generation.

Figure 2.8

CHAPTER 3

UNIVERSAL ASPECTS OF A SMART CITY

Some of today's greatest cities benefitted from visionaries who – centuries ago – saw possibilities for civic betterment and made it happen. A compelling example comes from leaders back in the 1800s. Way before the phrase "urban sprawl" had entered our psyche, they committed to preserving vast amounts of open spaces for public use. Think of Hyde Park in London, Central Park jutting through Manhattan or Ueno Park in Tokyo. They are all testaments to leaders "thinking outside the box" a very long time ago.

Fast-forward a couple of centuries. It's your turn to make that same kind of lasting impact on your city. This chapter will help get you started. In many ways, it is the most important chapter in the Guide because it lays out the universal principles that should underlie every city responsibility, from water to power to public safety and all the rest. Get these right and you've set up your city for decades of success.

This chapter includes 17 goals — we call them "targets" — that will propel you down the smart city path. We refer to these 17 as "universal targets" because each of them applies to every city responsibility.

Here's an example: One of the targets is to use analytics to achieve full situational awareness. That means giving system operators a real-time, big-picture view of what's going on so they can spot problems early and act quickly to mitigate them. An example might be an accident that has a major thoroughfare blocked. Knowing about the accident in real time gives transit operators a chance to reroute buses.

But that situational awareness also has great value to public safety, to water, to energy, to... well, to virtually every city responsibility, hence their inclusion in this universal chapter. (In later chapters, you'll read about targets that apply only to specific responsibilities – energy or transportation, for instance).

Before we drill down on the 17 universal targets, a quick refresher on key terms:

- **ICT** — information and communications technologies. The blanket term for the devices, software and communications that make cities smart.
- **Instrumentation** – the devices used to collect data about city conditions. Examples include smart meters, occupancy sensors, temperature sensors, light detectors, pressure sensors and many more.
- **Responsibilities** – the everyday essential functions and services a city provides such as water, public safety, transportation, etc.
- **Enablers** – to enable is "to give power, means, competence or ability." By that token, enablers are the individual ICT components that allow city responsibilities to get smart. Examples include computing resources, data analytics and similar functionalities.
- **Targets** – goals for smart city efforts. A series of objectives that, taken together, form the foundation of an ICT-enabled smart city.

Before we go further, let's take a look at some of the amazing benefits that your citizens will gain once you start checking off the smart city targets recommended in this Guide.

> ***City visionaries.***
> *Thanks to the work of visionary planners in the 1800s, Hyde Park remains a popular gathering spot in the middle of urban London.*
>
> ***Figure 3.1***

Benefits of realizing the universal targets

We've talked about the hurdles cities face on their smart city journey and how realizing targets will require commitment, planning and execution. *Now let's talk about the rewards!*

Because the 17 universal targets described here apply to every responsibility, the benefits highlighted below are also citywide in their application. We've organized the benefits by our three core smart city objectives – enhanced livability, workability and sustainability.

Livability will mean different things to different people because we all define quality of life in different ways. Yet the smart city benefits highlighted below have the potential to help everyone:

Revolutionizing people's relationship with their government. By providing instant, electronic access to the information people need, the services they require, and the interaction they want with officials, cities build citizen trust and satisfaction.

Improving city service by sharing data. Many of the most exciting city applications come from sharing data between departments. Or, in a similar fashion, by sharing data with outside developers who can innovate new applications. For instance, cities including Amsterdam, London, Philadelphia and San Francisco have instituted "Open Data" programs. They have resulted in hundreds of innovative applications, including trip planners, parking spot finders, bus locators, crime reporting and alerts, and business planning tools, to name just a few.

Enabling real-time alerts and real-time monitoring. Health and public safety are improved when citizens are alerted to fires, floods, air-quality issues, public disturbances, pipeline leaks, downed electricity lines, chemical spills, snowstorms and snow plows, metro lines, bus locations, etc.

Creating citywide situational awareness. When you are able to fully visualize your city's traffic, energy, gas and water networks, you can best ensure reliability and resiliency of those essential services.

Protecting personal privacy. People have a right to and great desire for privacy and that issue will certainly crop up when you start marching down the smart city path. The Guide's universal principles include recommendations on privacy.

> ***Revolutionizing people's relationship with their government.*** *By providing instant, electronic access to the information people need, when and where they need it, cities build new trust with their citizens.*

Figure 3.2

Workability means accelerated economic development.

Creating world-class infrastructure. Businesses weight the efficiency and reliability of city infrastructures when they make their investments. They have many options. Why locate in city A, when nearby city B has a more efficient transportation network, a more reliable and cost-effective energy grid, or a more advanced law enforcement program? Cities that have optimized their infrastructures are more attractive investment locations.

Protecting business from cybercrime. Hacking and theft are serious risks to businesses. A 2012 study reported that incidents of cybercrime doubled over the last three years, while their financial impact rose by 40%. Enforcing cybersecurity as described in this Guide will help city government achieve safety and resiliency, and create trust for companies contemplating a move to your city.

Unleashing innovation. Cities that free up their data via Open Data or similar programs will unleash the power of people on their data sets and benefit from new ideas. Data is a valuable and profitable resource that can fuel innovation and invention, thereby creating new businesses, revenue streams and jobs.

Creating a "recruiting tool" for attracting talent and jobs. Increasingly mobile businesses and professionals are attracted to cities that have a strong, compelling vision for a better future.

Supporting skills development. According to a 2012 study, despite the relatively high unemployment rate in the United States, 49% of employers reported having difficulty in filling science, technology, engineering and mathematics (STEM) jobs. City-supported skill development can be an enormous draw to businesses looking for specialized talent.

Sustainability is how smart cities provide necessary and desirable services in a way that doesn't deplete resources.

Reducing resource use through optimization. The optimization gains from analytics and improved planning mean that cities, their businesses and their residents consume fewer resources. By harnessing the power of ICT, smart cities can curb the theft of resources and deliver a better future for generations to come.

Enabling a broad selection of technology choices. Cities that pursue interoperability in their smart technology investments will save money by being able to pick from the widest variety of solutions possible.

Creating world-class infrastructure.
Cities that have optimized their infrastructures – transportation, energy, etc.– will be more attractive to businesses.

Figure 3.3

Reducing duplication of effort. When smart city efforts are confined to departmental silos, functions are needlessly repeated. This unnecessary duplication may range from market research to community outreach to technical design to security planning to staff training to procurement processes to designing user interfaces and much more. Agreeing in advance on universal principles takes care of these things once, for use in all departments.

Reducing costs through infrastructure sharing. Some early smart city efforts have overlooked the potential to share costs. Here are just a few of the elements that can often be purchased or designed just once and reused many times: geographical information systems (GIS); communications networks; cybersecurity designs and implementations; database management systems; enterprise service buses; workforce and field crew management architecure, and operations centers. Additionally, in some cases costs can be reduced by partnering with private sector providers (operators) who have already deployed networks and services.

Reducing costs by re-using software modules. By realizing the targets in this Guide, cities can construct their applications in a way that creates a collaborative and secure environment, makes it easy to share code modules between different applications, minimizing expensive programming.

Increasing economies of scale. By agreeing on universal standards and specifications, cities can often lower their purchasing costs while increasing interoperability. Otherwise, each city department makes its own small, slightly different order with diminished bargaining power.

Embedding best practices. By way of example, consider something as crucial as cybersecurity. Now suppose that every department is responsible on its own for researching, planning and implementing that security. It's not hard to recognize that some departments will not have the skills and resources to do the best possible job. By contrast, if the city adopts a universal security framework, it can be assured that the individual departmental implementations will be state-of-the-art.

Enabling better financial forecasting. Financial forecasting is an important discipline and it can be greatly enhanced with the help of the data flowing from smart cities. Combining and correlating growth projections, depreciation and historic operating patterns can improve cities' 5-, 10- and 20-year plans. And by monitoring key performance indicators, cities can measure their progress and their return on investment.

Squeezing the maximum value from city assets. Electronically monitoring the actual condition of assets at every moment helps predict when they will need maintenance in time to prevent breakdowns. With device management and asset optimization, cities will save money while still ensuring the reliability of their technology deployments.

Using computer simulations to plan with great precision. Thanks to computer modeling and simulations, cities can test assumptions, try different scenarios and make mistakes in the simulations instead of costly mistakes in real life. Many experts predict that smart city technologies will change the very nature of planning – from a once-in-a-decade activity based on estimates to an ongoing process based upon real-time data.

How to use this chapter (and the ones that follow)

The goal of the Readiness Guide is to help you make two key decisions: 1) where you want to end up and 2) where you should start.

This chapter and those that follow will help you with the first issue. They suggest the targets at which you should aim. Your only job is to review those targets and determine a) whether they apply to your city and b) how far along you are already.

When it comes to which ones apply, we are biased – we think every target in this Guide is essential to the long-term success of a smart city. Not to be overly dramatic, but you ignore these targets – especially the universal targets – at your own peril.

The universal targets are highlighted on the checklist you'll see on the next page (and again at the end of the chapter). Each target is explained in detail on the pages that follow. When it comes to how far along you are, you can use the column at the far right of the checklist to record your estimate. You'll use that estimate of progress in the final chapter, Ideas to Action, where you will set your priorities.

Universal targets. *Knowing where you are strong and weak will help you choose where to point your smart city efforts first.*

Figure 3.4

Knowing where you are strong and weak will help you choose where to point your smart city efforts first.

You don't have to over-think the process. Nor do you have to become an expert in every target. When you have gone through all the chapters and completed the consolidated target list in the final chapter, you will be handing it to specialists to build detailed project plans. You can count on their expertise for the details.

A few large cities will hand their target list to in-house staff. But most cities will use outside experts. Either way, your job is to hand those experts your "wish list" – your prioritized target list. That list will tell them, in general terms, where you want to start and where you want to end up.

So don't feel overwhelmed as you read through the targets. Your job is not to solve all of these issues. That's where the experts come in. Your job is to know which issues need a solution and to decide which issues to tackle first.

If you have further questions about targets and checklists, reach out to the Smart Cities Council via the website or the contact information in the appendix.

And now, on to the universal targets. As you read through each one, jump to a checklist to record your assessment of your city's progress. After completing this chapter and the ones that follow, use the summary checklist in the final chapter to combine your results into one document.

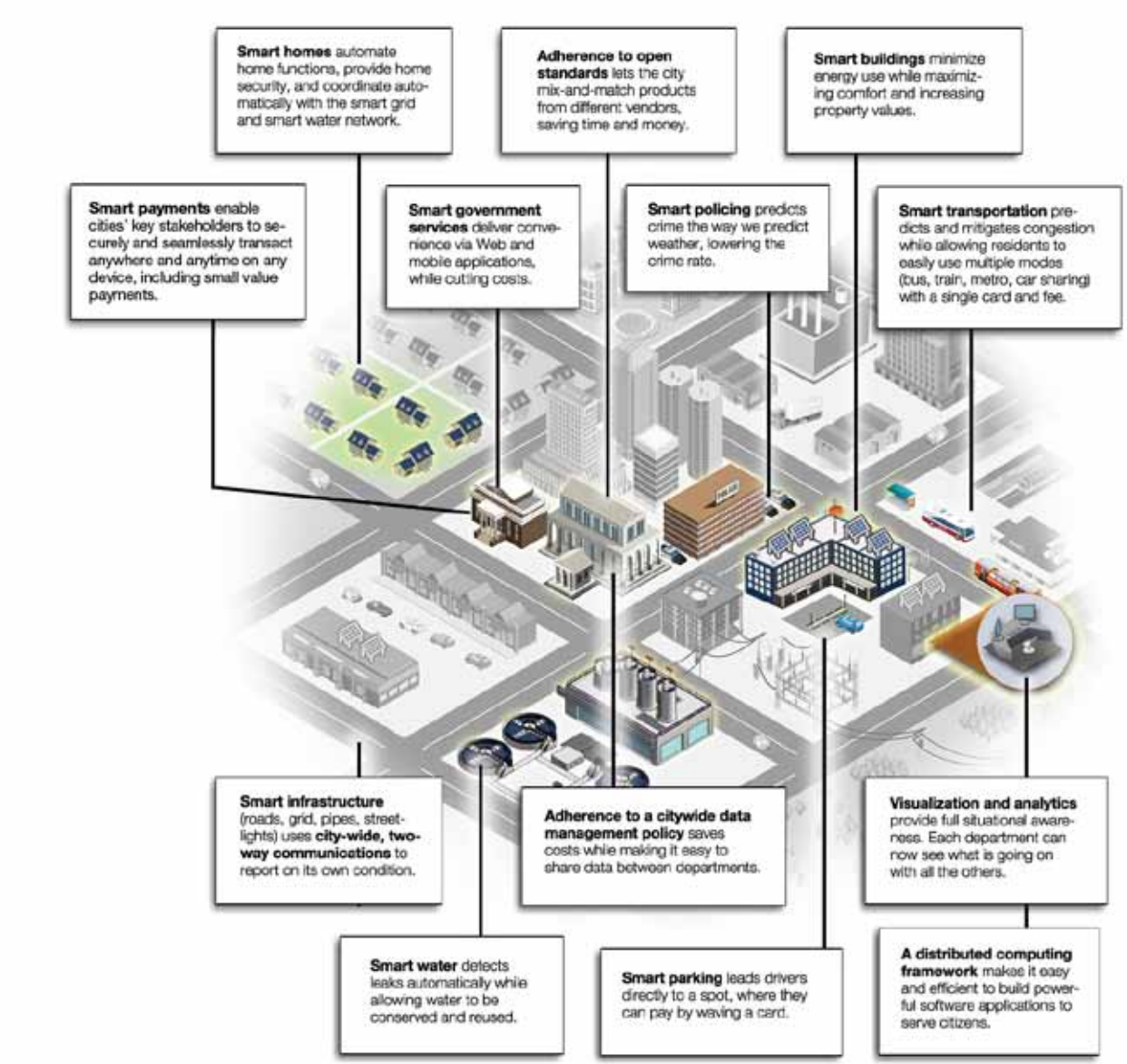
UNIVERSAL TARGETS

TECHNOLOGY

Enabler	Universal Targets How smart cities deploy and use ICT to enhance livability, workability and sustainability	Implementation Progress None Partial Over 50% Complete
Instrumentation & Control	Implement optimal instrumentation	
Connectivity	Connect devices with citywide, multi-service communications	
Interoperability	Adhere to open standards Use open integration architectures and loosely coupled interfaces Prioritize use of legacy investments	
Security & Privacy	Publish privacy rules Create a security framework Implement cybersecurity	
Data Management	Create a citywide data management, transparency and sharing policy	
Computing Resources	Consider a cloud computing framework Use an open innovation platform Have access to a central GIS Have access to comprehensive device management	
Analytics	Achieve full situational awareness Achieve operational optimization Achieve asset optimization Pursue predictive analytics	

Figure 3.5

UNIVERSAL



Action items.
Cities that achieve the universal targets described in this chapter gain a wide variety of powerful benefits.

Figure 3.6

Instrumentation and control

Instrumentation is the bedrock of smart cities. It provides the key source of data that allows a city to make informed decisions on how to reduce costs and allocate funding. In energy, instrumentation may mean smart meters that measure energy flow. In transportation it may mean embedded devices in roads and highways that measure traffic.

Implement optimal instrumentation. The purpose of this target is two-fold. 1) We use instrumentation to gather information about city conditions. 2) We use control devices to take action remotely — for instance, to throw a switch or open a valve. Becoming smart is all about having the right data to work with to make better decisions. So the overarching goal is ***optimal*** instrumentation and control.

Optimal is the key word here. The ideal smart city will have exactly the devices it needs, exactly where needed. In many responsibility areas, optimal may mean a device at every end point. In water, for instance, it may mean a smart water meter at every customer premise. In other cases, it may mean a sensor "every so often" – as frequently as needed to generate enough data to provide a full picture of what's going on.

Three issues are worth mentioning as they apply to instrumentation; these three will be addressed in more detail later in the chapter:

1. **Privacy and security** — Given the amount of data generated, cities must be absolutely vigilant about respecting privacy and implementing security.

2. **Legacy devices** — Your city may already have lots of data available without the need for additional instrumentation immediately. For instance, anonymous cell phone GPS data can tell you where people are, or how fast they are moving on roadways. Key intersections may already have traffic sensors. Streetlights may already detect ambient light. Water, power or gas utilities may already have smart meters. You may decide to add additional sensors – especially now that prices are plummeting – but it's often possible to get started with the data you are getting already.

3. **Connectivity** — In smart cities, instrumentation needs to be connectible. Having sensors that need to be checked manually is not optimal – for instance, you wouldn't want to have to send a technician to every water pump in your city.

> ***Implement optimal instrumentation.***
> *Optimal instrumentation is what creates the data critical to a smart city.*
>
> ***Figure 3.7***

Implementing optimal instrumentation creates the data critical to a smart city. It is also the first step in connecting city infrastructure to the "Internet of Things," which is described next in the connectivity discussion.

Optimal instrumentation:

HOW SMART WASTEWATER MANAGEMENT SAVED AN INDIANA CITY MILLIONS

South Bend, Indiana had a serious problem: wastewater spilling into the St. Joseph River and welling up in basements. The city's wastewater pipes and treatment facilities just couldn't handle the volume.

The city was looking at an estimate of $120 million for a daunting infrastructure upgrade. Instead, it entered a public-private partnership with Notre Dame University, local tech company Emnet and Smart Cities Council member IBM to come up with a new way to monitor and control its wastewater collection system. The new approach cost the city 1/20th of the initial estimate – a much more budget-friendly $6 million.

The integration of IBM technology with smart valves and sensors from business partner EmNet helped the city to be proactive in its wastewater management, avoiding additional infrastructure investments while improving public health. Meanwhile, Notre Dame students came up with innovative apps to allow residents to report flooding, social media tools that collect information on water systems and more. As a result, the technology and research made it possible to automate what had been manual and labor-intensive data collection.

With the new system in place, the city is now able to monitor and actively control its wastewater collection system, which has helped cut down on sewer back-ups and overflows.

> ***Implementation and control.***
> *An innovative, affordable solution for South Bend's maxed out wastewater system uses smart sensors (instrumentation) plus smart valves (control) plus smart software from Council member IBM.*
>
> ***Figure 3.8***

Connectivity

Take a moment to consider the incredible ways technology has changed our lives in the last four decades – microprocessors, ATMs, the World Wide Web, email, Google maps, smartphones and iPads to name a few. Clearly we've been on a connectivity roll for a while. And it's not going to stop. Today we are entering the Internet of Things (IoT) era where people talk to devices and devices talk to each other. This helps explains why connectivity is such a robust smart city enabler, and why machine-to-machine communications is all the buzz these days.

Connect devices with citywide, multi-service communications. Above we discussed gathering data through optimal instrumentation. Once those instruments are generating information, they need to be connected so they can communicate to provide data, as well as be able to receive orders.

The target, therefore, is to connect all devices to a citywide communications system. In rare cases, cities use a single communications network for all device connectivity. In most cases, cities use a variety of communications channels, including cellular, fiber, WiFi, powerline and RF mesh.

But it's not enough to have just any communications system. It's critical to have systems that are reliable and secure, based on open standards, high data rates and able to offer real-time communications to those devices that need it.

Most cities will have multiple communications systems, because no single network can realistically support every single application now and into the future. To save costs, cities ought to give strong consideration to the following approaches:

- **Minimize the number of networks supported at city expense.** To the extent that the city or its utilities need their own private networks, they should try to establish multi-purpose networks rather than a collection of single-purpose communications networks.
- **Investigate the viability of existing public networks** before building your own private network. For instance, existing cellular networks have the capacity to support smart grids, smart traffic management and smart water networks.
- **Encourage cross-departmental planning and design** to learn whether multiple departments can share a single network.
- **Investigate policies and incentives that encourage the private sector** to invest in building and maintaining citywide networks.
- **Prioritize technologies and tools that can manage "hybrid" (mixed) networks.** Tools exist that can merge different communications technologies, even old analog technologies such as radio.

Connecting instrumentation and control devices allows a city to feed data into analytical programs that greatly improve outcomes, minimize resource use and save money, as we will cover in detail later.

Connect devices. *Multi-service communications systems can carry messages for multiple applications from multiple sources.*

Figure 3.9

Citywide communications:

ONE NETWORK RUNS THREE METERS — WATER, HEAT, GAS

Smart Cities Council member Itron deployed water, heat and gas meters, a wireless fixed network and software for Sino-Singapore Tianjin Eco-City in Tianjin, China. It is China's only unified platform that manages water, heat and gas data together under one system.

The network allows the city to achieve its vision of energy and water resource conservation by providing actionable data such as high accuracy readings and reading rates, automatic meter reading and graphical data analysis to educate residents about their energy and water usage.

Sino-Singapore Tianjin Eco-City is a flagship government-to-government project between Singapore and China. Established in 2007, it is built on the vision of being "a thriving city which is socially harmonious, environmentally-friendly and resource-efficient." When completed in 2020, it is estimated to have approximately 350,000 residents.

> ***Minimize the number of networks.*** *The comprehensive solution that Itron deployed in Tianjin, China measures, collects and analyzes data from water, heat and gas meters, using a single communications system.*

Figure 3.10

Interoperability

Interoperability ensures the technologies you deploy work well together. There are three interoperability targets:

Adhere to open standards. If you hope to achieve your smart city goals, different technologies from different vendors must be able to work together. In particular, they must be able to exchange information. Adhering to standards helps to guarantee that the products you buy can use predefined mechanisms to talk to each other.

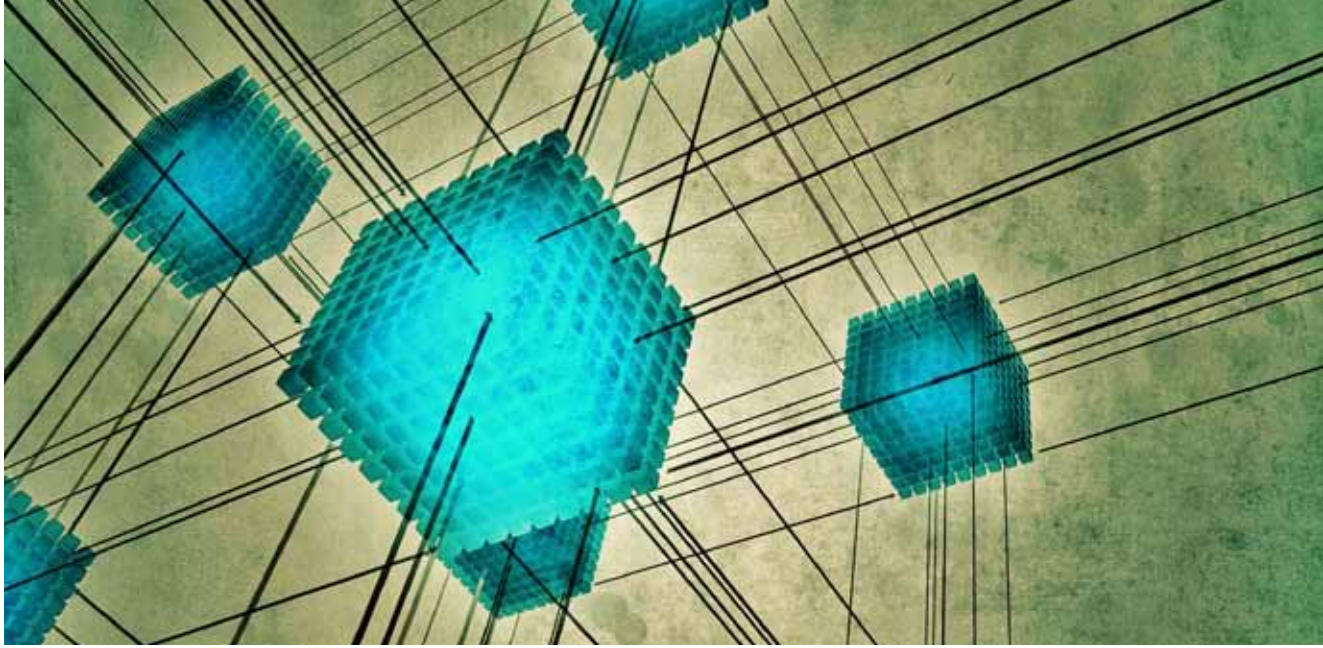


Figure 3.11

And you don't want just any standards, you want "open" standards – standards that have been defined by an industry group and published for all to use. This contrasts with "proprietary" standards, which typically come from a single vendor who retains control over who can use them and when they will change.

Open standards help cities control both their expenses and their risk. They allow cities to mix and match products from different vendors without jeopardizing the ability to exchange data. Put another way, open standards contribute to interoperability, choice and flexibility. They also make maintenance easier, because there are communities of specialists trained in published standards, such as those from Council advisors the International Electrotechnical Commission (IEC), the Institute of Electrical and Electronics Engineers (IEEE), the International Telecommunication Union (ITU), the American National Standards Institute (ANSI) and many others including 3GPP for 3G/4G and the WiFi Alliance.

Although open standards are absolutely essential to the long-term success of a smart city, putting them into practice can be challenging. There are hundreds if not thousands of standards that apply to one aspect or another of urban life. The best advice is to leave the heavy lifting to the experts. When you get to the project planning phase (as described in the final chapter), select suppliers with a public, proven commitment to open standards. Give them the task of selecting the best ones to use, subject to the oversight of your project manager or systems integrator.

When it comes to the smart grid portion, there is happily some good news. The IEC has undertaken the job of creating a free Smart Grid Standards Mapping Tool that makes it far easier to discover and choose between standards. Using either a diagram or a list, you can drill down to a specific aspect, then see a list of all the standards that relate. The IEC lists not just its own standards, but those from other organizations as well.

Use open integration architectures and loosely coupled interfaces to facilitate sharing of data and reuse of code. This gets a bit technical, but the important thing to understand is that you can build your applications in a way that makes it easy to reuse code "modules," saving time and expense. Systems that are "loosely coupled" don't have components that are dependent on each other, theoretically making it easier to swap them in and out. Open integration architectures are enhanced by methodologies such as service-oriented architecture (SOA) and enterprise service bus (ESB). Benefits include:

- **Faster software implementations** because they can be assembled in part from previously written modules
- **More robust implementations** because the city can have standardized tools and best practices
- **Greater scalability** because the loose coupling that is part of an open integration architecture allows for high availability, fault tolerance and load balancing — techniques that allow systems to deal with huge amounts of data
- **Easier changes** because you alter only the affected module(s), not the entire application, and because changing one module has minimal impact on the rest of the system

OPEN INTEGRATION ARCHITECTURE SYSTEM

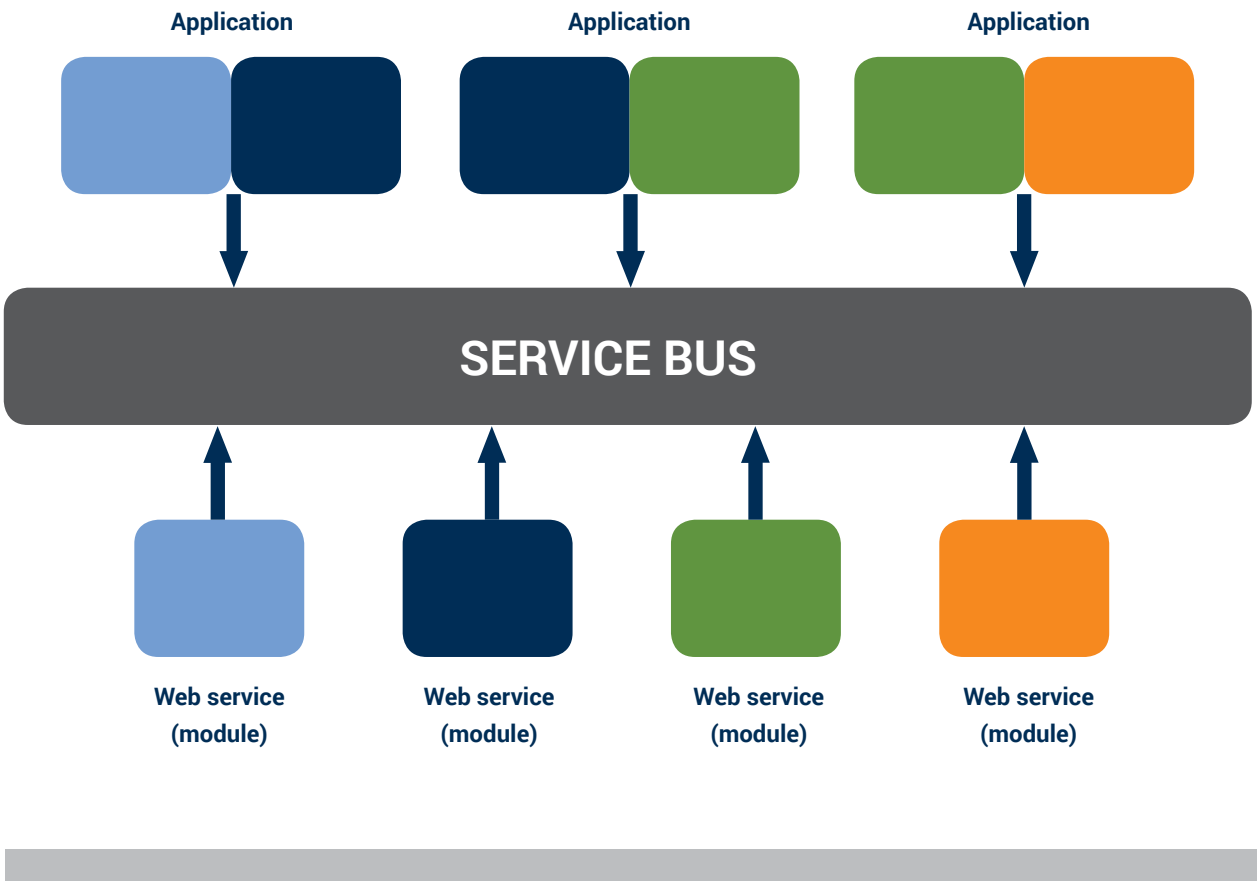
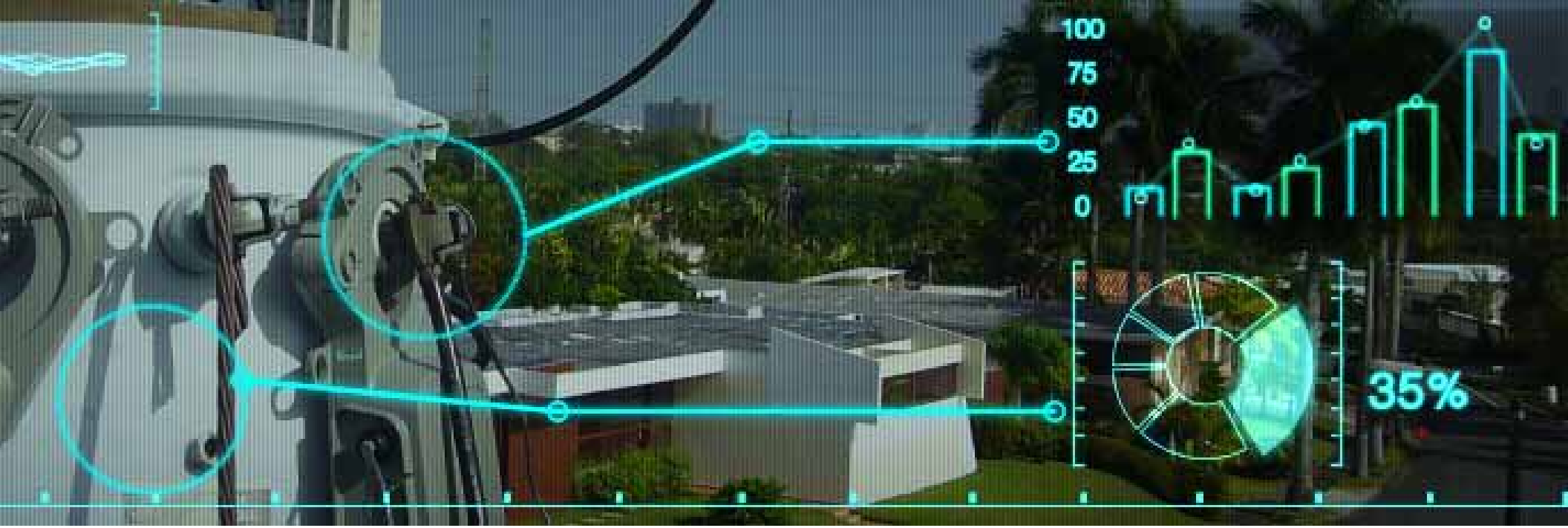


Figure 3.12



Prioritize legacy investments. No city can afford to rip out its current infrastructure and replace everything from scratch. Priority must go to making the most of existing investments. Typically, that means retrofitting existing assets — streets, buildings, equipment — with sensors and communications.

Fortunately, a wave of new, low-cost technologies makes it possible to connect legacy assets. In the area of emergency response, it is now possible to integrate old, analog radios with state-of-the-art IP-based communications, stitching them together into a seamless network. Likewise, a city government can often find ways to continue using old software by sending its data to new software modules that add value on top. Likewise, an electric power utility doesn't have to replace its old transformers, it can simply add transformer monitors to report on their conditions.

> ***Prioritize legacy investments.*** *Council member Grid20/20, produces an inexpensive monitor that can be attached to existing transformers to collect important information about their conditions. In similar fashion, many legacy assets and investments can be connected to the smart city.*

Figure 3.13

Security and privacy

One of the greatest challenges for smart city leaders is to reassure residents that their rights will be respected and their data protected. This section highlights three important targets that address those issues.

Publish privacy rules. Make it a priority to produce clear privacy policies that are easily accessible. The rules should balance residents' desire for privacy and control with the ability to gain access to data to provide better services. They should stipulate:

- **Which data sets** are owned by which stakeholders
- **What rights and protections** are afforded by ownership
- **Which data sets are private** (requiring authorization prior to sharing)
- **Which data sets can be shared** with the city or authorized third parties
- **How data can be shared** if defined protocols for making information anonymous are followed

Publishing privacy rules can save time, money and headaches. It can also unleash innovation. Entrepreneurs are more comfortable building new products and services if they know the rules in advance and they know those rules will apply equally to their competition.

It's one thing to have privacy rules. It's another to ensure that residents and businessses know about them — and yet another to actively enforce them in collaboration with national and state/province level authorities.

A 2013 column in the Boston Globe titled "The Too-Smart City" garnered a lot of attention. It took a "big brother is watching" slant on the smart cities movement: "A city tracking its citizens, even for helpful reasons, encroaches on the personal liberty we count on in public spaces."

Cities and cultures will have different priorities for privacy. There are several sources of guidance on privacy rules that cities may want to review. As you will see, you don't need to invent your privacy guidelines from scratch. There are several sources of helpful examples, including:

* European Union Privacy Directive
* Electronic Privacy Information Center (EPIC)
* International Association of Privacy Professionals
* Criminal Justice Information Services
* Federal Information Processing Standard
* Office of the Information and Privacy Commissioner of Ontario, Canada

Figure 3.14

Publish privacy rules:

CALIFORNIA UTILITY TAKES LESSONS FROM CANADA FOR ITS PRIVACY FRAMEWORK

The city of San Diego, California's municipal utility in 2012 launched a Privacy by Design smart grid initiative in conjunction with Ontario, Canada Privacy Commissioner Ann Cavoukian, a recognized champion of consumer privacy safeguards.

"Our cross-border partnership with SDG&E follows similar successful alliances forged with other organizations globally, as well as in my jurisdiction of Ontario, Canada, to build in Privacy by Design," said Cavoukian. "Privacy is a fundamental right of every energy customer, and I am very pleased to be working with SDG&E to ensure that our innovative privacy framework is an integral part of the smart grid deployment."

Developed by Dr. Cavoukian, Privacy by Design has been made an international standard, and is a practical solution for ensuring privacy that can be designed into the ever-growing and systemic efforts of ICT, and of large-scale networked data systems, as the default condition.

> ***Publish privacy rules.*** *Cities can turn to several established systems to get started. For instance, the Privacy by Design system, originally developed in Ontario, Canada, is based on seven fundamental principles.*

Figure 3.15

The 7 Foundational Principles

1. Proactive not Reactive; Preventative not Remedial

The Privacy by Design (PbD) approach is characterized by proactive rather than reactive measures. It anticipates and prevents privacy invasive events before they happen. PbD does not wait for privacy risks to materialize, nor does it offer remedies for resolving privacy infractions once they have occurred — it aims to prevent them from occurring. In short, Privacy by Design comes before-the-fact, not after.

2. Privacy as the Default Setting

We can all be certain of one thing — the default rules! Privacy by Design seeks to deliver the maximum degree of privacy by ensuring that personal data are automatically protected in any given IT system or business practice. If an individual does nothing, their privacy still remains intact. No action is required on the part of the individual to protect their privacy — it is built into the system, by default.

3. Privacy Embedded into Design

Privacy by Design is embedded into the design and architecture of IT systems and business practices. It is not bolted on as an add-on, after the fact. The result is that privacy becomes an essential component of the core functionality being delivered. Privacy is integral to the system, without diminishing functionality.

4. Full Functionality — Positive-Sum, not Zero-Sum

Privacy by Design seeks to accommodate all legitimate interests and objectives in a positive-sum "win-win" manner, not through a dated, zero-sum approach, where unnecessary trade-offs are made. Privacy by Design avoids the pretense of false dichotomies, such as privacy vs. security, demonstrating that it is possible to have both.

5. End-to-End Security — Full Lifecycle Protection

Privacy by Design, having been embedded into the system prior to the first element of information being collected, extends securely throughout the entire lifecycle of the data involved — strong security measures are essential to privacy, from start to finish. This ensures that all data are securely retained, and then securely destroyed at the end of the process, in a timely fashion. Thus, Privacy by Design ensures cradle to grave, secure lifecycle management of information, end-to-end.

6. Visibility and Transparency — Keep Open

Privacy by Design seeks to assure all stakeholders that whatever the business practice or technology involved, it is in fact, operating according to the stated promises and objectives, subject to independent verification. Its component parts and operations remain visible and transparent, to users and providers alike. Remember, trust but verify.

7. Respect for User Privacy — Keep it User-Centric

Above all, Privacy by Design requires architects and operators to keep the interests of the individual uppermost by offering such measures as strong privacy defaults, appropriate notice, and empowering user-friendly options. Keep it user-centric.

Create a citywide security policy that continually assesses risks. Privacy is freedom from public scrutiny. Security is freedom from danger and for that a city needs a rigorous, citywide security policy. That policy should encompass data, devices and communications systems at minimum. Smart cities generate a lot of data. They also connect critical infrastructure to the Internet. Those actions create many benefits, but they also create new threats. It's best not to leave it to each individual department to come up with a security plan. Instead, implement and enforce best practices citywide.

A security policy should use a risk management framework that continually assesses vulnerabilities. Risk management is the identification, assessment and prioritization of risks combined with a plan to minimize their impacts. Risk management continues throughout the technology lifecycle and drives the evolution of security protocols and practices.

A smart city's risk management framework must be comprehensive, encompassing the cybersecurity as well as the physical security of all assets — from massive infrastructure to tiny mobile devices. The framework should encompass not just the necessary technical steps, but also a thorough program of education and training. (Many famous security breaches were launched with the help of "social engineering" to convince a naive person to take a step that made the system vulnerable.)

Risk management cannot avoid all risk, but it can minimize adverse effects. It lessens unwelcome surprises, assists in correct prioritization and reassures residents. A security framework is a combination of well-defined policies, procedures, standards and guidelines that provide consistency citywide. It also promotes a proactive approach to security, identifying and mitigating threats ***before*** they occur.

> ***Create a citywide security policy that continually assesses risks.*** *It's important to remember that (like privacy) security requirements specified during the design phase must be continually updated to counter new threats and to ensure they remain in compliance.*

Figure 3.16

Create a citywide security policy:

HOW JACKSONVILLE MADE ITS VIRTUAL ENVIRONMENT MORE SECURE

Jacksonville is the 14th largest city in North Carolina and home to more than 70,000 residents. Jacksonville's Information Technology Services (ITS) department provides citywide support for all computer, phone, security and geographic information systems through its operations center for over 500 end users.

As the city's workers became more and more dependent on the ITS department, Jacksonville's IT director Earl Bunting along with other city officials, decided it was time to refresh the department's infrastructure to ensure it remained fully functional at all times. It also wanted to give employees access to needed materials, but in a secure fashion.

Jacksonville decided to upgrade to a Virtualization Experience Infrastructure (VXI) from Council member Cisco, which supports Jacksonville's operations centers. The approach goes beyond traditional virtual desktops to deliver next-generation virtual workspaces by unifying virtual desktops, voice and video.

While Jacksonville citizens and employees have seen a number of benefits from the upgrade, the solution has also helped Jacksonville's virtual environment become more secure. "Our IT department no longer has to waste time monitoring for threats," says Bunting. "VXI has made our environment increasingly secure and protected us from the growing number of online threats that comes with such a large number of users."

> ***Create a citywide security policy that continually assesses risks.***
> *Upgrading its ICT infrastructure provided many benefits for Jacksonville, North Carolina, including better protection from the growing number of online threats.*
>
> ***Figure 3.17***

Data management

The streams of data that smart cities collect create enormous opportunities, but also require special handling. Smart cities treat public data as a citywide asset. That data needs to be accessible to other systems and stakeholders including, where possible, the research community to help ensure that the analytic environment is always current. Citizens, of course, will expect full access to their own data. These requirements demand a citywide policy.

As we move forward, city data will be used by multiple applications from multiple departments. And it may be used by outside developers as the foundation for useful services to benefit residents. An error in master data can cause errors in all the applications that use it. In a similar fashion, an error in releasing data to those not authorized can cause a cascade of problems.

One more time for emphasis: ***A smart city's most precious resource is the data it produces.*** Do not squander and endanger that valuable commodity by failing to carefully define a thorough data policy, as explained below.

Create a citywide data management, transparency and sharing policy. Ideally, cities should build a master plan and an information data model that spells out how data is governed, stored and made accessible. Best practices call for a clear governance directive that a) establishes the chain of authority and control over data assets and b) spells out who makes access decisions and who determines accountability. The citywide data management policy defines a city information model for all entities and assets that preserves relationships, attributes and behaviors.

This citywide policy should cover both private and public data and ensure that data from each department is made available to others. It must also align with the policies in the security and privacy targets discussed previously. It is important for data to be stored on secure, reliable and scalable systems long enough to enable the dependable pattern analysis and reliable forecasting explained in the analytics target later in this Guide.

A citywide data management plan will increase the city's agility (ability to quickly build new applications as needed) and accuracy (by ensuring everyone is working with correct data). It can also lower costs by reducing errors and eliminating unnecessary duplication. A citywide plan also makes it much easier to enforce privacy, security and best practices.

> ***Create a citywide data management, transparency and sharing policy.***
> *The policy should cover both private and public data and ensure that data from each department is made available to others.*
>
> ***Figure 3.18***

Computing resources

Keeping up with ever-advancing computing technologies in an era of budget constraints can put city leaders between the proverbial rock and hard place. But smart cities find a way – and sometimes find the more advanced solution is more budget-friendly too. Even so, there is a right way and a wrong way to pursue your computing objectives, as you'll discover in reading about the four targets in this section.

Consider a cloud computing framework. There are many ways to deploy computers, but most cities should consider cloud computing first. It is the computing framework best equipped to deliver efficiency and optimization.

Cloud computing is the practice of using a network of remote servers to store, manage and process data. Typically those servers are accessed via the Internet. Please note that cloud computing can be delivered as a service from a third party – sometimes called "hosted solutions" or "software-as-a-service" (SaaS). Or it can be built and operated by a city using the same architectural principles as third-party providers.

Cloud computing provides a common, shared foundation across departments and across different computer systems. Consider these attributes:

- **Identity services** for consistent and secure single sign-on
- **Virtualization** for seamless application portability. Virtualization is the creation of a virtual (rather than actual) version of something, such as an operating system. A single server can run as multiple "virtual" computers with different operating systems, for instance.
- **Management functions** for full visibility and control
- **Scalability** to support millions of data collection points
- **Industry-standard frameworks** and languages for writing applications

Applications and services reside in the cloud, where they are accessible from any device. Additionally, those applications and services are typically built with an event-triggered enterprise service bus architecture that provides a structured method for combining loosely coupled software components. As we discussed earlier in the interoperability target, this approach makes it easy to share data and reuse software code between departments.

The benefits of cloud computing are many:

- **Growth** – It becomes easier to add computing power in small increments
- **Power** – It's typically less costly and simpler to scale up computing services
- **Reliability** – If one computer crashes, others can easily pick up the slack
- **Cost** – It becomes possible to mix and match hardware from different vendors, increasing choice and thus driving down expenditures. In addition, many third-party providers will "rent" software to cities for a monthly charge, with little or no upfront cost.
- **Advanced features** – Smaller cities can gain the same functionality as their larger cousins by tapping into cloud offerings from third parties. The provider sells the service to many different customers, allowing it to enjoy economies of scale that make it possible to create advanced features. Smaller cities would never be able to afford the large ICT staff and server farm required to host such applications on their own.

Cloud computing may not be an immediate option for every city. Cities that have already made large investments in other approaches may settle on a hybrid computing model. And cities in geographies with a cultural emphasis on centralization may prefer a centralized computing model.

Consider cloud computing:

BARCELONA REALIZES VISION OF INNOVATIVE CITY GOVERNANCE WITH CLOUD, DEVICES AND APPS

Barcelona, Spain has a global reputation for innovation. Many of the technological solutions that the city has adopted in recent years are at the leading edge of city management.

Council member Microsoft is a close partner in this effort. It has helped the city drive new services for citizens and visitors and create and support new technology-based companies and entrepreneurs, while also enabling the city government to reduce costs through new cloud computing services and devices.

In 2011, Barcelona began to use Windows Azure cloud-based services to make information available to citizens, which could be easily accessed over the Internet.

The main driver for adoption of a public cloud was better management of the public data that is collected by the city's municipal operations and recordkeeping practices.

In addition to storing data in the cloud for others to analyze, the Barcelona City Council is harnessing the opportunities that city data presents through Big Data and analytics solutions. Having gained confidence in the scalability and security features of Windows Azure, the City Council embarked on an Open Data initiative intended to standardize digital formats and streamline data analysis.

The ultimate goal of the initiative is to promote economic growth by encouraging data sharing between city government and the private sector.

> ***Consider cloud computing.*** *Barcelona has utilized the power of the Microsoft Windows Azure cloud -based platform to help businesses be more productive and to draw more visitors to the city.*

Figure 3.19

- **Establish an open innovation platform - Open Data.** Today's Open Data movement represents one of the most powerful opportunities cities have to connect with citizens in meaningful, life-impacting ways. The move to make public data freely accessible to anyone who wants to use it for legitimate purposes has been referred to as "the big bang" for all of the Big Data that cities are amassing today. U.S. President Barack Obama characterizes Open Data as "the new default for government information."

However you label it, by making raw public information easy to access, you allow city employees, utilities, citizens and third-party developers to create innovative applications and services for the benefit of the city and its residents.

Most of this information has been collected at taxpayer expense. And most of it is available to the public in theory. Until recently, however, it could not be accessed in a useful way. (You can't build a data-based application if you have to go city hall and pull it out of paper files.)

New York City has been one of several leaders in the Open Data movement. In September 2013, officials there announced that since the launch of its Open Data portal in 2011, the city has opened up more than 1,100 data sets from over 60 agencies. These data sets total more than 600 million rows and have received more than 2.8 million views. NYC also announced a city-wide plan to unlock all of its public data by 2018.

NYC, of course, is not alone. Government agencies around the world are embracing Open Data, providing dozens if not hundreds of applications that take advantage of city data. These applications range from:

- **Transit planning apps** that show the best way to travel
- **Crime reporting apps** that show trouble spots
- **Street monitoring apps** that pinpoint potholes and problems
- **Mapping apps** for first responders
- **Location apps** that show where to find ATMs, hotspots, day care centers, urgent care centers, government offices, parks, meeting spaces, etc.

Clearly Open Data and similar innovation platforms can improve public services in countless ways. It can also make government agencies more accountable, generate new revenue streams and help to stimulate economic growth.

Crime reporting apps. *Amber Alerts, shown here on a Windows phone, alert the public about missing children and where to call if they have useful information.*

Figure 3.20

But cities often confront stumbling blocks on the road to an Open Data environment. Two that may be most challenging:

1. Governance and privacy issues. Who owns the data, who controls it, what safeguards are in place to protect personal information when a city decides to open its data for public consumption? Open Data policies must be clarified in the broader data management, transparency and sharing policy discussed earlier.

2. Non-standard data formats. Rather than spending taxpayer dollars to reinvent the wheel in every city, one of the promises of Open Data is the ability to share apps between cities. But that requires cities to use the same data schema, which is often not the case. However there is an initiative underway involving seven major U.S. cities – Boston, Chicago, Los Angeles, New York City, Philadelphia, San Francisco and Seattle – to create a database of standardized Open Data applications.

Fortunately, help is at hand for cities that want to join the Open Data movement, as you'll read in the adjacent sidebar.

> ***Establish an open innovation platform.*** *Data.gov showcases examples of cities and developers working together to improve the lives of city residents.*

Figure 3.21

OPEN DATA: HOW TO GET STARTED

There's no single path to an Open Data initiative, but most cities will want to take these three steps:

Create a team of Open Data advocates: You'll want a team that includes personnel from a number of departments, including but not limited to: IT, communications/media and managers from departments with data sets with citizen appeal – for example, public safety, transit, public health. Perhaps most important is to have executive-level representation on the team – the city manager or mayor, for instance.

Develop an Open Data policy: First, develop an Open Data policy that is included in and consistent with the city's broader data management, transparency and sharing policy. Second, create an Open Data policy roadmap that outlines your goals, which data sets you will start with (this can be expanded once you've tried a few pilots), where and how you will make them available (a new web portal, on your existing city website, etc.) and what needs to get done by when and by whom. Third, smart city planners should emphasize the

importance of open software interfaces and open data encodings, preferably open interfaces and encodings that implement freely usable global interface and encoding standards. These enable technical interoperability between diverse systems, which enables Open Data policies to work.

Choose your first project: Typically the safest approach is to choose a relatively small, low-cost pilot project to get some experience, work out any problems and get a success under your belt. You may want to take the approach that other cities have found successful and reach out to your local developer community via contests and hackathons. They'll likely have ideas about which data sets would make useful apps. Another route is to analyze what kinds of information is most requested by members of the public.

Useful Open Data resources

There are many, many places to turn for ideas and inspiration on Open Data initiatives. We'll highlight a few here and link other sources below.

City Forward is a free, web-based platform that enables users – city officials, researchers, academics and interested citizens worldwide – to view and interact with publicly available city data about cities and metropolitan areas around the world. On the site, which is a philanthropic donation of services and technology from Council member IBM, users can search for data by city, subject or source. It's a good resource for viewing the kinds of data other municipalities have made available to the public.

Code for America (CfA), described as a "Peace Corps for geeks" by Jennifer Pahlka who founded it in 2009, runs a fellowship program designed to leverage technology and government data to make cities run better. Among the apps developed by CfA's fellows are Boston's adopt-a-hydrant app and Honolulu's tsunami warning app.

Data-Smart City Solutions – an initiative by the Ash Center at Harvard Kennedy School and powered by Bloomberg Philanthropies – features news and trends in civic data. It's a helpful resource if you want to see what other cities are doing with Open Data.

Data.gov showcases examples of cities and developers working together to improve the lives of city residents.

You may also want to visit:

- The Open Data Foundation
- World Bank's Data page
- Open Data Commons

Freeing London's data.
The London Datastore was established in 2010 by the Greater London Authority (GLA) with the goal of "freeing London's data" so the world at large could use it as they saw fit. Some people see Open Data as part and parcel with the move to greater transparency. The idea is that information collected at public expense should be available to all, except where release would infringe privacy or commercial confidentiality. But the success of London's experiment shows that it is also a way to garner a long list of useful applications for government, for business and for everyday citizens, usually at zero expense to the city.

Figure 3.22

Establish an Open Data platform:

HOW EDMONTON REDUCES CONSTRUCTION SEASON ANGST

Street construction projects are a big deal for businesses in the area where the construction is occurring, for citizens who need to get from Point A to Point B in a timely fashion and for neighborhood residents who must endure the noise.

Edmonton, Canada enjoys a very short period of warm weather when all construction projects seem to take place, thus at any given point during this time, the number of active projects is quite large. As Smart Cities Council member Center for Technology in Government (CTG) put it, "Edmonton is known for its two seasons: Winter and Road Construction. It makes perfect sense that one of its flagship Open Data initiatives would involve releasing street construction data."

And that's what Edmonton did. The city website presents construction project information using both static and interactive maps. The interactive map allows users to click on a blue dot and bring up a description of the project at that location. A local developer also took the information and created a mobile app for smartphones.

As a result of the new tools, CTG reports use of the data set has increased substantially. From its launch in April 2012, monthly views increased to over 1,200, then declined gradually to less than 250 by mid-October, when the construction season was largely over. As of October 2012 there had been just short of 11,000 views, over 300 downloads of the data, and links to the site had been embedded over 7,800 times.

> ***Establish an Open Data platform.*** *The construction season in Edmonton, Canada, is short and intense. An Open Data initiative has helped citizens cope with the disruptions.*
>
> ***Figure 3.23***

Have access to a central GIS.
The Houston, Texas public works department GIS is available online. The rendering above shows water main locations. Having a GIS that maps all of a city's assets and location information is a big contributor to what makes a smart city smart.

Figure 3.24

Have access to a central GIS. A geographic information system (GIS) that maps all of the city's assets and location information is a big contributor to what makes a smart city smart. Most cities will want to implement a single, central GIS system so that data from one department (traffic alerts, for instance) can be shared with others (such as emergency responders). Some cities even share the cost of GIS services with outside organizations, such as utilties and phone companies.

GIS is tailor-made for smart cities. To name just a few of the great applications of this technology, cities can use GIS to:

- **Map crime data** to aid their public safety work
- **Locate pipes, pumps, cables** and other assets to help better monitor and analyze the efficacy of their water infrastructure
- **Maximize traffic flow** and share helpful traffic maps with the public
- **Conduct better environmental impact assessments** for their buildings and parks

There are also many benefits to cities with GIS:

- **Spatial decision-making** is greatly improved
- **Efficiency gains** accrue through more intelligent maintenance scheduling and delivery routes
- **Improved accuracy of essential records** such as property boundaries and locations of key assets
- **Resiliency** is boosted through improved situational awareness in times of stress

Everything in a city has a location. In a smart city, location information is being used and produced for countless purposes by countless different systems. Cities need to encourage use of open standards that provide seamless

communication of geographic information between different systems. Open interface and encoding standards prevent vendor lock-in and enable systems of many kinds to share all types of geographic information. Most GISs implement open encoding and interface standards that enable them to "talk to" other GISs as well as diverse mobile devices, emergency response systems, smart grids, sensor webs, smart vehicles and more.

Application developers discover countless opportunities for innovation when cities provide access to 3D urban models, address data, elevation data, zoning, bus routes etc. via encodings and interfaces that implement open standards.

Have access to comprehensive network and device management. Eventually cities could have hundreds of thousands or even millions of small devices connected to their networks. That's a lot of devices! Smart cities (or their suppliers) will need a robust device management platform that handles tasks such as device detection and registration, device configuration, device connection and disconnection, device security, device troubleshooting and device updates and upgrades. Such a platform is able to support virtually any kind of device, and it can span multiple communications networks.

Being able to manage devices remotely and with computer assistance offers significant benefits. Among them:

- **Cities can save time,** improve their infrastructure security and quickly and easily implement any necessary software upgrades
- **Cost savings accrue** to cities through the central management of their devices
- **It is easier to enforce consistency** and compliance with the city's data management, security and privacy policies

> ***Have access to comprehensive network and device management.*** *Cities can save time, improve security and easily and quickly upgrade software via device management.*

Figure 3.25

Analytics

We don't want to diminish the importance of the other enablers. But truth be told, analytics is a ***super enabler.*** Analytics takes massive quantities of data and turns it into actionable intelligence that enhances livability, workability and sustainability in very direct ways. In this section we'll cover three targets that let cities tap into the full power of analytics.

Achieve full situational awareness. Gain full knowledge of what is going on throughout the city.

This situational awareness can be delivered in many ways. From "dashboards" to visualizations to command and control centers and to alerts delivered to computers or phones. The exact method of delivery depends on the unique circumstances of your city.

In most cities, this kind of awareness doesn't happen today. If you consider systems such as energy, water, traffic, policing and emergency response, you'll recognize that today's operators are often "flying blind." They may know general parameters, but they don't know precisely what is going on at every point throughout the system. One example is an electric utility that has not yet deployed smart meters or other sensing technologies across the electric grid. If power is out in a neighborhood, the utility may not know it until a customer calls in. Same story with transit operators, who may not get a heads-up that a bus has been disabled in an accident until the driver has a chance to make a call.

Giving operators full situational awareness has a long list of benefits. One is safety – for instance, we don't want police officers or firefighters sent into danger without a full picture of what they're getting into. A second is reliability and resiliency – for instance, utility workers can restore outages much more quickly if they aren't waiting for someone to call in and report them. And third is efficiency – a full picture of the entire system makes it much easier to make the correct choices and trade-offs. Additionally, operating budgets, staff and shift requirements can be reduced through mobile and remote monitoring and control technologies.

Achieve full situational awareness. *Having a full picture of an entire city system makes it much easier to make the correct choices and trade-offs.*

Figure 3.26

Achieve operational optimization. *Smart cities combine data from sensors and subsystems with computing power to determine the best path forward.*

Figure 3.27

Achieve operational optimization. Taking steps to arrive at the best decisions (including financial decisions) for the overall system.

A simple definition is "the process of making something as good as possible." It implies balancing tradeoffs to achieve the best results. Today, infrastructure and system optimization – if it occurs at all – happens without the ability to truly see the big picture. But in the smart city of tomorrow, optimization will have data from many sensors and subsystems plus the computer power to analyze all of that input to find the best path forward.

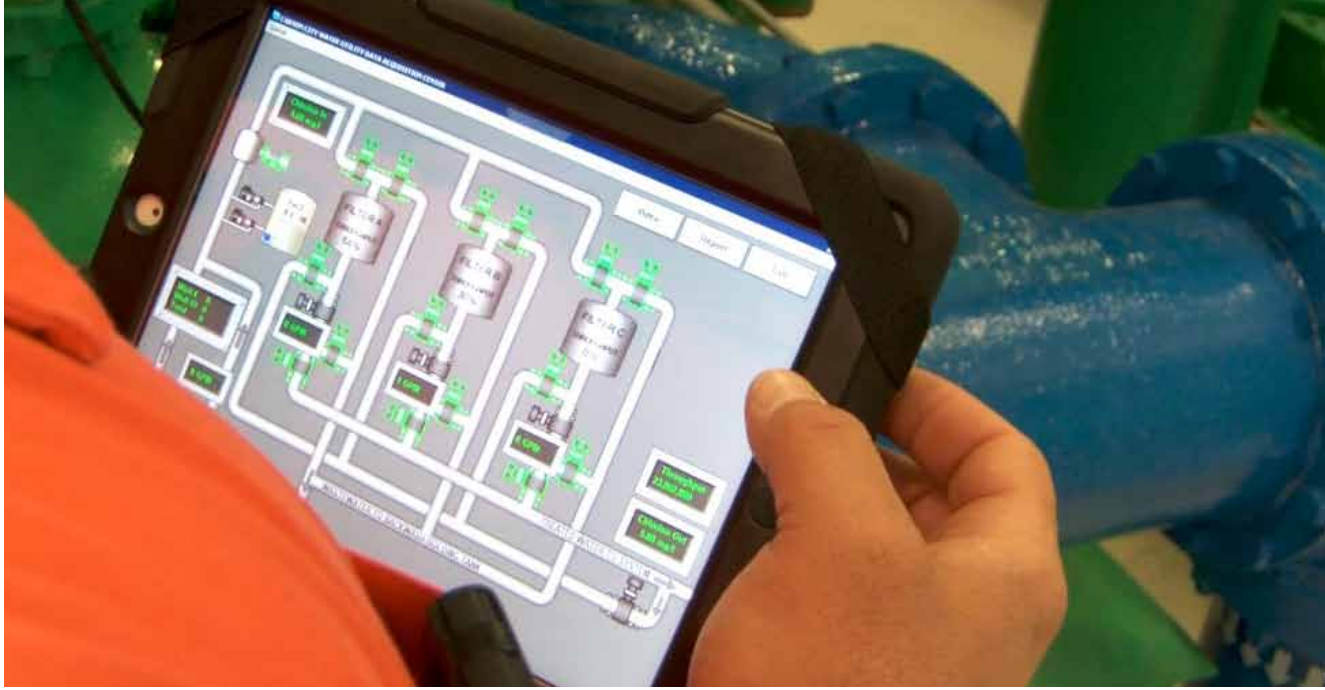
As you can see, infrastructure and system operational optimization offers many benefits. For instance, in energy and water scenarios it:

- Provides for the efficient generation, distribution, consumption and reporting of resources, both in the aggregate and at the individual business/citizen level
- Strikes an optimal balance between asset and citizen needs and health
- Enables the application of learning in the continuous maintenance, tuning and commissioning of assets

Bottom line, operational optimization delivers cost saving, resource saving and better outcomes to cities and people.

Achieve operational optimization:

A SMART CITY AT THE FOOT OF THE SIERRA NEVADA MOUNTAINS



Carson City is the capital of the state of Nevada. Its Public Works Department is responsible for taking care of the city's water, wastewater, transportation, landfill, fleet, environmental and renewable power systems. In order to achieve its goals, the department created an infrastructure revolving around the capabilities of its people and technology from Council member Invensys.

Carson City has created a totally integrated management system that controls the city's water and wastewater system. The solution also includes management of the department's solar plants that provide up to 748,000 kWh of clean power annually. The department even maintains the city's traffic lights. "What we've created here is a smarter Carson City. One with a complete solution that involves the Wonderware® System Platform running the Wonderware mobile reporting application with SmartGlance on virtual machines. The solution provides our team with communications over wireless platforms that include both standard and mobile monitoring and control," says James Jacklett, Electrical/Signal Supervisor at Carson City Public Works Department.

The ability of the department's engineers and operators to use mobile devices to control the water, wastewater, energy and transportation systems has allowed Carson City to become more efficient by making sure that people are always on the move. The solution provides management with instant access to key performance indicators and critical process information right on their mobile devices. Leveraging virtualization, tablets and smartphones to increase the efficiency of its operators and management has resulted in increased situational awareness, a higher level of operational readiness and a 15% reduction in man hours.

> ***Achieve operational optimization.*** *Carson City Public Works officials say leveraging virtualization, tablets and smartphones to increase the efficiency of its operators and management has resulted in a higher level of operational readiness.*
>
> ***Figure 3.28***

Achieve asset optimization. Smart cities gain the maximum lifetime value from all of their assets by applying advanced analytics to the data gathered from their instrumentation. In other words, city assets – roads, power poles, transformers, pumps and so on – are equipped with sensors and instrumentation that report their condition. Then asset management systems can analyze that data to optimize asset performance and maximize their lifetime value.

Even a medium-sized city can save tens of millions of dollars over time through asset optimization. For instance, a city can service its buses based on their actual condition not on a guess or an average or fixed schedule – sometimes referred to as "condition-based" or "predictive" maintenance.

Likewise, a city can replace or upgrade only the equipment that actually needs it, whether water pumps or bridges. Doing that extends the useful life of assets that may be past their design life on paper but are still performing well in real life.

Good asset management systems can also determine the "criticality" of an asset, so the city can accurately prioritize which assets need attention first because of the impact their failure would have on the system as a whole.

Pursue predictive analytics. As we've said, smart cities can pull data pieces together to analyze what is happening in real time and make operational decisions. But the value of that data doesn't end there. Through predictive analytics cities can get a glimpse of what's going to happen next – from where crime is most likely to occur to where streetlights are going to fail to where traffic congestion will stall the morning commute.

With predictive analytics you can uncover patterns and associations you might not discover as quickly otherwise. Schools, for instance, might use analytics to identify patterns in dropout rates and then which students are at-risk and which retention strategies might prove effective.

Here's another example: Data scientists at the U.S. Department of Energy's Pacific Northwest National Laboratory, a Council member, have created a social media analysis tool capable of analyzing billions of tweets and other social media messages in just seconds. The idea is to discover patterns and make sense of the data and ultimately to surface useful information that can enhance public safety and health. An increasing number of messages on social media about social unrest could provide early warning that can help authorities protect citizens from riots or other disturbances.

> ***Pursue predictive analytics.***
> *Cities can get more from the data they collect through predictive analytics, which predict what is likely to happen next.*
>
> ***Figure 3.29***

ADDITIONAL RESOURCES

Target: Use open integration architectures

Arkansas integrates 30 systems for better social and healthcare delivery

The Arkansas Department of Human Services is using a service-oriented architecture to integrate 30 different systems, a first step toward modernizing the way it delivers social and healthcare services to residents. Using advanced technologies from Council member IBM's smart cities portfolio, the goal is to transform an IT infrastructure that is composed of more than 30 discrete system silos in an aging architecture.

Target: Consider cloud computing

How the cloud helps a South Korean port city diversify its economy

Busan is South Korea's second largest city and the fifth-largest container-handling port in the world, but it wants to find ways to attract new types of industries by building a desirable workforce. It turned to Council member Cisco to develop a cloud-based platform designed to spur innovation and economic growth.

Target: Achieve operational optimization

City of Charlotte facilitates tourism planning processes with event permitting solution

When news broke that the 2012 Democratic National Convention would be held in Charlotte, North Carolina, the city knew immediately that it was time to replace its manual processes for event permitting with software. The city chose a cloud-based solution from Council member Microsoft that automates event request and back-end approval workflows, offers detailed reporting, and enables mobile workforce management of event evaluations and approvals.

Target: Achieve asset optimization

Boston pilots asset management platform to keep the street lights on

The city of Boston maintains over 60,000 street lights that keep residential streets and main thoroughfares appropriately lit. At any given time, roughly three percent of these lights are out, with their bulbs needing to be replaced or wiring needing to be fixed. Leveraging the Maximo solution from Council member IBM, Boston's Public Works Department is piloting a new asset management platform with predictive analytics capabilities to better coordinate street light repair and maintenance.

Enhance workability

Buenos Aires launches initiative to support investors, generate jobs

Buenos Aires, Argentina, officials created a new department dedicated to working with businesses that want to locate or relocate in the city. To support the department's operations, the city worked with Microsoft partner Accendo to deploy a custom solution based on the Microsoft platform. With this solution, the department has streamlined processes, reducing the time needed for a project to meet formal requirements by more than 65%, and created a more transparent working environment.

UNIVERSAL TARGETS

TECHNOLOGY

Enabler	Universal Targets How smart cities deploy and use ICT to enhance livability, workability and sustainability	Implementation Progress None Partial Over 50% Complete
Instrumentation & Control	Implement optimal instrumentation	
Connectivity	Connect devices with citywide, multi-service communications	
Interoperability	Adhere to open standards Use open integration architectures and loosely coupled interfaces Prioritize use of legacy investments	
Security & Privacy	Publish privacy rules Create a security framework Implement cybersecurity	
Data Management	Create a citywide data management, transparency and sharing policy	
Computing Resources	Consider a cloud computing framework Use an open innovation platform Have access to a central GIS Have access to comprehensive device management	
Analytics	Achieve full situational awareness Achieve operational optimization Achieve asset optimization Pursue predictive analytics	

Figure 3.30

CHAPTER 4

BUILT ENVIRONMENT

The built environment is an essential piece of the smart city puzzle. Buildings are the biggest single source of carbon emissions, accounting for about 40 percent of the world's carbon footprint, according to the World Business Council for Sustainable Development. Buildings are energy hogs too, eating up nearly half of all energy consumed in the United States. Any city serious about livability, workability and sustainability must raise the "intelligence quotient" of its built environment.

This chapter will give city leaders and planners the tools to make the built environment part of the solution. It begins by defining the terms and explaining how buildings interact with information and communications technologies (ICT). It turns next to the way smart buildings create benefits for a city. Finally, it lists the technology targets that allow a city to achieve those benefits. As we go along, we'll pause for brief case studies from around the world.

Key definitions

The term 'built environment' encompasses all human-made infrastructures. It refers to buildings, of course, but also to parks, stadiums and public spaces. However, three aspects of the built environment – streets, energy infrastructure and water infrastructure – are not emphasized here because they are addressed in separate chapters.

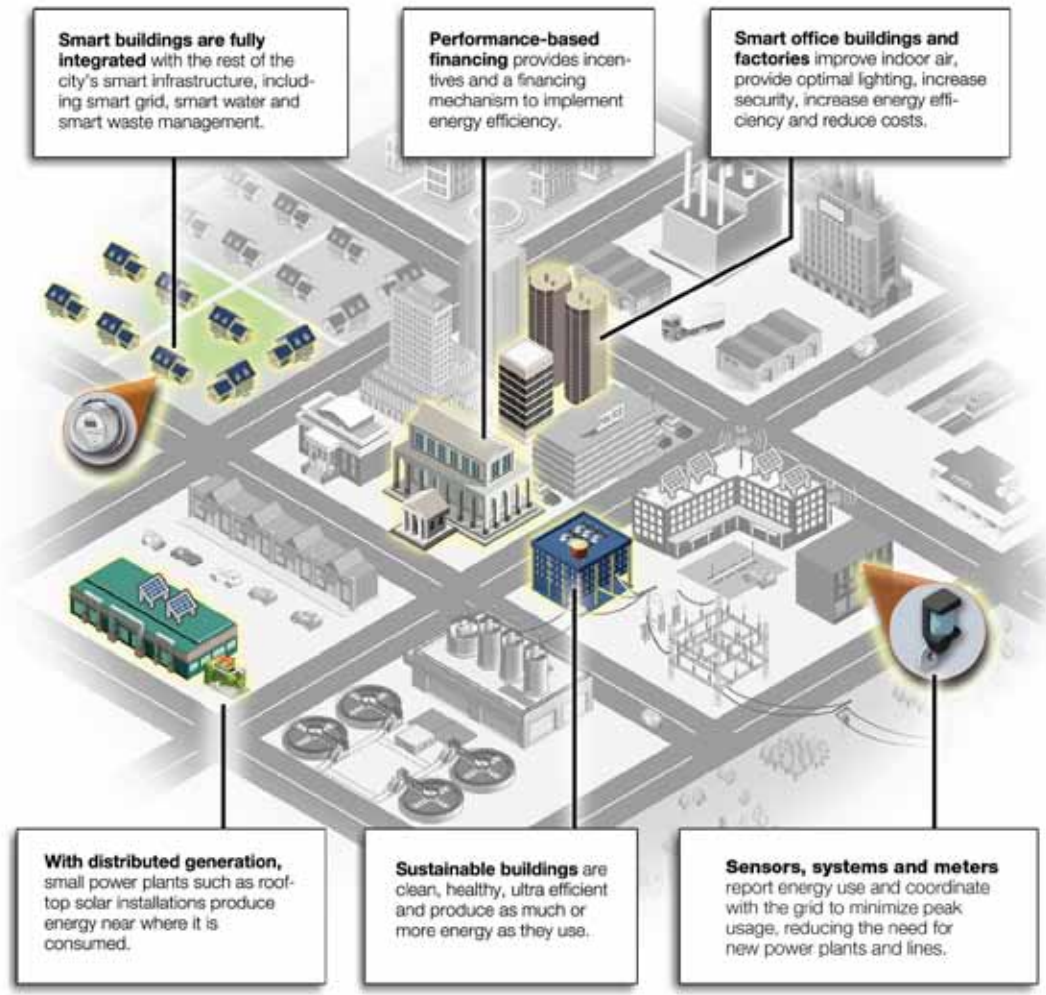
Buildings are a prominent part of every city, from private homes to offices, factories, stores, schools, hotels, restaurants and theaters. 'Smart buildings' is the common shorthand for structures empowered by ICT. Smart buildings use sensors, meters, systems and software to monitor and control a wide range of building functions – lighting, energy, water, HVAC, communications, video monitoring, intrusion detection, elevator monitoring and fire safety among them.

Why make buildings smarter? In its June 2013 Global Sustainability Perspective, real estate developer Jones Lang LaSalle put it this way: "Advances in smart building technology are enabling a new era in building energy efficiency and carbon footprint reduction, yielding a return on investment for building owners within one to two years. We can now perform real-time remote monitoring and control of entire portfolios of buildings, leading to dramatic improvements in building performance and meaningful energy savings."

> ***Built environment encompasses all human-made infrastructures.*** *Smart buildings use sensors, meters, systems and software to monitor and control a wide range of building functions – lighting, energy, water, HVAC, communications, video monitoring, intrusion detection, elevator monitoring and fire safety among them.*

Figure 4.1

SMART BUILT ENVIRONMENT



Making buildings smarter.
Smart buildings use sensors, meters, systems and software to monitor and control a wide range of building functions – lighting, energy, water, HVAC, communications, video monitoring, intrusion detection, elevator monitoring and fire safety among them.

Figure 4.2

Achieve operational optimization:

SUN LIFE STADIUM USES DATA ANALYTICS TO SCORE WITH FANS

Sports franchises everywhere are competing for eyeballs with big-screen HDTVs, all manner of mobile devices and other venues broadcasting games. So officials at Florida's Sun Life Stadium – home of the Miami Dolphins football team – considered ways to make the game-day experience for fans even better. They decided to borrow some smart cities technologies.

"The goal was to save our fans time by alleviating friction points, and on the monetary side, to enable a more efficient business that would lessen the need to raise ticket prices and provide the resources to invest in the future," explained Jim Rushton, the Chief Revenue Officer. "It was a clear mandate for a new way of doing business."

One solution the stadium settled on was using data analytics to optimize operations and traffic flow – long lines being one of the "friction points" Rushton mentioned.

Working with Smart Cities Council member IBM and leveraging the IBM Intelligent Operations Center, data is streamed in real time from stadium point-of-sale systems, turnstile scans at gates, weather feeds and other sources. The stadium's command center integrates all the data sources into a common control room console. The combination of real-time monitoring with business rules and intelligent controls enables stadium officials to optimize the operations and traffic flow.

> ***Achieve operational optimization.*** *Officials at Sun Life Stadium used smart city technologies to optimize operations and traffic flow. Among many other benefits, the effort has reduced long lines.*

Figure 4.3

The city-building connection

In most cities, the built environment is a patchwork of private and city-owned buildings. But even though a city government may own only a small fraction of the buildings, it can hold great sway over all buildings in its jurisdiction. For instance, it can:

Lead by example and ensure that its own buildings adhere to the targets explained in this chapter, unleashing the power of ICT in public buildings.

Create and enforce codes and standards that embody the changes it wants

Create incentives for owners to make their buildings smart

Educate residents through public awareness and outreach campaigns

Provide support and guidance by giving access to advice and trained staff via web, phone or in person

The methods cities adopt for driving change in built environments will vary, of course, but leaders pursuing a smart cities agenda will want smart buildings as an action item.

So what are the technology and best practices targets that enable a smarter built environment? This chapter will discuss how targets introduced in the Universal chapter apply to the built environment. But first, a quick look at dependencies in the built environment and then the benefits an intelligent built environment provides.

Dependencies within the built environment

Improvements in the built environment will need to be planned with an understanding of dependencies on other city systems and services. If we limit our dependency list to just three other systems for the sake of simplicity, it is easy to see that buildings rely on services from energy, communications and water systems.

The connection is pretty straightforward. Commercial, industrial and residential building systems alike all require electricity and/or natural gas. Building occupants require potable water and wastewater removal. And reliable communications are a requirement today for business and industry as well as residents.

Benefits of realizing the targets

Here are just a few of the ways an intelligent built environment can enhance livability, workability and sustainability.

Livability

Improving occupant comfort. With full situational awareness and optimization of building conditions, a smart building can tailor light, heat and cooling to each area or even to each individual. Since most people spend nearly all of their time indoors, improving that environment improves their comfort quotient.

Enhancing occupant safety. ICT can greatly improve safety and security via access cards, video monitoring, fire and smoke alarms and similar means. Full situational awareness means that building operators have a complete picture of their building and its environs, and are able to respond to issues or threats in real time. In some cases, these systems can even correct problems remotely and automatically.

Improving occupant health. Indoor air can be more polluted than the air outdoors. Smart buildings monitor air conditions to ensure that occupants aren't exposed to high levels of

carbon dioxide, radon, chemicals or other potential health hazards.

Providing convenience and "remote control" capabilities. Who hasn't left for vacation only to wonder if you remembered to activate the burglar alarm? Thanks to advances in ICT, remote control capabilities can remotely monitor and manage security and energy systems from afar using a computer, tablet or smartphone.

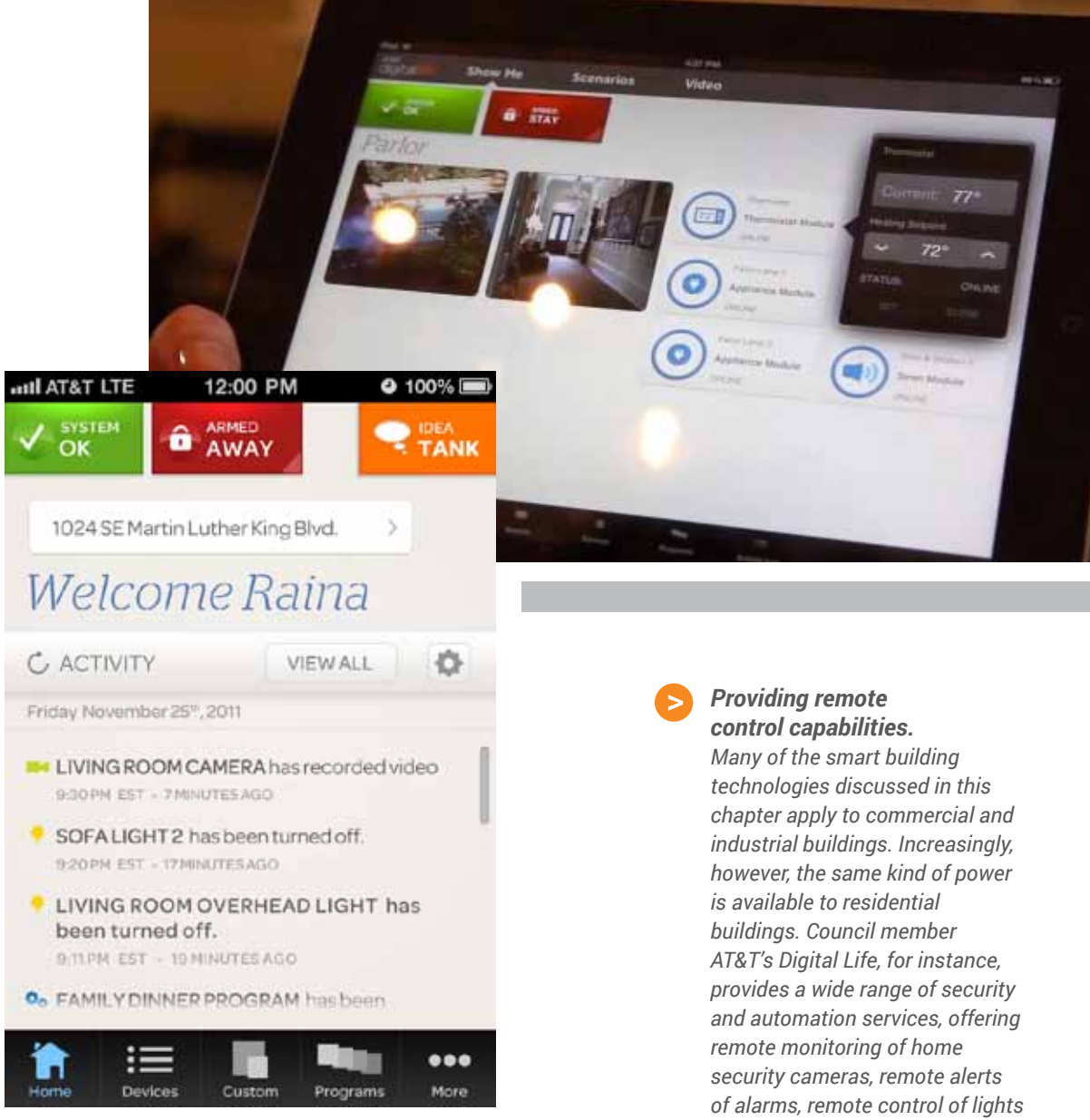
Workability

Lowering business utility bills. Smart buildings save on power, water, gas and waste, giving owners and occupants a competitive advantage.

Increasing worker satisfaction. Who doesn't want to work in a state-of-the-art building where the air is fresh, creature comforts are automated and safety and security are wired in? Businesses located in smart buildings are more attractive to potential employees, which allows them to compete for the best and brightest.

Sustainability

The built environment can make a major contribution to lowering emissions and lowering resource use. It is not an exaggeration to say that it is impossible to meet sustainability



Providing remote control capabilities. *Many of the smart building technologies discussed in this chapter apply to commercial and industrial buildings. Increasingly, however, the same kind of power is available to residential buildings. Council member AT&T's Digital Life, for instance, provides a wide range of security and automation services, offering remote monitoring of home security cameras, remote alerts of alarms, remote control of lights and thermostats and remote locking and unlocking of doors.*

Figure 4.4

Sustainability benefits.
Most buildings can reduce energy waste by 10 to 30 percent.

Figure 4.5

goals without using smart technology to improve the built environment. Examples include:

Reducing energy waste. Most buildings can save 10 to 30 percent on energy just by installing an intelligent building management system to manage devices such as occupancy sensors, light dimmers and smart thermostats. There are many other ways a smart building can reduce overall costs too. For instance, buildings with smart meters or smart thermostats can participate in utility demand response programs. By briefly reducing consumption during peak times they allow the utility to make do with fewer expensive standby power plants. (See the Energy chapter for details.) Or a building can employ "thermal storage," which uses cheap power in the middle of the night to freeze ice. During the day, when power prices are high, it uses the ice to help cool the building.

Reducing water waste. In the same way that ICT helps smart buildings save energy, it helps them save water too. Operational optimization helps smart buildings manage water resources with precise efficiency, eliminating waste and reducing cost for owners and occupants. Sometimes it's just a matter of better scheduling. For instance, scheduling pumping and irrigation at night when power is cheaper.

Reducing carbon emissions. Smart buildings use less energy and less water – important because water requires large amounts of energy to pump and treat. As a result, carbon and other greenhouse gas emissions are lower in smart cities.

Reducing the frequency and cost of repairs. Today's building management systems can monitor key equipment to notice problems as soon as they arrive -- or, in some cases, predict problems before they occur. They can prioritize work orders so the maintenance crew always works on the most important problem first. And they can keep equipment fine-tuned so it operates at maximum efficiency.

Enabling distributed generation. Not only can ICT reduce energy waste, it can help buildings produce their own energy via on-site solar panels, wind turbines, fuel cells and the like. Distributed generation won't replace power plants outright. But together with energy storage and demand response, it can reduce the number of peaker power plants. (Peaker plants run only when there is high demand for power and sit idle the rest of the time.) Distributed generation also helps reduce the environmental costs associated with transmitting energy over long distances.

Providing ROI for building owners. Smart buildings are a win for building owners. Operational optimization delivers both cost savings and enhanced value per square foot.

‘SMART CODE’ HELPS WEST AFRICAN CITY ENHANCE LIVABILITY

Libreville is the capital of Gabon, a rapidly developing country in west Africa. Recent growth – to almost 1 million people – has outpaced the city’s ability to accommodate change and has taken place largely without the benefit of comprehensive urban planning. As a result, Libreville suffers from unplanned land uses and incompatible development.

The government has introduced the “Smart Code” into Gabon and adopted it as the primary basis for urban land development in Libreville. The Smart Code provides a framework for flexibility that is not possible with traditional zoning, making it possible to incorporate new ideas in land planning as well as smart technologies in transport and water utilities.

Council member Bechtel is working with the Gabonese government to deliver several development projects intended to address pressing issues related to the housing stock and enhancing Libreville’s built environment.

Better quality infrastructure, adapted to the local culture and integrated with new commercial services, will significantly improve the city’s quality of life. A particular focus is on improving less developed neighborhoods, the *quartiers sous integrés,* with the benefits of better housing, transport and water and sanitary systems services.

> ***Enhance livability.*** *Better quality infrastructure will help improve the quality of life in Libreville, where several development projects are expected to help accommodate rapid growth in the west African city.*

Figure 4.6

Built environment targets

To this point we've defined the built environment, discussed how cities can influence their buildings and highlighted the benefits of smart buildings. We'll conclude by examining the technologies and best practices that can bring those benefits to your city.

We presume that you've already read the Universal chapter, which explains the targets that apply throughout a city. When it comes to the built environment, those universal goals are sufficient – there are no additional building-specific targets.

For convenience, you will see a checklist at the end of the chapter that lists the universal targets. Below we point out refinements to several of them that demonstrate their relevance to the built environment.

Instrumentation and control

Buildings that use smart devices to monitor conditions like energy use, water use, air quality and heat can capture data that building managers can use to make better decisions about managing resources.

Implement optimal instrumentation. You'll want to keep several things in mind as you determine optimal instrumentation for buildings.

For one thing, don't think that building instrumentation simply means a smart meter. You can now remotely monitor almost any building condition – occupancy, light level, air quality, temperature, etc.

For another, you will want to distinguish between existing and new buildings. In existing buildings, you want to take full advantage of any sensors or switches that are already present. Fortunately, companies are starting to make software that can talk to legacy equipment from many different manufacturers. It is usually much less expensive to find a software "overseer" than to rip out old instrumentation and replace it with new.

When it comes to new buildings, you can be more ambitious. It is much less costly to put state-of-the-art instrumentation into a new building than to retrofit it into an existing building. Thus, as you plan the city's building codes and incentives, you can raise the bar for new buildings as compared to old.

This is an area that will require holistic thinking and collaboration between departments

> ***Implement optimal instrumentation.*** *Building managers can use data captured from smart devices to make better decisions about resource usage.*

Figure 4.7

Connect devices with citywide, multi-service communications. *Many forward thinking building owners are choosing a single, "merged" IP network – one that can carry all traffic, whether data, voice or video.*

Figure 4.8

and between outside stakeholders. For instance, the electric power utility may want smart meters, thermostats and appliances to adhere to communications protocols. Likewise, the fire department may have requirements for fire alarms and smoke detectors. Obviously, the city's codes and recommendations should be compatible.

Connectivity

Once you've deployed smart sensors and systems in a building, the next step is to allow them to communicate the information they gather.

Connect devices with citywide, multi-service communications. In a few cases, a building's sensors and systems may communicate directly with the citywide communications system. For instance, a smart meter or a smart thermostat may tie in directly so it can talk to the electric power utility. In a similar fashion, some utilities talk directly to building load control switches to turn equipment off if the grid is under stress. (The owners get compensation from the utility.)

In most cases, though, the building's sensors will communicate internally to a building management system. That software then monitors and summarizes that internal data and shares it externally as permitted by building owners.

When it comes to new buildings – and sometimes even for old ones -- many forward thinking building owners are choosing a single, "merged" IP network – one that can carry all traffic, whether data, voice or video.

Interoperability

Interoperability targets ensure that your built environment plays nicely with others. Of the three universal interoperability targets, two require additional discussion.

Adhere to open standards. Building technology must adhere to the same communications standards as all other smart city gear – even when the building industry is a barrier to this smart city goal. And it must also contend with standards unique to the built environment.

When it comes to communicating between the building and the rest of the city, you can rely on the standards set forth in the Telecommunications chapter, notably IPv6. But when it comes to the equipment and the communications within the building, you will have to navigate a maze of options.

Adhere to open standards:

GERMAN CITY CONSOLIDATES BUILDING MANAGEMENT AND CUTS ENERGY USE

The city of Bremen, Germany wanted to unify more than 1,200 municipal properties under a single, open building management system (BMS) to optimize the efficiency of heating systems and reduce energy consumption.

The challenge was that six control stations across the city were running a variety of proprietary building control systems. After analyzing the options, the city's property services company settled on a vendor-agnostic BMS based on the Wonderware® solution from Smart Cities Council member Invensys.

That approach allowed the city to consolidate the various legacy systems into a single operator interface.

Now regional supervisors working from any location can log onto the system and troubleshoot problems in real time at any of the city of Bremen's buildings. Wonderware InTouch® also sends alerts and alarms to individual work-stations, so operators can take swift corrective measures and supervisors have visibility to their actions.

Energy consumption in the buildings is down 15 percent to 18 percent.

> ***Adhere to open standards.*** *Choosing a vendor-agnostic building management system, Bremen, Germany was able to consolidate various legacy building management systems into a single operator interface.*

Figure 4.9

The buildings sector has been slow to adopt open standards. In areas such as internal communications within a building, the sector has several competing "standards," including BACnet and LonWorks.

In short, you will need a) the help of an expert to make the right choices and b) a firm determination to stay open no matter what inducements are offered to use a proprietary system instead.

Prioritize the use of legacy investments. It bears repeating – cities and building owners should make every effort to tap into existing devices and equipment before retrofitting buildings with new gear. Older devices can often be integrated with building management systems, thereby avoiding unnecessary replacement. Using existing equipment when possible is a wise way to get maximum value from your investments. For an example, see the *88 Acres case study* linked at the end of this chapter; it explains how Microsoft leveraged legacy investments when it rolled out smart buildings on its campus in Redmond, Washington.

Security and privacy

Of the three universal security and privacy targets, one needs extra discussion.

Publish privacy rules. It's important to remember that information coming from buildings is often extremely sensitive. Consider occupancy sensors, which could reveal when high-value merchandise is unguarded. Or consider energy usage – should that be shared to help the city analyze its energy efficiency targets? Or consider public buildings that use video surveillance to record comings and goings. In what circumstances can the videos be viewed and by whom? In short, be sure to consider your city's built environment when planning your citywide privacy policies.

Data management

Our universal data management target deserves emphasis for the built environment.

Create and adhere to a citywide data management, transparency and sharing policy. The information that can be gleaned from buildings is invaluable for city goals such as energy efficiency, carbon footprint reduction, economic development, transit planning and land use planning. It is crucial that your built environment initiatives adhere to a careful data architecture so that information can flow seamlessly as needed.

Computing resources

Local governments are typically responsible for many buildings – everything from jails to public swimming pools to sewage treatment facilities to bus barns and city hall itself. Of the four universal targets in this section, two deserve emphasis.

Consider a cloud computing framework. A few years ago, only the biggest buildings could cost-justify a top-of-the-line building management system. And until recently, only a few large property owners could afford a system to oversee a whole portfolio of buildings in different neighborhoods or even different cities.

Today, thanks to cloud computing, these advanced capabilities are affordable and widely available. Cloud computing gives access to:

- High-powered computers
- Sophisticated software
- Expert staff
- 24x7 staffing and monitoring
- Redundant backup
- Advanced security, both cyber and physical

Consider a cloud computing framework:

MICROSOFT BRINGS SMART BUILDINGS TO SEATTLE

Seattle, Washington has a goal to better understand how to create economic opportunity for the city while saving energy and developing a sustainable urban environment.

Council member Microsoft has been working with Seattle's Office of Economic Development to develop an approach to driving energy efficiency at city scale. The result is a smart buildings pilot for the downtown area inspired by the smart buildings pilot implemented on Microsoft's Redmond campus. That pilot used Big Data to provide forecasted energy savings of 10percent per year. It's anticipated those savings will be surpassed by the Seattle pilot with energy and maintenance savings between 10 and 25 percent.

The pilot will increase energy efficiency in large commercial buildings across Seattle's downtown corridor; the initial set of buildings totals approximately 2 million square feet. It's a mix of unique building uses, from the Seattle Municipal Tower and the Sheraton Hotel to Boeing facilities and a University of Washington School of Medicine research building.

A cloud solution based on Microsoft Azure cloud technology will collect data from the myriad systems in those buildings and use data analytics to provide a prescriptive approach to how the building management systems can be tuned to improve energy efficiency.

> ***Consider a cloud computing framework.*** *Thanks to the advent of cloud computing,, building management systems that monitor and control energy usage are more affordable and more widely available than they were just a few years ago.*

Figure 4.10

Instead of financing a huge data center and staffing it with specialists, a city can often simply rent all the hardware and software power it needs via the cloud.

Have access to a central GIS. A robust geographic information system (GIS) is invaluable for many city functions related to buildings, including maintenance, public works, parks, building codes, planning and many more. The information you glean about your buildings becomes much more powerful when located on a map.

Analytics

Below we explain how the four universal analytics targets apply to the built environment.

Achieve full situational awareness. Situational awareness has two aspects in the built environment. The first is awareness of individual buildings (or collections of buildings). Today's systems can monitor and display every important parameter. They can even be programmed to alert operators when conditions go out of bounds. Building managers can quickly spot problems and dispatch resources to restore functionality. In some cases, problem identification and resolution can be automated, or even predictive, so that problems are resolved before they cause damage.

Achieve operational optimization. The ultimate goal of a smart building, is to have everything running as smoothly and efficiently as possible. Smart buildings use analytics to ensure that a building's resource usage is efficient. And with the power of analytics, buildings can optimize their conditions to ensure the continued health, productivity and comfort of occupants.

Achieve asset optimization. Sophisticated asset management software can calculate which buildings should be replaced or repaired and when.

Pursue predictive analytics. Unexpected equipment failures can take a toll on maintenance budgets; so can work stoppages caused by equipment failures. Predictive maintenance uses analytics to predict which building equipment is close to failure so it can be repaired or replaced before it fails.

> ***Achieve operational optimization.*** *Smart buildings use analytics to ensure that a building's resource usage is efficient.*

Figure 4.11

Achieve operational optimization:

SMART CONTROL SYSTEMS GIVE ABANDONED BUILDING A NEW LIFE

An "intervention" staged at a long-abandoned building in Molise, Italy was designed to bring it up to current energy efficiency standards and to give it a useful life again.

Toward that end, Council member ABB provided a building automation system based on the international KNX standard with functions including:

- Modifying lighting based on the presence of people in different settings and the level of natural lighting.
- Controlling air conditioning based on the presence of people in different settings, window opening and solar radiation.
- Control and supervision through a PC and a Touch Panel installed in the porter's lodge. The system manages internal and external lighting, occupancy sensors, air conditioning, sunshades and more. Through the PC it is also possible to pre-program on and off times, for example external lighting and corridor lighting.

For the lighting system alone, the estimated electricity saving is about 50-60 MWh, corresponding to a saving of about 10,000 Euros (roughly $13,000).

> ***Achieve operational optimization.*** *A long abandoned building in Molise, Italy served as a proving ground for smart control systems to meet energy efficiency mandates.*
>
> ***Figure 4.12***

ADDITIONAL RESOURCES

Target: Prioritize the use of legacy investments

88 Acres - how Microsoft quietly built the city of the future

A team of engineers at Microsoft cast aside suggestions that the company spend US$60 million to turn its 500-acre headquarters into a smart campus to achieve energy savings and other efficiency gains. Instead, applying an "Internet of Things meets Big Data" approach, they invented a data-driven software solution that is saving Microsoft millions of dollars. Now Microsoft and its partners are helping building managers around he world deploy the same solution.

Target: Achieve operational optimization

Classroom sensors reduce the number of sick kids – and save money

Analyzing ventilation rates from sensors in more than 150 California classrooms for over two years, researchers at Lawrence Berkeley National Lab found that bringing rates up to the state-mandated standard could reduce student absences by approximately 3.4 percent. Improving ventilation reduces the amount of carbon dioxide students breathe.

Target: Achieve asset optimation

Building life-cycle cost tool helps compare alternative designs

The National Institute of Standards and Technology (NIST) developed the Building Life-Cycle Cost (BLCC) program to provide computational support for the analysis of capital investments in buildings. The software can evaluate federal, state, and local government projects for both new and existing buildings.

Benefit: Providing ROI for building owners

Report explores synergies between cities and building owners in the smart city ecosystem

Cooperation among stakeholders in the urban smart building ecosystem can help accelerate investment in smart technologies to meet energy efficiency targets and business objectives, according to a report from International Data Corp. (IDC). Smart building technologies enable the optimization of facilities and generate economic and environmental benefits, key goals in the development of sustainable smart cities.

BUILT ENVIRONMENT TARGETS

TECHNOLOGY

Enabler	Built Environment Targets How smart cities deploy and use ICT to enhance their built environment	Implementation Progress None Partial Over 50% Complete
Instrumentation & Control	Implement optimal instrumentation	
Connectivity	Connect devices with citywide, multi-service communications	
Interoperability	Adhere to open standards Use open integration architectures and loosely coupled interfaces Prioritize use of legacy investments	
Security & Privacy	Publish privacy rules Create a security framework Implement cybersecurity	
Data Management	Create a citywide data management, transparency and sharing policy	
Computing Resources	Consider a cloud computing framework Use an open innovation platform Have access to a central GIS Have access to comprehensive device management	
Analytics	Achieve full situational awareness Achieve operational optimization Achieve asset optimization Pursue predictive analytics	

Figure 4.13

CHAPTER 5

ENERGY

Cities can't function without energy. It fuels our cars, subways and trains. It cools, heats and lights our homes and businesses. It pumps our water and processes the food we eat. And it powers the technologies that are the foundation of a smart city.

So it's easy to see why energy is integral to all city responsibilities and profoundly impacts livability, workability and sustainability. This chapter covers energy's critical role in smart cities, from enabling small-scale power plants that generate energy close to where it's used to advanced technologies that help keep the lights on during power outages. We use the term "energy" broadly throughout to encompass all infrastructures that cities use to produce and deliver energy – electricity, gas, steam, renewables, etc.

Energy as a smart cities starting place. Since city leaders are well aware of their own city's pain points, we said in the introduction to this Readiness Guide that we won't recommend which responsibility areas cities should tackle first. But given the critical role energy plays in just about everything that happens in a city, leaders uncertain where to start their smart city journey should consider making smart energy a priority.

That's because the success of a smart city relies on creating and supporting a smart energy system. That's a system that knows in real time where a transformer has blown and automatically reroutes power to keep the lights on in homes and businesses. It's a system that collects and manipulates data from sensors and smart devices to give operators a complete view of the energy infrastructure – for instance, how much power solar installations are generating or when they need to signal a demand response call to help balance the load on the electric and gas grid.

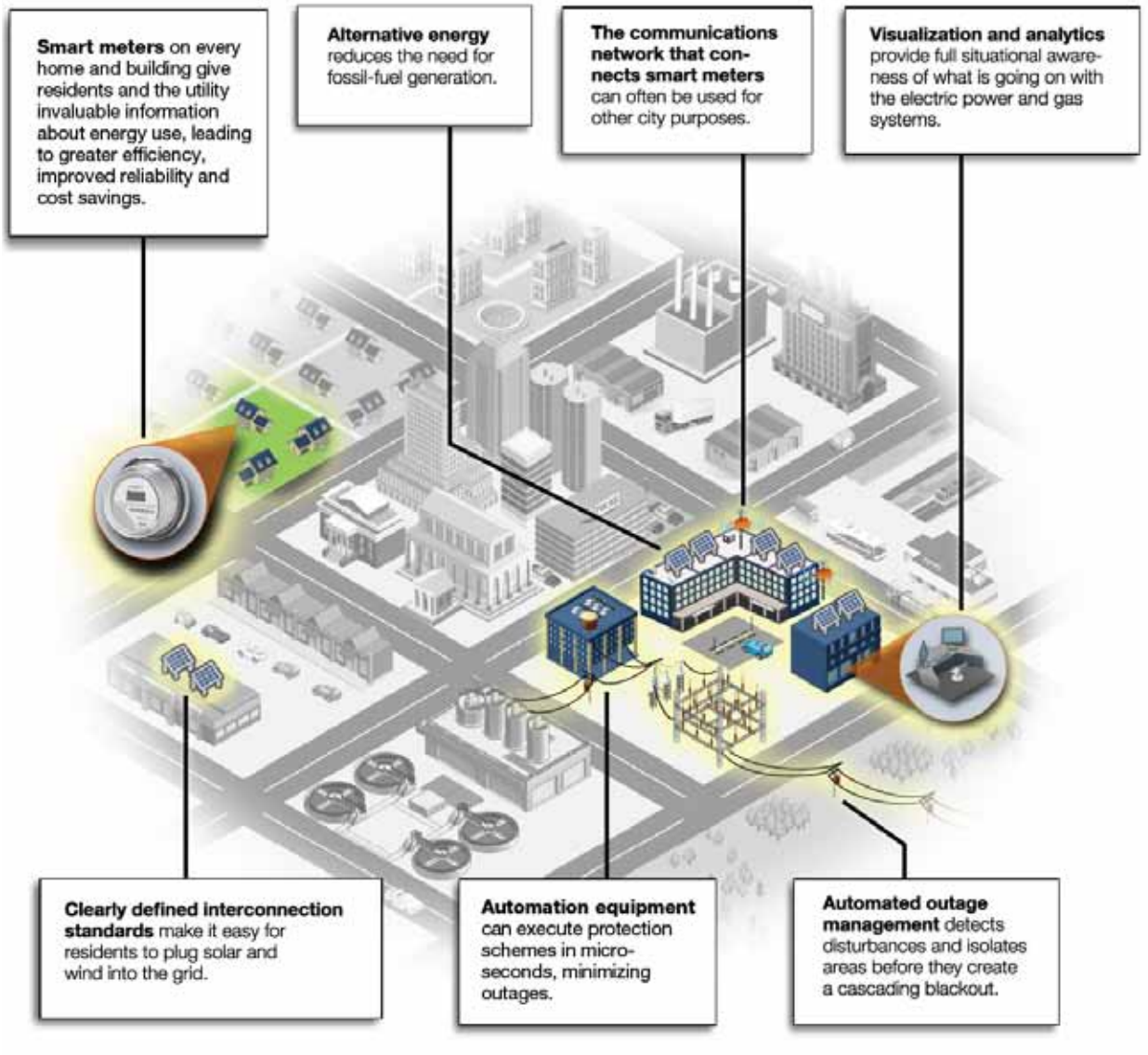
ICT's role in smart energy. Information and communications technologies (ICT) help cities optimize these energy systems, making them more efficient and more resilient. Implementing smart energy systems also helps preserve precious natural resources and gives residents, businesses and cities themselves a whole host of ways to monitor and control their energy consumption to save money.

There are a number of components of a smart energy system. In the pages that follow we'll identify the technologies and technology-supporting practices involved and the array of benefits that cities accrue when they implement them.

> ***ICT's role in more sustainable cities.*** *Amsterdam leveraged public-private partnerships to build a broadband platform for service delivery to achieve social, economic and environmental sustainability.*

Figure 5.1

ENERGY



> ***Energy's critical role in smart cities.*** *Smart energy powers the technologies that are the foundation of a smart city, from smart meters that offer two-way communications between customer premises and utilities, to outage management systems that make the power grid more resilient.*

Figure 5.2

PIONEERING MUNICIPAL UTILITY – A SMART GRID POSTER CHILD

As the first American utility to receive smart grid stimulus funding and as the first to be "completely operational with smart grid technology," Glendale Water and Power (GWP), located in Southern California, is a bit of a smart grid poster child.

In the GWP system, a single communication system is handling both power and water. Anchored by a suite of technology from Smart Cities Council member Itron, the system includes an Itron advanced wireless communication network that integrates both electric and water meters. It also features leak detection technology for the water system and Itron's meter data management solution to manage the huge volumes of data the system generates and enable other smart grid programs and applications.

GWP completed installation of the system, which included 83,000 Itron smart electric meters and 33,000 smart water meters in 2011. Components of the overall smart grid system included in-home display units that provide electricity and water usage information, costs and control to consumers as well as thermal storage units, electric vehicle smart charging, demand response and distribution automation.

Speaking at a conference after the installation was complete, then GWP General Manager Glenn Steiger

> ***Energy as a smart city starting place.*** *Substation upgrades that were part of Glendale Water & Power's modernization effort allow more power to flow through its system, increasing its ability to meet customer demand.*
>
> ***Figure 5.3***

talked about the project. "The key thing to remember is that smart grid is really an IT communication system," he explained. "The heart of the system and the ongoing applications are IT-driven. To be successful, you have to shift focus from hardware and infrastructure to IT."

On the water side, the system is providing leak detection capability that is saving precious water in perennially water-challenged Southern California, and also saving money in water they didn't have to purchase. "We're actually optimizing the water system with the data we're collecting through the electric system," Steiger said, referring to the energy costs associated with treating and delivering clean water to Glendale residents.

Smart grid technology ultimately comes down to saving money, Steiger said, for the municipal utility but also cost containment for its customers. GWP's system and the data it delivers have enabled it to streamline operations, improve business processes, and roll fewer trucks, he added. That means keeping costs low for customers, which leads to strong customer support.

Dependencies in energy

Improvements in a city's energy infrastructure – deploying a smart grid, for instance – can't occur without an understanding of dependencies between energy and other city systems and services. Three stand out: communications, transportation and the built environment.

A smart grid is by definition a specialized communications network that moves electricity and data to balance supply and demand and maintain reliable service. The distribution lines and underground cables that are part of the energy grid often follow the layout of city streets (part of the built environment), creating dependencies between utility services and the various transportation systems that also rely on streets.

The built environment is also a major consumer of electricity and natural gas – and potentially a producer of electricity too. As distributed generation evolves and building owners adopt solar, fuel cell and related technoloiges, utilities and city governments will form even closer alliances.

Benefits of realizing the energy targets

What kind of results can smart cities expect once they've walked down the smart energy path? We've highlighted many of them below, based on their relevance to livability, workability and sustainability.

Livability

Empowering customers with choice and control. Instrumentation, connectivity and analytics combine to give electric and gas customers more information about when and where they are using energy, plus tools to help them control that usage so they can lower their bills.

Improving reliability and resilience. Smart grids can "self-heal" from simple problems, making them more resilient to storms and disasters. With outage management systems, trouble areas can be pinpointed, shaving hours or even days from restoration times. And most smart grids make it easy to combine centralized, "long-distance" generation with local distributed generation, making the system more resistant to supply interruptions.

Lowering costs for citizens. Operational optimization means fewer resources are consumed and paid for. These savings can be passed along to citizens, resulting in lower energy bills.

Workability

Improving competitive advantage. A U.S. Department of Energy lab estimates that economic losses from outages cost $80-130 billion per year in the U.S. alone. Businesses in cities with modern, ultra-reliable energy systems have a competitive advantage.

Creating new jobs. Renewable energy and local energy typically produce more local jobs than "traditional" energy (where energy may be shipped from large centralized plants outside the region).

Generating business investment in cities. A study of the correlation between smart grid – a key component of the smart city – and economic growth discovered that cities with a smart grid have an annual GDP growth rate that is 0.7% higher, office occupancy rates 2.5% higher, and an unemployment rate 1% lower when compared to less advanced cities.

Sustainability

Using less energy. Smart energy is cleaner and more efficient, producing less impact on the environment. First, it makes it easier to use wind, solar and other renewable sources. Second, it wastes less energy during transmission and delivery. Third, it gives customers tools to reduce their energy usage and costs. And there are add-on effects, because using less energy means using less water too.

Decreasing reliance on nonrenewable energy sources. Smart grids make it far easier for customers to generate energy on premise (for instance, via rooftop solar) and to trade energy back and forth with the grid. Implementing the right devices and instrumentation, such as improved solar meters, have led many financiers to offer $0 down residential and commercial solar programs, reducing the barriers to solar generation. And smart energy, with the help of reliable two-way communications, makes grids more flexible overall to customer demand.

Lessening energy operating costs. Smart energy reduces operating costs compared to traditional methods. For example, sensors and monitors can report on the actual condition of expensive equipment so it can be serviced based on actual condition and not a guess. This kind of asset management can squeeze many extra years of use from an asset, without compromising safety. For another, smart systems can manage peak times by briefly reducing demand (called demand response) instead of building new standby power plants that will only get used a few times per year, and can even dim LED street lights to enable lower operating costs.

> ***Creating new jobs.*** *Solar installations and other forms of renewable energy and distributed generation create new, green jobs.*

Figure 5.4

Instrumentation and control

We start our discussion of this chapter's targets with optimal instrumentation which, when applied to smart energy, refers to smart devices such as sensors and smart meters that gather information about the flow and condition of power and about the condition of equipment within the energy infrastructure.

Implement optimal instrumentation. Thanks to real-time information supplied by smart devices, system operators can predict, diagnose and mitigate issues that might previously have caused an outage or blackout. Examples of energy instrumentation include the deployment of smart meters and distribution system sensors.

Smart meters, which are installed on homes and businesses, are perhaps the most visible instrument in a smart energy network and certainly the most controversial due to concerns about potential health impacts and privacy. All of which points to the importance of developing an effective citizen engagement strategy long before you start deploying them.

Today there are smart meters for electricity, gas and water. They provide two-way communication between the customer premise and the utility. In the old days meters had to be read manually; smart meters transmit energy usage details directly to the utility. When smart meters are combined with smart thermostats, smart appliances and/or energy management devices, consumers can participate in energy-saving demand response programs where they voluntarily allow the utility to send a signal to the smart meter or other device to temporarily make a modest adjustment in energy usage.

> ***Implement optimal instrumentation.*** *Smart meters are part of the smart energy network and also part of a citywide two-way communications system.*
>
> ***Figure 5.5***

Implement optimal instrumentation:

CITY OF GRIFFIN EMPOWERS RESIDENTS WITH SMART GRID ELECTRIC METERS

Always progressive in its operations, the City of Griffin, Georgia's electric department wanted to give its customers the power to monitor their electric usage to help them manage utility costs. It also sought a more precise way to measure residents' power usage to ensure accurate billing and a way to simplify routine processes.

Griffin replaced aging mechanical meters with smart meters that use Council member AT&T's wireless network to transmit customers' power use to the city electric department. The smart grid solution gives customers better control over how much electricity they use and makes it easy for the city to read meters and connect or disconnect service remotely. As a result, customers are better served and the city can more accurately predict its power needs to lower the cost of its electric purchases.

The city has already boosted its revenues because the digital meters capture electric usage more accurately than the 40-year-old mechanical meters. Griffin also saves money since it no longer has to pay contractors to read its meters.

"The biggest advantage," said Bill Bosch, the city's Electric Director, "is that we can help our customers manage their usage and power bills. That, in turn, will let us determine how much energy we need, which helps lower our purchased power cost."

The system also makes it easier for Griffin to respond to tornadoes and other major storms. "If there's an outage I know AT&T is out there getting my meters back to reading and I don't have to worry about it," Bosch said.

> ***Implement optimal instrumentation.*** *Griffin's smart grid solution gives customers better control over how much electricity they use.*
>
> ***Figure 5.6***

Connectivity

Not only are the smart meters and sensors part of the smart energy network, they are also part of a citywide two-way communications system – that "system of systems" discussed earlier.

Connect devices with citywide, multi-service communications. Connectivity allows data collected throughout the smart energy network to be transmitted for analysis and action. For example, connectivity might mean that your smart meters, distribution system sensors and utility are connected through two-way communications.

Interoperability

Utilities around the world have started building out smart electric grids and smart gas grids, both of which are part of what this Guide refers to as the all-encompassing smart energy network. But one of the stumbling blocks early on was a lack of standards – and as you can imagine there are numerous pieces of a smart grid that have to work together and talk to each other. Thanks to a number of standards bodies around the world that undertook the task of developing specifications, a lot of the issues that plagued the smart grid pioneers have been resolved. Below is a quick look at interoperability targets, including one that specifically applies to energy:

Adhere to open standards to increase choice and decrease costs. With open standards products can be mixed and matched from different vendors.

There are hundreds of standards just for the energy responsibility of a smart city. As we discussed in the Universal chapter, selecting standards is a job for specialists. Your job is first to insist on using them whenever possible and second to hire a supplier with a demonstrated knowledge and commitment to open standards. But the standards selection process is easier in the energy sector than in others thanks to the free Smart Grid Standards Mapping Tool from the International Electrotechnical Commission, a Council advisor. You can simply point and click to identify any standard in relation to its role within the smart grid. New standards are added regularly.

Use open integration architectures and loosely coupled interfaces so it is easier and simpler to share data between applications.

Prioritize use of legacy investments to avoid unnecessary spending and from stranding existing assets. This practice ensures maximum value and lifetime from existing technology investments.

Enabling distributed generation with interconnection standards. Recent decades have seen the proliferation of "distributed generation" – of small, decentralized power plants located at or near the spot energy is used. Think rooftop solar installations on high-rise apartment buildings or wind turbines helping power a shopping mall.

What are required to make distributed generation work effectively are straightforward, easy-to-use interconnection standards that define how the energy sources tie in to the energy grid. It's a relatively new business model for utilities, although many have or are in the process of developing protocols to accommodate distributed generation. Getting it right gives the city and its residents more options for economical and clean power generation without compromising secure and reliable grid operations.

Cities that own their local energy or gas utility can prioritize development of interconnection standards. Those with energy providers that are not municipally owned may need to find ways to encourage them to modernize their interconnection standards to accommodate what is clearly the wave of the future.

Distributed generation has enormous potential, including higher efficiency and greater resilience against natural or man-made disasters. It also reduces dependence on fossil fuels.

Enabling distributed generation:

MONITORING AN EXTENSIVE NETWORK OF RENEWABLE ENERGY GENERATION PLANTS

9REN Group designs, develops, builds and operates renewable turnkey power plants using photovoltaics, solar thermal energy and wind. The Spanish company operates some 570 photovoltaic installations, mainly in Spain and Italy. In addition to photovoltaic plants, the company has built 183 solar thermal plants as well as mini-wind installations. 9REN plants generate more than 10,000 megawatt-hours (MWh) of clean energy each month.

To manage and monitor its photovoltaic plant facilities, 9REN created EOSystem, a solution built on the Wonderware® System Platform from Council member Invensys. EOSystem is a real-time monitoring technology that provides instantaneous information from all photovoltaic installations operated by 9REN throughout Europe and the Middle East. System platform provides a single, scalable software solution for all the supervisory control and data acquisition (SCADA) and supervisory human machine interface (HMI) needs for monitoring 9REN's renewable energy installations.

From a single control center, 9REN can effectively monitor the operations infrastructure at each facility. "The Wonderware System Platform lets us access all our installations in real time," said Antonio Palacios Higueras, services technical manager for 9REN. "Because of this, we only require one person to control the operation of all of the 568 plants, regardless of location. We also have achieved a significant cost reduction in time per designer and project."

> ***Enabling distributed generation.*** *From a single control center, 9REN can effectively monitor the operations infrastructure at each of its renewable energy facilities, which includes some 570 photovoltaic installations.*
>
> ***Figure 5.7***

Security and privacy

There are at least three extremely compelling reasons why smart cities take security and privacy seriously in the context of energy as these three targets demonstrate.

Publish privacy rules. Smart meters have raised privacy concerns around the world. People worry that their daily habits are being tracked by their local utility via smart meters, which is why smart cities not only publish and adhere to privacy rules but they let citizens know about it proactively. Making privacy a priority can help ward off consumer backlash that could stall smart energy deployments.

Create a security framework. Security breaches can have a ripple effect. Developing a comprehensive security framework mitigates risk by identifying and addressing threats before they can cause damage. This is critical in the energy infrastructure – even more so given its inherent importance to the operation of other key infrastructures.

Implement cybersecurity. Cyber attacks against energy companies in the U.S. have been well-documented. But what were once thought to be attempts to steal information or trade secrets are now focused on causing serious damage to networks and equipment, according to warnings from the U.S. government. The take-away here for cities is that implementing cybersecurity safeguards early on maximizes protection while avoiding the potentially significant costs associated with an attack.

Data management

There is a tremendous amount of data pouring in from sensors, smart meters and other intelligent devices deployed throughout the energy infrastructure of a smart city.

Create and adhere to a citywide data management, transparency and sharing policy. Energy usage data should be integrated in the policy that was discussed in detail in the Universal chapter. And as noted in the previous section, energy usage data needs to comply with overall security and privacy rules.

That said, access to timely, accurate energy usage data is an essential component of a cleaner, more efficient energy system. So it's imperative that local utilities grant cities access to aggregated, summary usage data which can be invaluable for city planning, for carbon reduction programs, for energy efficiency programs, for low-income assistance programs, for improving city performance and for many other purposes.

To promote energy efficiency, it's also important for smart cities to encourage utilities to give electric and gas customers access to their own usage data. For example, cities can provide a web portal for viewing and managing energy usage in real time. That way customers can drill down on when and how they use energy to make choices and trade-offs that can reduce their energy usage and utility bills.

> ***Create and adhere to a citywide data management, transparency and sharing policy.***
> *When utility customers have access to data about when and how they use energy they can make choices and tradeoffs that can reduce their energy usage and utility bills.*

Figure 5.8

Create a citywide data sharing policy:

SEATTLE'S BIG BUILDING BENCHMARKING PROGRAM IS WORKING

Commercial buildings are one of the biggest consumers of energy. So it's significant that the vast majority – or 87% – of large building owners and managers in Seattle, Washington are now tracking and reporting building energy performance to the city under Seattle's Energy Benchmarking and Reporting Ordinance.

Benchmarking tracks the total amount of energy that a building uses and allows comparisons of energy performance to similar buildings. Seattle officials note it is a standard practice for owners and managers working to improve building energy efficiency and reduce energy costs.

Being able to see the data on their own building consumption and others is definitely opening the eyes of building owners and managers. One of them is Stephen Chandler, Facilities Manager at Verity Credit Union. "Energy bills only tell you so much," he says. "Benchmarking lets you see trends and how your building compares with others. As a facilities manager, I am always looking for ways to lower costs, and being energy efficient is a way to do that which benefits my company and its customers."

Since 2008, Verity Credit Union has reduced its annual energy consumption by 20% by tracking its use through benchmarking and making cost-effective energy efficiency improvements, according to the city.

> ***Create and adhere to a citywide data management, transparency and sharing policy.*** *Being able to see the data on their own building consumption and others is opening the eyes of building owners and managers in Seattle.*
>
> ***Figure 5.9***

Consider a cloud computing framework. *With computing resources reliant on energy, monitoring for efficiencies and economies is a smart approach. Cloud computing offers a way to reduce costs and increase reliability and scalability.*

Figure 5.10

Computing resources

Basically all of the computing resources that cities use rely on energy in some way, shape or form, so it makes sense for cities to constantly monitor for efficiencies and economies as they use, deploy and procure computing resources. As discussed in detail in the Universal chapter:

Consider a cloud computing framework to enable scalability of systems, reduce costs and improve reliability.

Use an open innovation platform to empower innovators, increase accountability, generate new revenue streams and stimulate economic growth.

Have access to a central geographic information system (GIS) to improve decision-making capabilities, enable efficiency gains through more intelligent scheduling and routing, provide improved accuracy of essential records and boost resiliency of key assets.

Have access to a comprehensive device management system to improve infrastructure security and resiliency, deliver cost savings and enforce compliance with city data management, security and privacy policies. This target, as we noted, takes on special importance in the energy discussion due to the numerous smart devices and other computing resources deployed throughout smart cities.

Analytics

As we've said previously, analytics are absolutely critical to smart city success and perhaps nowhere is that more evident than in a smart energy network that powers so much of what a city is and does. We'll quickly review three of the analytics targets already discussed in the Universal chapter and then introduce two more that speak volumes about energy's importance in a smart city.

Achieve full situational awareness. This refers to giving operators a complete picture of their energy system at any given moment to increase its reliability and resiliency and quickly respond to trouble. A complete operating picture is incredibly important to city energy systems. One example: It helps operators detect energy theft and thereby conserve resources.

Achieve operational optimization. Building the very best smart energy network possible is what cities want to achieve from the instrumentation and connectivity investments they make in their energy infrastructure.

Consider a cloud computing framework:

RESIDENTS TRIM ENERGY USE BY 20 PERCENT WHEN GIVEN REAL-TIME DATA

A consortium of companies is taking energy conservation to the next level by creating an entire eco-minded neighborhood just outside of Paris, France.

IssyGrid is France's first smart grid neighborhood, a demonstration project aimed at reducing energy use in the French town of Issy-les-Moulineaux. It is run by a consortium of corporate partners and local utilities that consider energy conservation an opportunity for businesses to solve. About 200 test homes and four commercial buildings in the community have been outfitted with energy consumption monitoring devices, with the goal of ultimately expanding the program to the entire town. IssyGrid collects energy consumption data and processes it in real time using Windows Azure, the cloud services platform from Council member Microsoft.

The consortium analyzes the data by using Microsoft SQL Server 2012 data management software. Then IssyGrid provides the data to citizens so that they can see how they are using electricity. This enables them to take specific actions to conserve – by turning off the television or lowering the temperature by two degrees.

The result: They reduce their consumption – and their energy bills – by 10 to 20 percent.

> ***Consider a cloud computing framework.*** *IssyGrid collects energy consumption data and processes it in real time using Windows Azure, the Microsoft cloud services platform.*

Figure 5.11

Optimized energy systems help conserve energy, delivering cost savings to cities, residents and businesses and also reducing the drain on energy resources.

Achieve asset optimization. This target plays an important role in the energy sphere, helping cities maximize the value of their assets by 1) calculating which energy assets need to be repaired or replaced and when, and 2) by predictive maintenance, which uses analytics to spot equipment that is close to failure so it can be repaired or replaced before problems arise.

Pursue predictive analytics. Drawing from instrumentation deployed across a city, analytics can enable advanced forecasting and management of a diverse, secure and resilient energy system. ICT helps cities account for demand, weather, effects from distributed resources that may be variable and other operational considerations. Understanding what to expect helps cities save on costs, conserve resources and prepare for extreme events.

Now we'll introduce two new energy-specific targets that are critical to smart city success.

Automate fault and outage management. This is about the "self-healing" grid we referred to earlier. The idea is that the utility that serves your city would enable remote sensors, smart meters and other advanced smart grid technologies deployed throughout the energy network to automatically reduce the number of outages and the duration of those that do occur. For instance, a sensor might detect a fault on the electric grid and be able to locate it and isolate it before it has time to affect other areas. Or smart meters may alert a utility's outage management system of trouble, allowing the utility to immediately dispatch crews and keep customers updated during and after the incident. Before the advent of these advanced technologies, utilities oftentimes didn't know about an outage until customers started calling in.

A quick look at economic losses incurred from power outages explains why this is so important. A study by the Berkeley National Lab back in 2004 estimated that outages cost $80-130 billion per year in economic losses in the U.S. alone. After Superstorm Sandy, which wreaked havoc across the northeastern U.S. in 2012, the U.S. Congress approved more than $60 billion in emergency aid, which is roughly what state governments reported in damages and other losses.

By encouraging automated solutions a city or utility can make the energy supply more reliable, improve response to outages which in turn makes businesses more competitive and residents more comfortable.

> ***Automate fault and outage management.*** *Automated solutions help make the energy supply more reliable and improve outage response.*

Figure 5.12

Automate fault and outage management:

CHATTANOOGA SMART GRID REDUCES OUTAGE TIME 55 PERCENT

In 2011 the Electric Power Board (EPB) installed a smart grid in Chattanooga, Tennessee that has achieved a 55 percent reduction in outage time. The area's businesses will save an estimated $40-$45 million a year, while the overall savings are likely to be $600 million over the first 10 years of deployment.

The project included many smart city functions:

- Ultra high-speed Internet, voice and video access to all residents
- A citywide WiFi network for the city and utility
- Street light controls
- Surveillance cameras
- Enhanced police and fire response

In addition to the smart city features, the project (video) also included a high-speed grid monitoring and control system along with Council member S&C Electric's IntelliRupter circuit reclosers at key points along the power lines. Those smart switches allow operators to pinpoint the location of an outage, cutting down on the need for physical inspectors and saving hours or even days.

When a tornado hit the town in March of 2012, it took out power to only 3,400 residents, half the amount that would have been affected before.

> ***Automate fault and outage management.*** *The smart grid installed in Chattanooga, Tennessee has achieved a 55 percent reduction in outage time.*
>
> ***Figure 5.13***

Creating a self-healing grid:

CENTERPOINT ENERGY AUTOMATES FAULT AND OUTAGE MANAGEMENT TO GET LIGHTS BACK ON SOONER

CenterPoint Energy was looking to improve to improve power reliability and restoration in greater Houston. It is using $50 million of its U.S. Department of Energy grant to build a self-healing smart grid that will use smart meters, power line sensors, remote switches and other automated equipment.

CenterPoint Energy has begun building an "intelligent grid" with power line monitoring equipment, remote switches and other automated equipment that will locate power line outages as they occur. This can speed recovery since repair crews won't have to search for the source of an outage and can begin repairs sooner.

In 2012 when there was an opportunity to use intelligent grid automation to re-route and restore power, it saved more than 611,000 customer minutes over 20 outages. This was a 21 percent improvement in outage response, with about 70 percent of affected customers experiencing an outage of just a few minutes rather than at least a half hour.

In addition, CenterPoint Energy has installed 2.2 million smart electric meters across Houston, and can use Power Off Notifications as an additional early detection system for power outages.

> ***Creating a self-healing grid.*** *Using intelligent grid automation to re-route and restore power, CenterPoint Energy has seen a 21 percent improvement in outage response.*

Figure 5.14

CenterPoint selected Ventyx, a subsidiary of Smart Cities Council member ABB, to implement an Advanced Distribution Management System (ADMS), the computer system which will be the intelligent grid's "brain." Due for completion in 2014, the ADMS will process data from power line sensors as well as from smart electric meters to identify the location of power outages and remotely control intelligent grid switching devices to shorten the duration of power outages.

"This system will give us greater insight into the health of our electric infrastructure and eventually create a 'self-healing' grid," said Kenny Mercado, division senior vice president for CenterPoint Energy's Regulated Operations Technology. "With this technology, we will be able to automatically reroute power around many outage locations to help us get the lights on sooner."

The ADMS will allow the intelligent grid to "self-heal" in the event of a major storm to restore power to as much of the system as possible. Then the damage to the system as a whole can be diagnosed and restored according to current practices. In many cases, the time to restore power through the intelligent grid could be significantly reduced.

> ***Use advanced smart grid technologies.***
> *When deployed throughout the energy network, automated technologies help reduce the number of outages and the duration of those that do occur.*
>
> ***Figure 5.15***

Segment and personalize programs for customers. This is one of the big pluses of today's smart energy networks. They can consider multiple variables – like a utility customer's preferences, system parameters, weather, cost of energy – to optimize and personalize rates and programs. As part of that personalization, a smart city's utility, whether municipally owned or a private utility that operates in the city, can identify energy use patterns and then make customized recommendations to help customers get the best possible rates or assist with fraud and service connection issues.

Today many electric and gas utilities charge a single rate for every residential customer at every time of the day. In reality, the cost of energy varies widely depending on the time. In particular, electric energy can be very inexpensive at night when demand is low and the output from wind farms is high. But it can be very costly during hot summer days when air conditioners are cranked up, demand is very high and energy is scarce.

Smart meters and smart grids make it possible for utilities to offer a variety of programs to encourage energy efficiency and cost savings. Examples include time-of-use rates, peak-time rebates, efficiency incentives and demand response programs. Council member Opower, for example, works with utilities around the world on customer engagement programs that use data analytics and behavioral science to motivate customers to be more efficient.

Personalizing programs greatly increases customer satisfaction. It also provides an avenue for the utility and the city to advance their goals. For instance, a demand response program that reduces demand during peak load periods can avoid or delay the need for new power plants and associated power lines. So can conservation and efficiency initiatives, which also help cities meet their carbon mitigation goals. Special incentives and programs for commercial and industrial customers can help attract and retain businesses.

> ***Segment and personalize programs for customers.*** *Smart meters and smart grids make it possible for utilities to offer a variety of programs to encourage energy efficiency and cost savings.*

Figure 5.16

Segment and personalize programs for customers:

COMPANY'S DEMAND RESPONSE INCENTIVES PAY FOR MORE TECHNOLOGY

When energy demand is high and supply is short, San Francisco, California-based Pacific Gas & Electric (PG&E) offers financial incentives to companies that reduce their load in response to a request.

NetApp, a Sunnyvale, California company that creates storage and data management solutions, signed up for PG&E's Demand Bidding Program, which means the utility pays NetApp $0.50/kWh when the request is made the day before and $0.60/kWh if the request is made the same day.

It started several years ago when NetApp saw an opportunity to significantly reduce energy consumption at its headquarters, which has 1.2 million square feet of space in 10 buildings. The headquarters uses 54 million kilowatt hours annually, with a peak demand of 7.6 megawatts. In 2008, NetApp's annual utility bill was US$7.7 million, 89 percent of that for electricity.

> ***Segment and personalize programs for customers.*** *California's Pacific Gas & Electric offers financial incentives to companies that reduce their energy load in response to a request. NetApp installed Cisco's Network Building Mediator to enable its participation in the program.*
>
> ***Figure 5.17***

Energy-efficient equipment is only part of the solution. "You also need to make intelligent decisions about equipment settings, and that requires gathering and analyzing information from disparate building systems, including metering systems and PDUs [power distribution units]," says David Shroyer, a NetApp controls engineer.

To aid that effort the company deployed the Network Building Mediator from Council member Cisco, which aggregates information from all of NetApp's building systems, including lighting, heating, ventilation, air conditioning, temperature sensors and PDUs, from multiple vendors.

Building engineers and facilities personnel can control systems in any building using a web-based interface. Demand response payments from PG&E paid for the system and NetApp has since deployed Network Building Mediator for automated demand response at its properties in Europe and India.

"Within 20 minutes of the demand-response signal from the utility, the Cisco Network Building Mediator reduces lighting by 50 percent and raises the temperature set point by four degrees, shedding 1.1 megawatts."

Facility helps public and private sector researchers scale up clean energy technologies

Located at the National Renewable Energy Laboratory's campus in Golden, Colorado, the new 182,500-square-foot Energy Systems Integration Facility (ESIF) is the first facility in the United States to help both public and private sector researchers scale-up promising clean energy technologies – from solar modules and wind turbines to electric vehicles and efficient, interactive home appliances – and test how they interact with each other and the grid at utility-scale. The U.S. Congress provided $135 million to construct and equip the facility.

Figure 5.18

ESIF, which opened in 2013, houses more than 15 experimental laboratories and several outdoor test beds, including an interactive hardware-in-the-loop system that lets researchers and manufacturers test their products at full power and real grid load levels.

The facility will also feature a petascale supercomputer that can support large-scale modeling and simulation at one quadrillion operations per second.

ADDITIONAL RESOURCES

Target: Implement optimal instrumentation

ABB uses Windows Embedded Server to deliver compact, robust power automation solution

State Grid Corporation of China (SGCC) wanted a monitoring and control system for power transmission and distribution equipment located in harsh, demanding environments. Working with Council member ABB, SGCC implemented a compact and rugged data acquisition and supervisory control system for production process control and scheduling automation. A Windows Embedded Server appliance from Council member Microsoft monitors and controls on-site equipment, including measurement and signal alarms.

Target: Create and adhere to a citywide data management, transparency and sharing policy including energy data

City of Dubuque: Investing in sustainability for future generations and future prosperity

Combining smart meters and powerful analytics, Dubuque, Iowa has given its citizens the insights they need to adjust their energy and water consumption, with results – such as up to an 11% reduction in electricity usage and a 7% reduction in water usage – to show for it. Working with Council member IBM, Dubuque's smart city pilot used cloud-based services to enable more efficient delivery and use of municipal services.

Target: Enable distributed generation with interconnection standards

Energy transition in urban environments: battling integration challenges with evolving technologies

As increasing urbanization challenges cities, there are key technologies and social innovations needing further development. Among them, as this white paper from Council member Alstom discusses, are the issues resulting from integration of distributed renewable energy resources with utility grids.

ENERGY TARGETS

*In the checklist below, targets specifically pertaining to the energy responsibility are in **bold**, universal targets are not.*

TECHNOLOGY

Enabler	Energy Targets How smart cities deploy and use ICT to enhance their energy infrastructures	Implementation Progress None Partial Over 50% Complete
Instrumentation & Control	Implement optimal instrumentation	
Connectivity	Connect devices with citywide, multi-service communications	
Interoperability	Adhere to open standards Use open integration architectures and loosely coupled interfaces Prioritize use of legacy investments **Enable distributed generation with interconnection standards**	
Security & Privacy	Publish privacy rules Create a security framework Implement cybersecurity	
Data Management	Create a citywide data management, transparency and sharing policy **(Supplement: including energy usage data)**	
Computing Resources	Consider a cloud computing framework Use an open innovation platform Have access to a central GIS Have access to comprehensive device management	
Analytics	Achieve full situational awareness Achieve operational optimization Achieve asset optimization Pursue predictive analytics **Automate fault and outage management** **Segment and personalize programs for customers**	

Figure 5.19

CHAPTER 6

TELECOMMUNICATIONS

Ubiquitous broadband telecommunication is a prerequisite for a smart city. This chapter explains how to achieve a telecommunications architecture that can serve as the foundation of a smart city and the foundation for major improvements in livability, workability and sustainability.

We begin by defining telecommunications, both as it exists today and as it will evolve tomorrow. After we discuss the "what," we'll talk about the "why" – why telecommunications is so vital to smart city success. We'll finish by discussing the targets for telecommunications – the end states at which you should aim your efforts. Along the way, we will pay brief visits to telecommunications success stories from around the world.

First, though, a word about our use of the terms "telecommunications" and "connectivity." Dictionaries define telecommunications as the electronic transmission of signals. When we use the word in this Guide, we are talking about a city responsibility to provide the policy environment and incentives to achieve high-quality telecommunications. However, city responsibilities such as power, public safety and transportation depend on telecommunications. In that sense, telecommunications is also an enabler. When we are talking about the technology in that sense, we use the term "connectivity" to make the distinction. You'll see the word "connectivity" listed in the Smart Cities Council Framework along with other enablers such as instrumentation and computing resources.

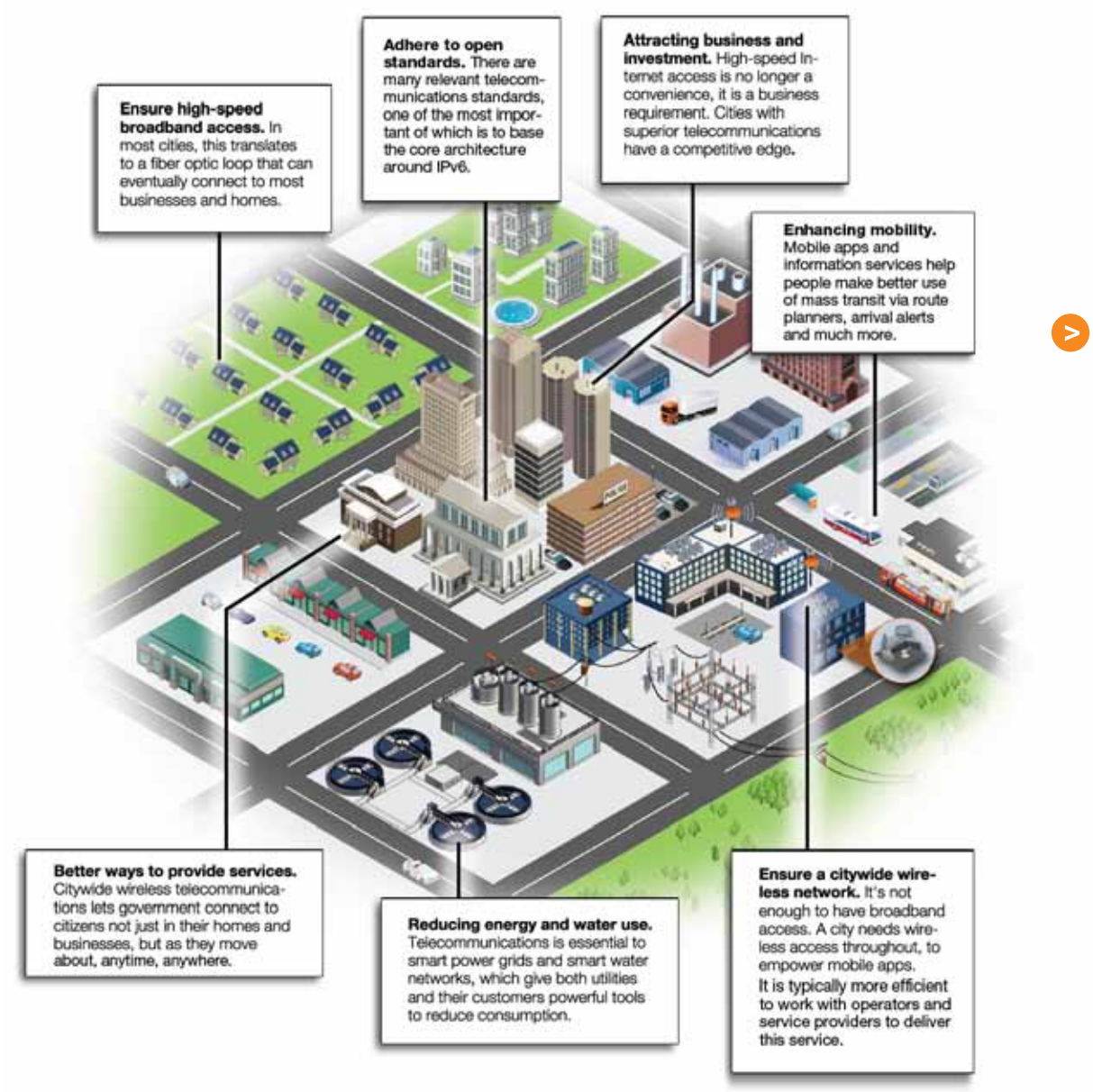
In the 21st century, people and businesses consume telecommunications like a resource, just as they consume electricity to light their homes and water to quench their thirst. As a result, it is vital that cities take on the responsibility of ensuring adequate telecommunications so their residents have access to high-quality communications. Cities don't have to build, own and operate the infrastructure – in fact most will not. But they must at least continue to set the conditions and policies that incentivize the private sector to install state-of-the-art telecommunications.

Telecommunications also acts as an enabler by providing connectivity. All the other responsibilities – water, power, transportation, etc. – require connectivity to communicate with the sensors and devices they use to collect data. That's why the Universal chapter already specified a universal target of "Connect devices with citywide, multi-service communications." In other words, you've got two important reasons to pay close attention to telecommunications: 1) for the value it creates on its own and 2) for the value it enables for all the other responsibilities.

> ***Telecommunications is a city responsibility.*** *In the 21st Century, an adequate telecommunications infrastructure is vital for business and industry as well as residents.*

Figure 6.1

TELECOMMUNICATIONS



> ***Telecommunications targets and benefits.*** *To build a proper foundation for a smart city, you must have high-speed broadband and citywide communications. With those elements in place, you can expect benefits like the ones called out here.*

Figure 6.2

Telecommunications today and tomorrow

Before we define the targets for tomorrow's telecommunications, we should first examine how it works today. Most cities already have many existing communications networks operating side-by-side. A typical city may have multiple cellular/mobile networks plus cable, satellite, RF mesh, microwave, radio, fiber optics, WiFi for homes and offices, ZigBee for smart meters and appliances and more (see list on the next page). Sadly, it can be challenging to bridge between today's networks, making it difficult to achieve the seamless, end-to-end connectivity required for a true smart city.

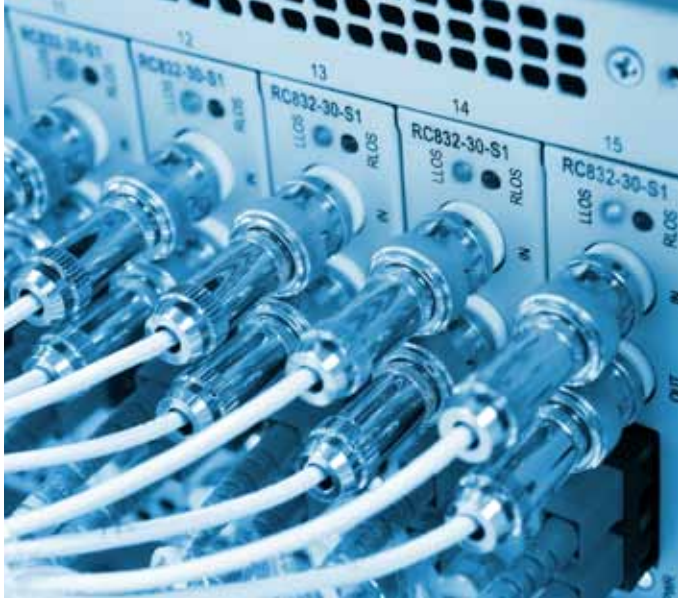
If that is today's reality, then where do we want to go next? The smart city of the future is likely to have an underlying fiber optic network as both a metro loop around the city (like a ring road for traffic) and then local access that links buildings to this loop. Incredibly, tests have been able to send 100 terabits per second through a single optical fiber – enough to download the entire contents of the Library of Congress in seconds! Although fibers do not run at this speed in normal usage, the extraordinary headroom in terms of performance increases is clear. Wireless access to this underlying network may be provided by WiFi, by RF Mesh, by cellular/mobile technologies or some combination.

Some businesses have taken steps to support this 'high-speed fiber backbone.' For instance, in 2012 Council member AT&T invested $14 billion across the United States to significantly expand wireless and wireline broadband networks, and to support future IP data growth and new services

These fiber optic networks provide the bandwidth and speed demanded by the Digital Age. The optical network will terminate in network equipment (eg., an optical network unit) that will then break out and deliver IP and other traffic types to their destinations via a local access network. But a city also needs omnipresent wireless to provide access to sensors, controllers, laptops, tablets, smartphones and other mobile devices.

Most importantly, this future city will have a converged architecture embodied in an all-IP, packet-based core network – a unified infrastructure that integrates various wired and wireless technologies, thereby achieving the seamless connectivity required. When we say "converged" or "unified" we do not mean that a city will end up with a single telecommunications system. Rather, we mean that it will end up with a single architecture – a single set of standards – that allow multiple networks to transmit information smoothly. As we move towards the future, interoperability will be key.

Those three elements – fiber plus wireless plus a converged, delayered architecture are the essentials to achieve the high speed, high reliability and high availability telecommunications required in a modern city.



> ***The telecommunications foundation.*** *The smart city of the future will have a fiber optic loop that reaches most buildings, combined with citywide wireless communications such as 3G/4G cellular, Ethernet, WiFi, RF mesh or some combination.*

Figure 6.3

TELECOMMUNICATIONS TERMINOLOGY

Most cities already have multiple telecommunications networks in place. Here are 10 of the telecommunications terms and technologies seen most often.

Cable – Coaxial cable, an inner conductor surrounded by insulation and a conductive shield, originally used for cable television but increasingly used as well for voice and data.

Cellular/mobile – A radio network of transceivers called base stations distributed over land areas called cells. Cellular/mobile uses licensed frequencies and services provided by regional and/or nationwide operators. It is typically used for mobile broadband data, voice and text services.It is increasingly being used in machine-to-machine applications. For example, to collect data from smart meters and other sensors. Comes in various flavors including 3G (3rd generation) and 4G-LTE (Long-Term Evolution).

Fiber / FTTH – Fiber optics are thin, flexible strands of glass that transmit signals as light. The bandwidth enables single fiber optic cables to easily deliver 1 Gbps (one thousand million bits per second) services and even faster. Fiber to the Home, or FTTH, describes fiber being deployed to directly connect an operator's central distribution office to individual homes.

Microwave – Line-of-sight devices that must typically be placed in high locations so the sender and receiver can "see" each other. Often relayed from station to station.

POTS – or Plain Old Telephone Service, typically delivered to homes and businesses over twisted pair wires. POTS is a part of the Public Switch Telecom Network (PTSN).

Powerline – Transmitting data over existing electric power lines both inside the home (HomePlug) or outside (Broadband over Powerline). Typically used to collect data from smart meters and other sensors.

RF Mesh -- A system using radio frequency (RF) in a "mesh" configuration such that individual nodes pass a message along until it reaches a "collector" or "gateway" that can forward it to the backhaul network. Typically used to collect data from smart meters and other sensors.

Satellite – Communications satellites can be thought of as microwave relay stations placed

Figure 6.4

very, very high (typically 22,000 miles above the earth). They are often used to relay global positioning signals or to deliver television services to homes and businesses.

WiFi – A popular networking tech-nology that uses unlicensed radio waves for short- to medium-range wireless connections.

ZigBee – A communication protocol for "personal area networks" (PANs) created by small, low-power digital radios. Typically used to connect smart meters to thermostats and home appliances that are a short distance apart.

The importance of telecommunications

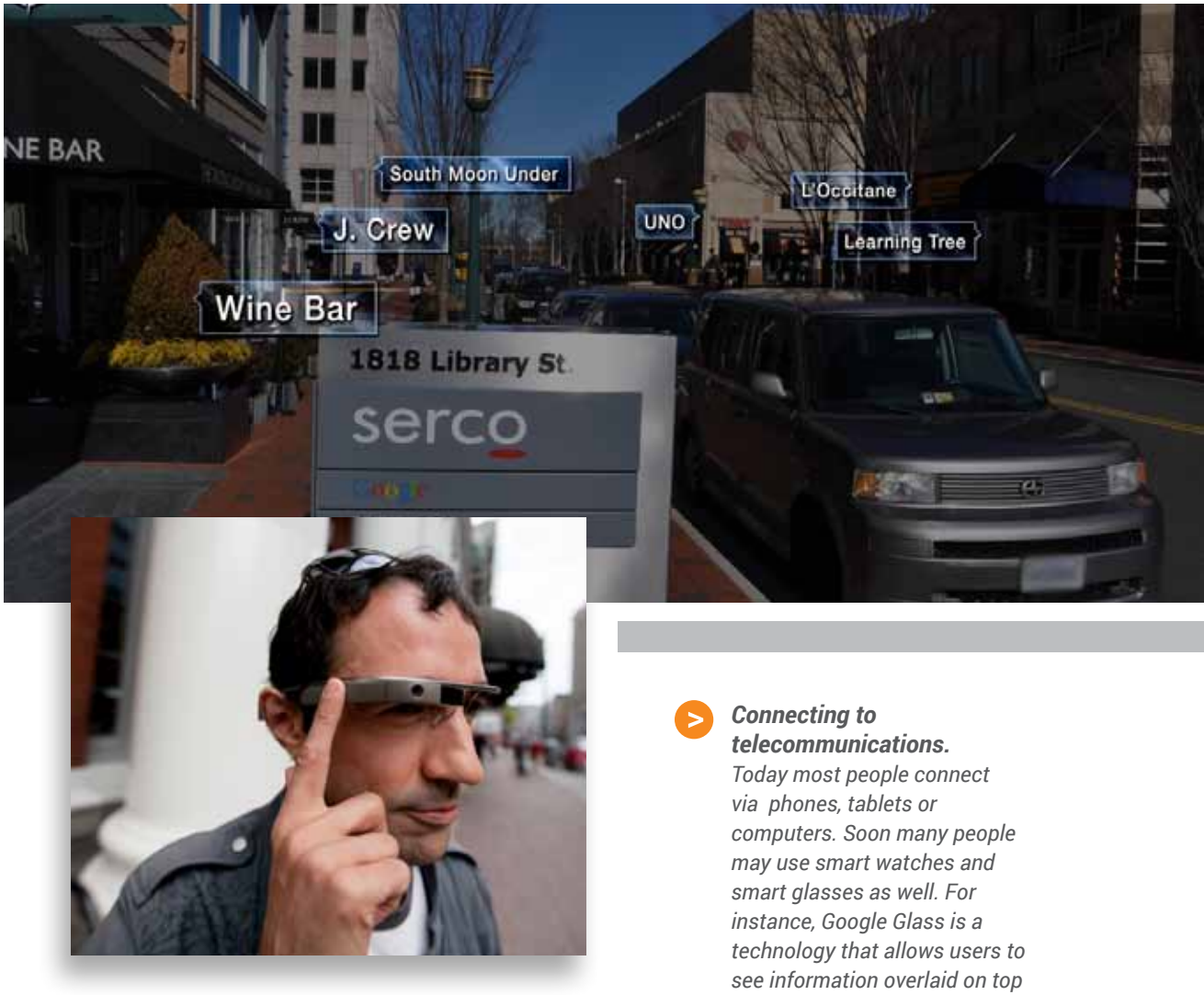
Telecommunications is used in two ways:

1. **To connect to devices people use indirectly** – such as sensors and switches. By 2020 there could be upwards of 50 billion devices and sensors connected in M2M (machine to machine) applications.

2. **To connect to devices people use directly.** Today that means computers, tablets and smartphones. Soon it may also mean smart watches and smart "glasses" (see nearby photos).

In both ways, telecommunications plays a pivotal role in the daily pulse of a city:

- Banks rely on it to process transactions
- Online retailers use it to receive and acknowledge orders
- Cloud computing data centers require it to communicate with thousands or even millions of computers
- Emergency responders need it to receive and act upon life-saving alerts
- Parents rely on it to stay in touch with their children
- Families use it to get access to movies, television and the Internet



Connecting to telecommunications. *Today most people connect via phones, tablets or computers. Soon many people may use smart watches and smart glasses as well. For instance, Google Glass is a technology that allows users to see information overlaid on top of their normal view of the world. It accepts commands via voice recognition. Images: Vancouver Sun and John Angelo*

Figure 6.5

Connecting to devices people use indirectly:

CELLULAR COMMUNICATIONS TAPPED FOR MASSIVE UK SMART METER ROLL OUT

In March 2011, the United Kingdom (UK) issued a policy to roll out smart metering to all residential and small- and medium-sized non-domestic gas and electricity customers in a cost-effective way, which optimizes the benefits to consumers, energy suppliers, network operators and other energy market participants and delivers environmental and other policy goals.

Among the policy objectives outlined by the UK Department of Energy & Climate Change (DECC) – the agency leading the smart meter initiative – is ensure that the communications infrastructure, metering and data management arrangements meet national requirements for security and resilience and command the confidence of stakeholders.

The DECC selected Telefónica UK, a cellular communications provider with an extensive existing wireless network, as the preferred communications service provider for the Central and Southern regions. Telefónica UK, with over 23 million customers, operates under the O2 brand running standards-based 2G and 3G networks, with 4G coming.

David Plumb, Digital and New Business Director of Telefónica UK, said: "It's a huge endorsement of cellular as the right communications technology and of our vision for smart meters to be the foundation of a smarter energy future for the UK."

> ***Connecting to devices people use indirectly.*** *A massive UK smart meter roll out will rely on cellular communications to provide the communications infrastructure in the Central and Southern regions, transmitting data from meters on homes and businesses to utilities.*

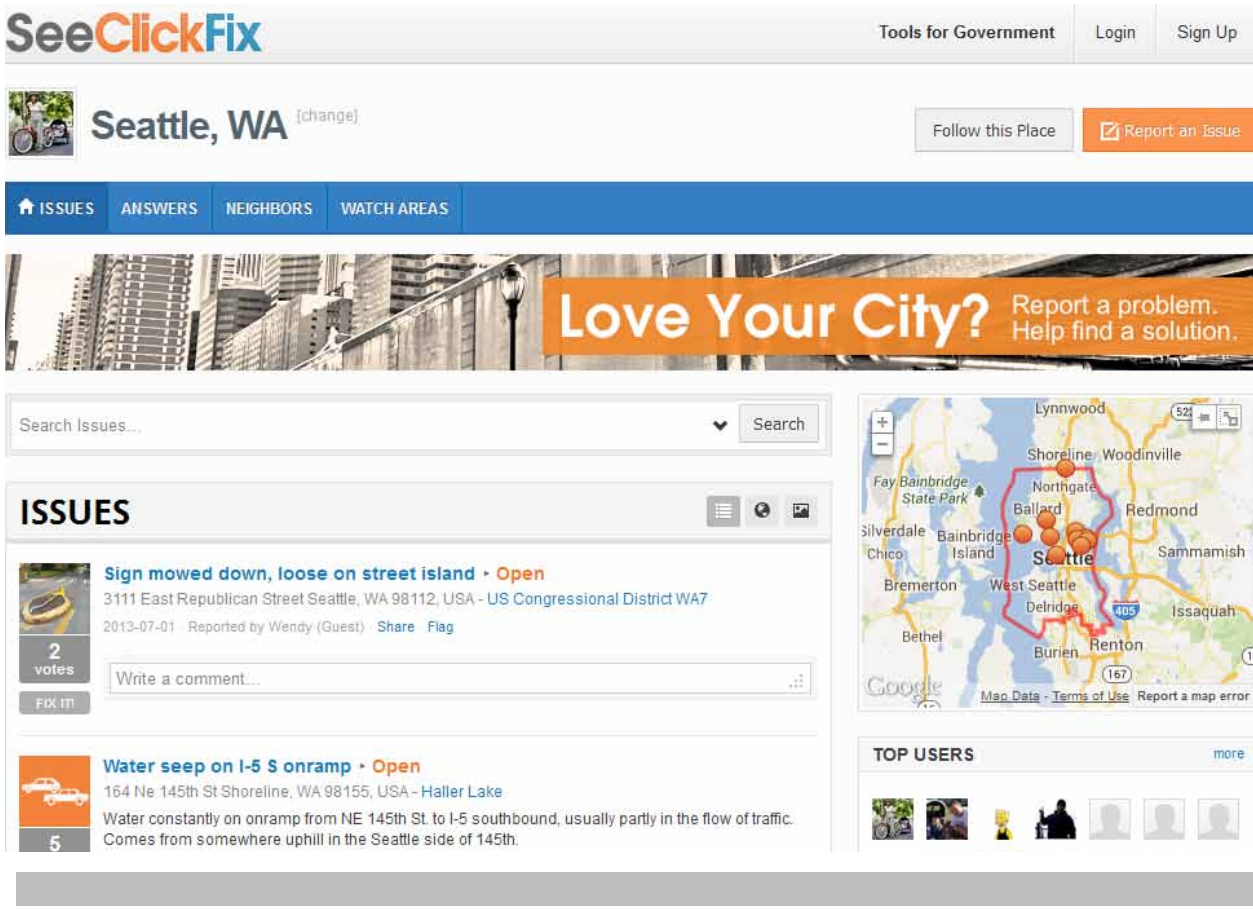
Figure 6.6

The list of ways telecommunications factors into daily life could go on and on, of course. Telecommunications is a necessity for prosperity in the modern economy. And a necessity for the digital lifestyle increasingly demanded by citizens. (In a 2011 Reuters survey, for instance, 61% of Americans said it would be easier to live without air travel than without the Internet.)

Our reliance on telecommunications will only increase as more people are connected to the Internet each day, and as we invent new uses – from tablets, to video streaming, to video phone calls. Council member Qualcomm – a world leader in 3G, 4G and next-generation wireless technologies – estimates that the world will soon need 1,000 times more bandwidth than it had in 2012.

Dependencies in telecommunications

As cities contemplate improvements in telecommunications services, they will need to plan them with an understanding of their dependencies on energy systems and services. This one is pretty simple: communications require power. Period.



Better ways to deliver services.
SeeClickFix allows anyone to report and track non-emergency issues anywhere in the world via computer or mobile device, empowering citizens, community groups and governments to improve their neighborhoods. It uses "distributed sensing" to recognize patterns such as those that gradually take place on a street. Citizens can report issues on the go, and set up watch areas to monitor their block. Governments can watch for potholes and cracked sidewalks. Police can monitor crime issues reported within the precinct.

Figure 6.7

Benefits of telecommunications

Telecommunications play a critical role in promoting livability, workability and sustainability in cities.

Livability

Reducing the "digital divide." Residents without access to the Internet are at an educational and economic disadvantage. By ensuring top-notch telecommunications everywhere, cities can help the disadvantaged level the playing field.

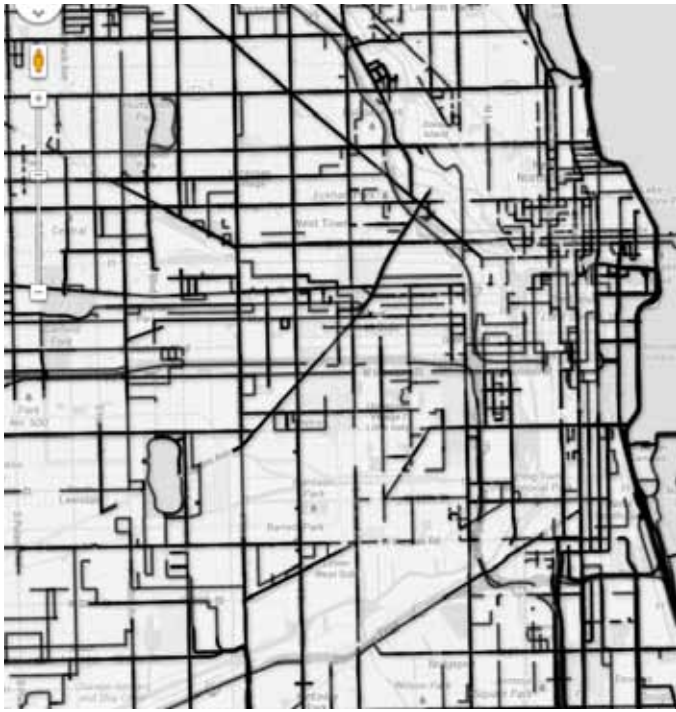
Empowering a connected lifestyle. Access to the Internet and mobile apps delivers an amazing body of human knowledge and connection, ranging from personal interests and hobbies to entertainment options, to job searching, to social media, to online courses and more. In developing countries around the world, mobile devices are now enabling people to have their first experiences with the Internet.

Better ways to deliver services. High-speed broadband creates a whole new way to deliver services. Government can deliver personalized alerts and applications directly to residents' smartphones. M2M solutions can be supported. Schools can make education available 24x7 to anyone with a computer or mobile device. Medical professionals can deliver advice and perform simple examinations remotely.

Enabling safe e-transactions. Many people have come to rely on online shopping and banking. Building a telecommunications infrastructure with solid cybersecurity makes citizen life more convenient and more secure. Enabling safe, easy online and mobile payments reduces the "friction" of the local economy, leading to higher sales and more jobs.

Improving access to health and education. Telecommunications is the bedrock for online education and telemedicine, enabling the delivery of these services above and beyond their traditional boundaries, and allowing health and education professionals to serve a far wider audience than ever before.

Enabling sustainable transportation. Citywide telecommunications makes it possible to monitor and optimize the flow of cars and pedestrians. Fleet managers can track their vehicles and optimize their routes, saving time and fuel while reducing pollution and minimizing the number of trucks on the road. Parking spaces can signal when they are free, so drivers can drive directly to an open spot and avoid circling the block repeatedly.



> ***Reducing congestion.*** *Chicago suffers through numerous snowstorms each winter. Using an application called Clear Streets, residents can now see which streets have been plowed because the city's snowplows report their position via telecommunications. Residents can enter their address to learn whether a plow has already been by.*

Figure 6.8

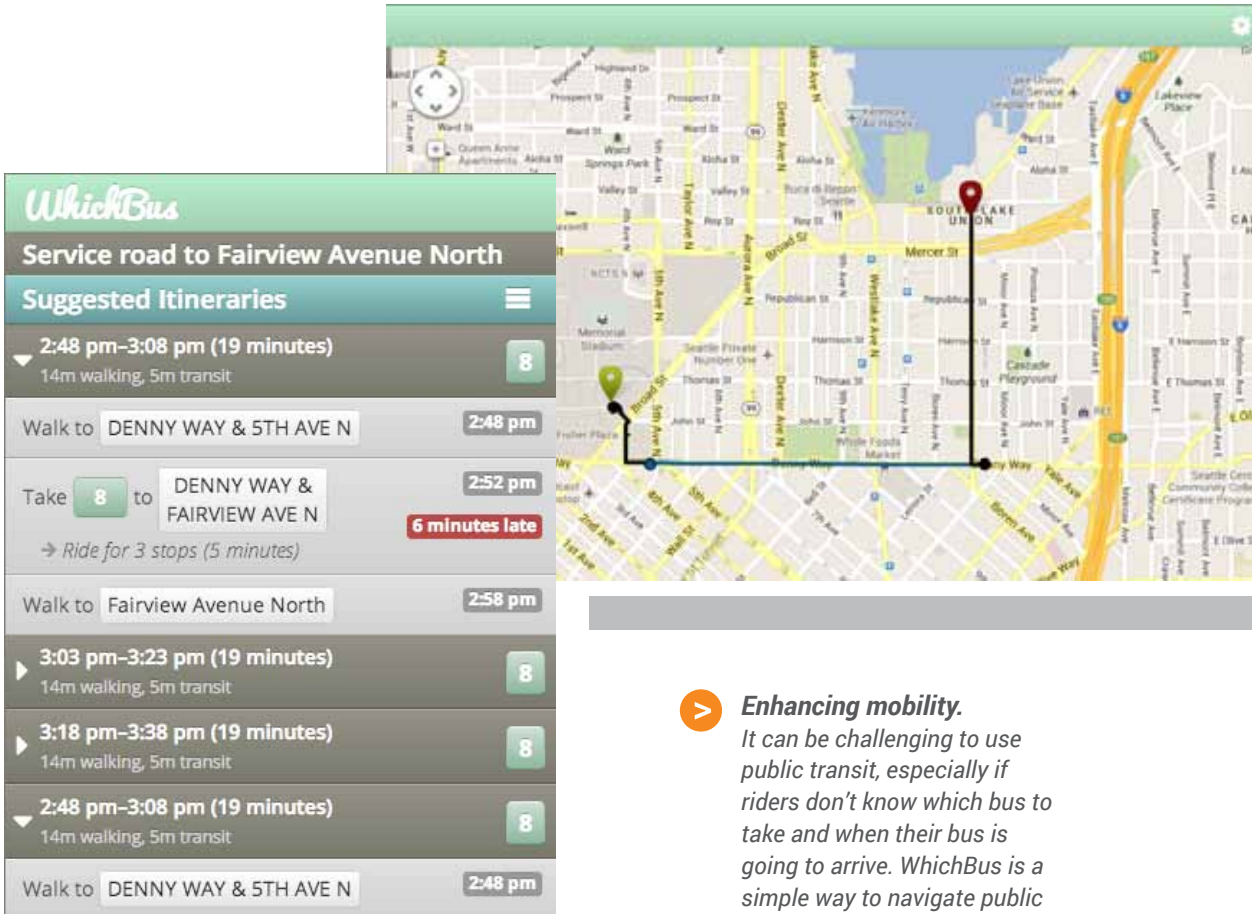
Workability

Enhancing mobility. All over the world, mobile apps are helping people plan their routes, make better use of mass transit, and otherwise travel with greater convenience and speed and less congestion and pollution.

Enabling telecommuting. Fast, reliable Internet access enables telecommuting, creating a more flexible and satisfying lifestyle while improving productivity.

Attracting business and investment. Broadband and high-speed Internet access are no longer a convenience, they are an economic and business requirement. Cities with superior telecommunications have an edge when courting business investment. This advantage was captured in a stunning 2011 study by the World Bank that found that GDP rises 1.3% for every 10% increase in broadband penetration. Similar effects have been found for mobile broadband.

Real estate developers and business owners consider a robust telecommunications infrastructure a requirement. A city's attractiveness is directly related to its ability to offer the services that support growth and create competitive differentiation. What's more, citywide telecommunications help attract investment to areas that would not otherwise see it, such as low-income inner-city neighborhoods.



Enhancing mobility.
It can be challenging to use public transit, especially if riders don't know which bus to take and when their bus is going to arrive. WhichBus is a simple way to navigate public transit in Seattle, Washington, USA. It combines both trip planning and real-time arrival information. It is available on any browser, including phones and tablets.

Figure 6.9

Creating jobs. A 2010 Communications Workers of America study found that every $5 billion investment in broadband creates 100,000 direct jobs plus another 150,000 "spinoff" positions.

Helping people boost their professional skills. Expanded access to broadband gives people better access to online professional training programs, online tertiary education and city employment services.

Increasing business access to the global economy. A smart telecommunications network allows local businesses to gain access to national and international markets, and for rural areas to connect to the world economy.

Sustainability

Reducing the need for transportation. Advanced telecommunications enables video-conferencing, telecommuting, telemedicine and online education – all things that lessen the need for lengthy commutes that pollute the air and prolong our dependence on fossil fuels.

Getting more from existing assets. When expensive equipment – transformers, pumps, power plants, power lines – can be remotely monitored, it can be pushed to its maximum capacity without fear of overload. By the same token, its actual condition can be monitored so repairs can be made before the equipment fails, thereby extending its life.

Reducing energy and water use. Smart grids need to connect their embedded devices to technicians and control centers if they are to succeed and reduce resource waste – and they rely on telecommunications for this service. Likewise, telecommunications enables smart buildings to report their conditions and optimize their systems to use as little water and power as possible.

Reducing the need for transportation. *Advanced telecommunications means people can more easily work from home, access medical advice via telemedicine and learn online – all of which reduce the need for lengthy commutes that pollute the air.*

Figure 6.10

Ensure ubiquitous broadband access. *Smart cities ensure best-of-breed, high-speed broadband access across their geography to all or most buildings.*

Figure 6.11

Telecommunications targets

To this point, we've defined telecommunications and discussed its importance. Now we'll discuss the specific targets that will allow a city to enjoy benefits like those described above.

Instrumentation and control

We use the term "smart cities" but they are also referred to as "digital cities." And for good reason, as you'll see in this section, where we introduce the two telecommunications-specific targets – broadband access and citywide wireless.

Ensure ubiquitous high-speed broadband access. This is the first target exclusive to the telecommunications responsibility. Smart cities ensure best-of-breed, high-speed broadband access across their geography to all or most buildings. Since cities have different legacy investments and circumstances, and because technology will change rapidly in 20 years, we cannot make a definitive technical specification. As noted, however, today this typically means a fiber optic backbone combined with increasingly high bandwidth wireless technologies. Your goal should be to eventually connect virtually every business and home to that fiber loop (or to whatever technology you use in its place).

Important note:
This target does not imply that a city needs to build out high-speed access at its own expense. In most parts of the world, broadband access is provided by the private sector. Elsewhere, public-private partnerships play a role. Even so, a city can provide valuable leadership, helpful incentives, and encouraging policies that go a long way to ensuring that residents and businesses have the access they need.

Ensure ubiquitous high-speed broadband access:

ROBUST TELECOMMUNICATIONS HELP AMSTERDAM COMPETE

Amsterdam, the financial and cultural capital of the Netherlands, strives to be one of Europe's greenest, most sustainable cities while continuing to maintain economic growth. Over the past decade, the city developed a plan for collaborating, envisioning, developing and testing connected solutions that could pave the way to a smarter, greener urban environment.

It teamed in numerous public-private partnerships to create the platforms and services needed to help achieve its goals. SmartCities Amsterdam is the public-private organization that oversees projects with more than 70 partners, including Council member Cisco and many other organizations.

"Broadband is the essential infrastructure for SmartCities projects," says Maaike Osieck, Communications Lead for SmartCities Amsterdam. "From connected buildings, to fiber to the home for residential service delivery, Cisco routing and switching solutions power the core network and aggregation capabilities that underlie projects designed to improve sustainable living and working, public spaces and mobility." Those solutions adhere to IPv6.

Amsterdam's vision evolved into a Cisco Smart+Connected Communities initiative to transform to a connected community. Its vision is wide-ranging, aiming to provide services for connected real estate, government services, utilities, transportation and healthcare. Teaming with a large ecosystem of private and commercial partners, Amsterdam

> ***Ensure high-speed broadband access.*** *Amsterdam has worked with Cisco and other companies to achieve broadband access throughout the city. As a result, says one official, Amsterdam has "a wide-open marketplace for innovative services and economic growth, as well as a fast track for the smarter and cheaper delivery of healthcare, education and other public services."*

Figure 6.12

deployed a citywide network that forms a strong foundation for the delivery of smart services and a wide-open marketplace supporting economic growth.

A citywide broadband network creates the foundation. Initiated in 2008, the network originally connected 40,000 households and small businesses through fiber to the home. Three years later, 140,000 homes and businesses had been connected and the city continues to deploy fiber across all areas of the city.

With widespread connectivity in place, the city and Cisco created a foundation to develop Smart Work Centers, which are sustainable work environments designed to deliver information to users, no matter where they choose to work. Located near residential communities, they help reduce or eliminate commuting while enabling workers to access their full corporate resources. Space can be rented by anyone from sole proprietors to multi-national corporations. Workers have access to office space, meeting rooms, broadband connectivity and Cisco TelePresence collaboration systems.

"This robust broadband foundation enables our city to compete with other European cities," says Frans-Anton Vermast, Advisor, Public and International Affairs, Physical Planning Department, City of Amsterdam. "In this way, we help ensure a wide open marketplace for innovative services and economic growth, as well as a fast track for the smarter and cheaper delivery of healthcare, education and other public services."

Ensure a citywide wireless network. This is the second and final target unique to telecommunications. A citywide wireless network ensures that people – whether at work, at play or otherwise on the go – are not tethered to stationary points of Internet access. A citywide wireless network leveraging WiFi or cellular empowers a city and everyone in it, creating competitive advantage and convenience.

Cities have several technology choices. Some may choose WiFi, a wireless standard that has been around for years. And other regions are choosing the latest versions of cellular/mobile technology, most notably LTE. Most cities work with providers to identify the solution(s) right for them.

Citywide public wireless has been a luxury until recently. But we are seeing evidence that it is gradually becoming a must-have, at least for those cities that hope to attract high-income technology professionals. For instance, Austin, Texas in the spring of 2013 hammered out an agreement to deploy an ultra-high-speed Google Fiber network and later announced that a significant WiFi network would hook into it. The city of Vancouver, B.C. began deploying a citywide wireless network as outlined in its 2013 Digital Strategy, which calls wireles access "a fundamental aspect of any digital' city" and one that "is expected by citizens." And many cities are using mobile/cellular, including LTE, to ensure citywide coverage. Going forward, citywide wireless access is likely to be heterogeneous – that is, citizens and businesses will access a variety of wireless technologies in both licensed and unlicensed bands to get the best experiences.

Ensure a citywide wireless network:

SILICON VALLEY POWER PROVIDES A FREE PUBLIC WIFI NETWORK

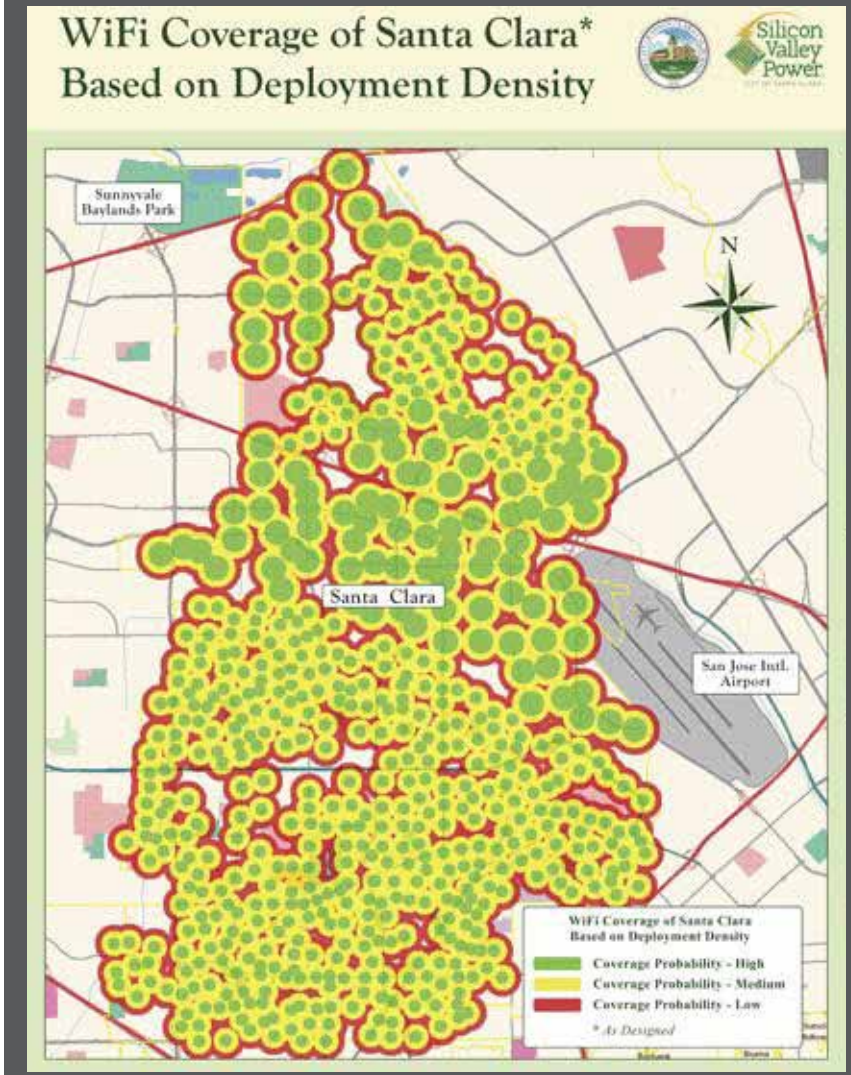
In 2013, Silicon Valley Power (SVP) opened up its existing Tropos wireless communications network provided by Smart Cities Council member ABB to provide free public outdoor WiFi access throughout the city of Santa Clara. Residents and visitors use client laptops, tablets and smartphones with standard WiFi connections to access the Internet throughout the outdoor areas of Santa Clara. The new Santa Clara Free WiFi service replaces an outdated and limited system and provides WiFi access to residents as well as the tens of thousands of workers who commute to the city to work for companies that form the cornerstone of the high-tech industry.

The SVP MeterConnect program includes the Tropos field area communications network, which is based on open-standard IP networking and radios. Previously used to read smart meters, it has now been opened up for use by residents as well.

In the future, the city plans to use the same network to provide mobile access for municipal field workers (public safety, building and fire inspectors, parks and recreation and others) to reduce operational costs and deliver greater bandwidth.

> ***Ensure a citywide wireless network.*** *Silicon Valley Power's MeterConnect program includes a WiFi communications system that connects smart meters to SVP offices while also providing citywide access for other city services. It is also an example of a multi-service communications system.*

Figure 6.13



Connectivity

So far we've talked about the telecommunications responsibility – how telecommunication can ***empower*** a smart city and its residents. In this section, we highlight how connectivity acts as an ***enabler*** of smart cities.

Connect all devices with a citywide, multi-service communications system(s). This universal target deserves additional discussion as it applies to telecommunications.

Earlier we discussed the importance of high-speed access and citywide wireless. For connectivity purposes – for connecting sensors, switches and devices – it is not strictly necessary to have either one. In theory, connectivity can be accomplished with low-speed wireline technology. Many electric power utilities, for instance, use low-speed powerline technology to talk to their smart meters and sensors.

Regardless of the telecommunications technology you choose for device connectivity, strive to make it a "multi-service" network. That is, try to use it for a variety of purposes across different city departments. If each department stands up its own special-purpose network, your city will spend far more than needed. What's more, it will have a harder time managing and maintaining all those disparate networks. And a harder time passing data back and forth between departments. In fact, the services architecture layer should be abstracted from the underlying access network technologies. This enables the network to be continually upgraded with less disruption of the service layer

The clear trend worldwide is to move away from slow, single-purpose communications to fast, multi-service networks. This implies that you may be able to achieve device connectivity by using a high-capacity network that is already in place – be it cellular/mobile 3G or 4G-LTE, WiFi or other solutions like RF mesh, though data rates vary dramatically. You should identify which technology makes the most sense for your city according to your performance and cost requirements, and your circumstances.

If you are approaching device connectivity for the first time, then your technical team must take a hard look at two aspects: bandwidth and latency. Bandwidth is the amount of data that can flow through at one time (just as the width of a pipe determines how much water can flow through). Latency is the time lag to get data back and forth. A network can be high bandwidth (lots of data at the same time) but low latency (a slow roundtrip). Or vice versa.

Your technical team must carefully determine your bandwidth and latency requirements. For instance, a network for monitoring street lights may be able to get by with high latency (a slow roundtrip). After all, it doesn't really matter if a light turns on or off a few seconds late. But a network for monitoring electric power substations may need very low latency (a fast roundtrip). That network must be able to send and receive signals very rapidly so it can prevent a small outage from cascading to a big blackout.

Whatever your current requirements, try to leave headroom for future growth. At the very least, make sure that the products you choose are "future-friendly" – are capable of expansion when the time comes. In the early days of the smart grid, for instance, some pioneering utilities selected underpowered connectivity solutions in the hopes of saving money. But they spent more money in the long run. Many of them had to go back and upgrade their initial network a few years later. Others had to put in a new system parallel to the old one to get enough capacity. If you build it, they will come, so build in as much extra capacity as your budget allows.

Connect devices with a multi-service communications system:

CITY COUNCIL MAKES SIGNIFICANT SAVINGS WITH UNIFIED COMMUNICATIONS

Leicester City Council provides universal public services to the largest city in the East Midlands, UK, with a population of more than 300,000.

Faced with the challenge of funding cuts, rising customer expectations and having to move premises, the council embarked on a business transformation strategy. It needed to take control of its data, enhance customer experience and modernize its ICT infrastructure to support flexible, collaborative working. As part of this modernization program the council looked to replace its Novell email, diary and file and print solution, along with its existing private branch exchange (PBX) telephone system, supporting more than 8,000 unique numbers.

It deployed a solution using Council member Microsoft's desktop, server, collaboration, unified communications, business intelligence and mapping technologies—replacing the Novell systems with a Microsoft platform.

As a result, efficiencies have been achieved across the council through the adoption of new ways of working and the migration to Microsoft technology. Having documents in electronic format has helped staff access key information quickly and securely, resulting in better service productivity, improved decision making and increased staff sense of worth. The council's carbon footprint has been reduced through green ICT and collaboration with other agencies has been enhanced through better data management.

> ***Connect devices with a multi-service communications system.***
> *The Leicester City Council's business transformation strategy included Microsoft desktop, server, collaboration, unified communications, business intelligence and mapping technologies.*
>
> ***Figure 6.14***

Interoperability

Telecommunications networks are major expenditures that cities must get right. These interoperability targets ensure that the systems you use will not strand you with a dead-end system, or tie you to a single vendor.

Adhere to open standards. By insisting on open standards, cities increase choice and decrease cost, as products can be mixed and matched from different vendors. Telecommunications has dozens of relevant standards, but the most important is IPv6 (Internet Protocol version 6), since IPv6 has the huge address space required to accommodate the millions of devices that will ultimately connect to the network. In addition to building the core architecture around IPv6, cities should adhere to published standards from accredited groups such IEEE, WiFi Alliance, IEC, 3GPP and the ITU. Cities can get ahead by leveraging standards that have global scale and interoperability, with strong vendor base and widespread demand.

Prioritize the use of legacy investments. Every city wants to wring maximum value out of its technology investments. If there are ways to use existing assets in the build out of a telecommunications network, it will save money for other purposes and reduce the number of stranded assets. During the dot-com bubble, many different companies built optical fiber networks, each hoping to corner the market. However, the advent of a technique called "wavelength-division multiplexing" increased the capacity of a single fiber by a factor of 100. As a result, the value of those networks collapsed. The misfortune of those companies means that many cities have miles of "dark fiber" under their streets – fiber that can be repurposed at a fraction of its original cost.

Longmont, Colorado, for example, recently located and repurposed an 18-mile fiber optic loop that was installed in 1997 for $1.1 million by a local power company. It was abandoned after an early partner in the broadband venture went bankrupt. Finding and repurposing fiber can save cities millions in installation costs while re-invigorating the local economy.

Privacy and security

For all of the benefits that broadband and wireless technologies provide, there are important privacy and security considerations that need to be addressed. In particular:

Create a security framework. This universal target is especially important to telecommunications, since the telecommunications network is one of the "access points" for cyber criminals. There is no point in hardening the

> ***Prioritize the use of legacy investments.*** *Longmont, Colorado has repurposed a fiber optic loop abandoned in 1997. Cities can often find ways to reduce costs by using existing assets to build out their telecommunications networks.*

Figure 6.15

rest of the city if the telecommunications system has its door unlocked. Your citywide security framework should explicitly lay out minimum security standards for any telecommunications network it employs.

Implement cybersecurity. The same is true for this universal target. The more telecommunications, the more vulnerability to cyber attack. Insisting on cybersecurity measures early on maximizes protection while minimizing costs.

Computing resources

An advanced telecommunications system that includes high-speed broadband and citywide wireless not only makes it easier for city residents and businesses to access the Internet anytime from anywhere. It also enables these important targets.

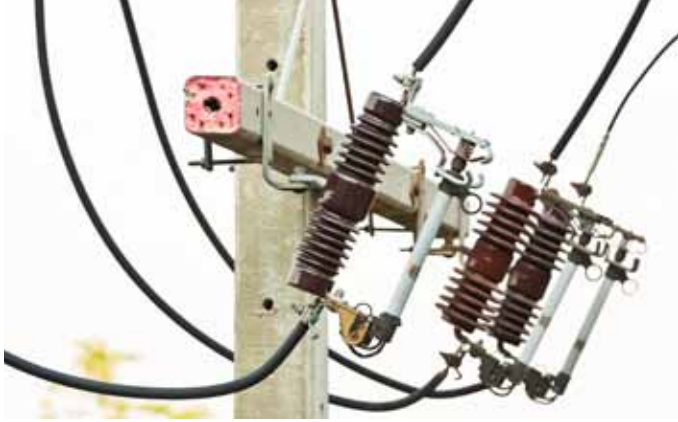
Have access to a central GIS. The point of citywide wireless is to empower residents as they move about the city. Once they are mobile, they will of course want access to global positioning and geographic information. For instance, city employees will want the ability to see field assets on a map with descriptions – traffic signals, street lights, water mains, park facilities, etc.

Have access to comprehensive network and device management. Once a city has high-speed access and citywide wireless, the number of connected devices will skyrocket. You will need device management software to provision and manage those devices. Departments with maintenance operations will need to manage mobile phones, tablets and laptops connected to the network. Municipal power and water utilities may need to monitor and manage thousands or even millions of smart meters and sensors. Likewise, if the city operates any telecommunications networks of its own, it will need network management software. For instance, some municipal electric power utilities seek "hybrid" management software that can oversee multiple networks from a single console. (Many utilities have multiple networks in place side-by-side.) And don't forget the importance of a comprehensive device management program to enforce compliance with city data management, security and privacy policies.

Partnering with suppliers, operators and service providers is the typical path to get access to network and device management.

Analytics

We mentioned in an earlier chapter how smartphones create the equivalent of human sensors that collect and broadcast data over telecommunications networks. These add to the data stream that cities can use to analyze patterns and trends and improve city services. One of the universal targets for analytics deserves additional discussion in the context of telecommunications.



> ***Achieve asset optimization.*** *In telecommunications, multi-service networks can maximum ROI.*
>
> ***Figure 6.16***

Achieve asset optimization. This universal target refers primarily to the use of sophisticated software to a) run equipment to capacity while still staying safe and b) predicting when expensive equipment will need repair and c) calculating which equipment is most critical to prioritize replacements and upgrades. When it comes to telecommunications, it can also refer to a "manual" process – namely, the idea of multi-service networks – using a single telecommunications network for multiple purposes to extract maximum value from your investment.

COORDINATION HELPS DELIVER A NATIONAL BROADBAND-STYLE NETWORK IN MUSCAT, OMAN

The wastewater company in Muscat, the capital of the Sultanate of Oman in the Gulf, has shown great vision as it looked to install a new sewer system across 70% of the Governorate of Muscat.

Recognising they would be digging up streets with large trenches, the company engaged in a study to consider the benefit of creating an FTTH network at the same time. Trenching and the associated civil works can be as high as 80 percent of the total network cost for FTTH. But being able to install ducts into an existing open trench, with the backfill and reinstatement already going to be paid for by the main sewer project, was very attractive.

By the end of the project, Muscat will have a FTTH network at a cost far below what would normally need to be spent and with open-access planned in from the start.

The team at Haya Water, their consultants, the Ministry of Communication, Finance Ministry and the telecom's regulator all worked hard to put in place the right conditions and investment for the development. In fact, the attractiveness of this network for the 70 percent of the governorate meant the government and relevant bodies decided to invest in brownfield deployments across the other 30%. This is more expensive as it does not benefit from the 'free ride' of trenches dug for another purpose. However, it shows the determination of all parties to create a world-class network.

> ***Coordination reduces costs and disruption.*** *One thing which annoys residents and businesses is when streets are dug up by one company, repaired and then dug up a month later by another. The project in Muscat is an example of what can be created with vision and coordination.*

Figure 6.17

ADDITIONAL RESOURCES

Target: Ensure ubiquitous high-speed broadband access

Speed matters: benefits of broadband

This white paper on the benefits of broadband from the Communications Workers of America makes the point that high-speed Internet access has become vital to the success of individuals and communities. It suggests governmental action—in partnership with the private sector—is essential to stimulate broadband investment.

Benefits of collaboration

How a Florida city got 1 gigabyte service (and saved $200,000)

Envious of the Google Fiber cities program that had passed Jacksonville, Florida by, the city's IT team started looking at other ways to get a high-speed network in Jacksonville. In 2012 the discussion turned to ways to get 1 gigabyte service, which aligned with the mayor's vision for technology enhancements and consolidation.

Broadband beyond your borders

Preparing for public safety broadband

City leaders exploring the deployment of a broadband network for public safety may find some useful pointers from this best practices document prepared for state leaders in the U.S. when legislation was passed calling for a nationwide broadband network dedicated to public safety communications. The document explains what such a deployment means from a technology standpoint and provides readiness advice for leaders.

TELECOMMUNICATIONS TARGETS

*In the checklist below, targets specifically pertaining to the telecommunications responsibility are in **bold,** universal targets are not.*

TECHNOLOGY

Enabler	Telecommunications Targets How smart cities deploy and use ICT to enhance their telecommunications	Implementation Progress None Partial Over 50% Complete
Instrumentation & Control	Implement optimal instrumentation **Ensure ubiquitous high-speed broadband access** **Ensure a citywide wireless network**	
Connectivity	Connect devices with citywide, multi-service communications	
Interoperability	Adhere to open standards Use open integration architectures and loosely coupled interfaces Prioritize use of legacy investments	
Security & Privacy	Publish privacy rules Create a security framework Implement cybersecurity	
Data Management	Create a citywide data management, transparency and sharing policy	
Computing Resources	Consider a cloud computing framework Use an open innovation platform Have access to a central GIS Have access to comprehensive device management	
Analytics	Achieve full situational awareness Achieve operational optimization Achieve asset optimization Pursue predictive analytics	

Figure 6.18

CHAPTER 7

TRANSPORTATION

In this chapter we refer to transportation as any and every system that moves people around a city. Think of a city's streets, vehicles, railways, subways, buses, bicycles, streetcars, ferries and so on. All play an essential role in the hustle and bustle of today's cities – in commuting to work, running errands, attending classes, enjoying a night out, shipping and receiving products, delivering pizzas. We rely on the vast web of transportation networks in our cities. We trust that they will get us where we need to be in an efficient, safe manner for a reasonable price.

But that's not always the case. Transportation networks in cities around the world struggle with serious problems, like congestion. A recent study calculated that traffic congestion in 2011 wasted $121 billion in the United States alone in time, fuel and money. Another study predicts that emissions from vehicles idling in traffic jams will result in 1,600 premature deaths and $13 billion in "total social costs" in the U.S. by 2020.

Of course it's not a problem the U.S. faces alone. A 2012 Congestion Index comparing congestion levels in 2012 versus 2011 in 161 cities across five continents ranked the top 10 most congested cities as:

1. Moscow
2. Istanbul
3. Warsaw
4. Marseille
5. Palermo
6. Los Angeles
7. Sydney
8. Stuttgart
9. Paris
10. Rome

Fortunately, there are a lot of ways cities can fix traffic congestion by deploying ICT, as you'll read about in the pages that follow.

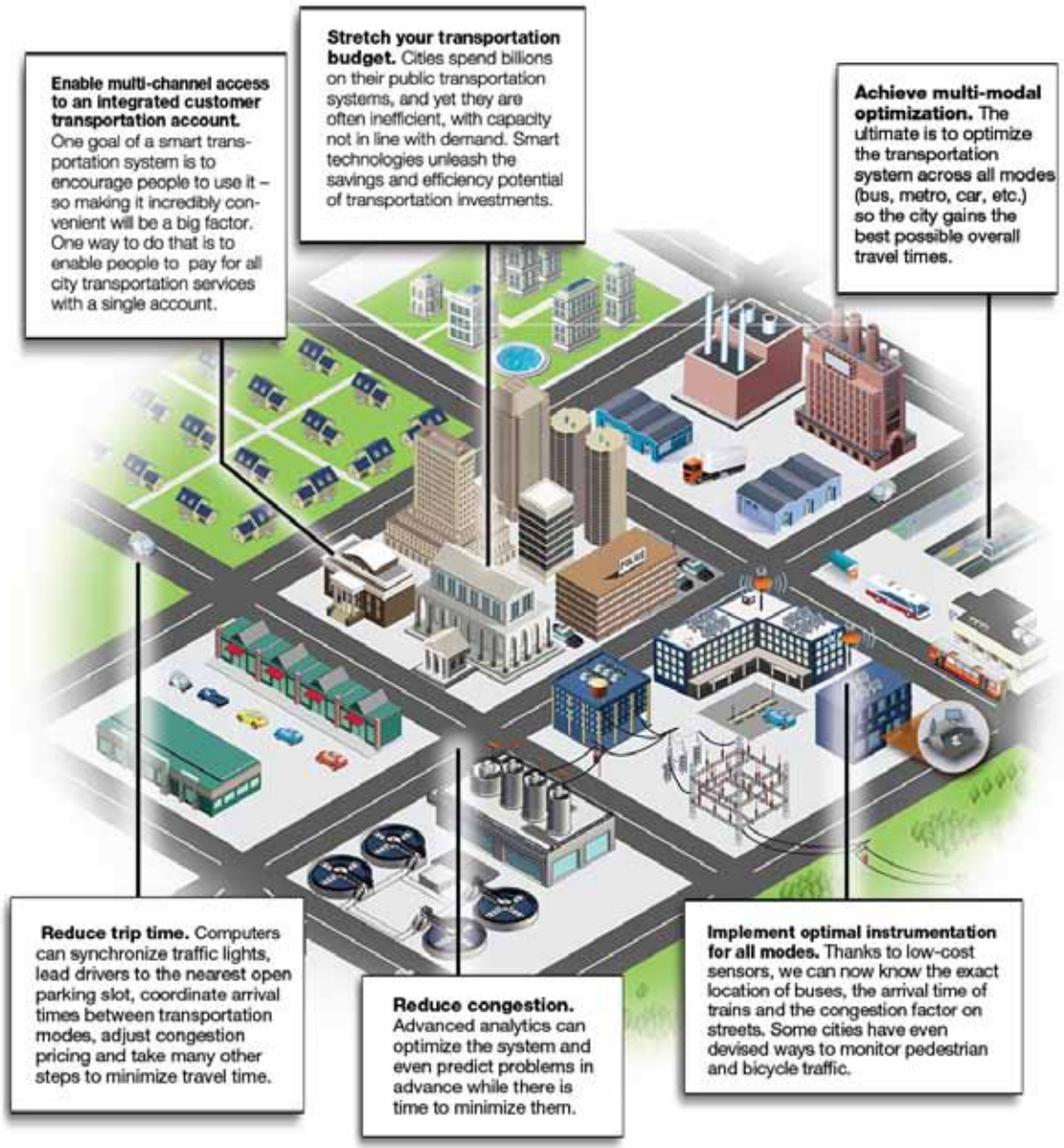
The promise of smart transportation and the reality of city congestion mean that this market subsector is growing rapidly. A 2012 study by MarketsAndMarkets found that global spending on smart transportation initiatives will quadruple to more than $102 billion in 2018 from almost $27 billion in 2012.

As you explore this chapter you'll discover there are four targets that cities need to achieve to put smart transportation into high gear. We'll also briefly discuss how the universal targets apply to transportation. But first, a quick look at transportation dependencies and then we'll highlight the incredible benefits in livability, workability and sustainability that smart transportation networks provide.

> ***The promise of smart transportation.*** *Cities around the world struggle with traffic congestion. Fortunately there are a lot of opportunities to improve traffic flows using ICT.*

Figure 7.1

TRANSPORTATION



> ***Easing traffic congestion by deploying ICT.***
> *We rely on the vast web of transportation networks in our cities, yet so many metro areas struggle with congestion. Advanced analytics and instrumentation can provide cities with the information they need to minimize it.*

Figure 7.2

Achieve operational optimization:

WHAT A DIFFERENCE FAST, ACCURATE TRAFFIC DATA MAKES IN BUCHEON CITY

Located at the crossroads of Seoul and Incheon in the western part of Korea, Bucheon City is an attractive and bustling area that promotes itself as the cultural hub of metropolitan Seoul.

The city lacked the insight it needed to reduce traffic congestion and minimize emergency response times for traffic incidents. Traffic data from its existing solution was highly inaccurate (≤ 50 percent). For areas where a vehicle detection monitor was not installed, the city was monitoring traffic flow and counting manually from closed-circuit television video, a time-consuming task that often resulted in inaccurate and unreliable traffic data. Without a better traffic monitoring system, the city struggled to reduce congestion, manage urban traffic and meet the needs of its citizens.

To overcome the problem, Bucheon City implemented a solution that provides real-time traffic information and alerts to help drivers avoid congestion.

Utilizing the Smart Vision Suite Traffic Extension and other solutions from Smart Cities Council member IBM, Bucheon City:

- **Increased accuracy of traffic volume data** from 50 percent (or less) to 90 percent, ensuring that drivers receive more accurate reports on traffic tie-ups, suggested route changes, etc.
- **Increased speed of collecting traffic data** by over 1,200 percent, enabling the city to deliver traffic information to drivers, law enforcement and emergency responders in real time
- **Saved on costs** by using existing closed-circuit television video without the need for installing an additional vehicle detection system
- **Reduced labor costs** for manually monitoring traffic volume and counting vehicles

> ***Achieve operational optimization.*** *Bucheon City increased traffic data collection speed by over 1,200 percent, enabling the city to deliver traffic information to drivers, law enforcement and emergency responders in real time.*

Figure 7.3

Dependencies in transportation

Improving transportation infrastructure and services are a high priority for many cities. As they plan improvements they will want to be cognizant of the interdependencies between transportation systems and energy and communications systems as well as the built environment. The connection between transportation and the built environment is straightforward – roads, rails and ports are typically essential components of a smart transportation system – but can also represent massive construction investments.

Beyond cost considerations, the various modes of transport all require power and communications to function properly within a smart transportation environment – especially true as cities move to electrified light rail or buses and set up recharging infrastructure for electric vehicles.

Benefits of smart transportation

In the highlights that follow you'll get a better understanding how smart transportation improves a city's livability, workability and sustainability:

Livability

Reducing traffic and congestion. Advanced analytics and instrumentation can provide cities with the information they need to minimize congestion. Traffic lights can be synchronized and adjusted for optimal traffic flow. In-vehicle collision-avoidance systems can take action to prevent congestion-causing accidents. Incident detention and notification systems can analyze information from cameras and vehicles to detect traffic problems, alert drivers and suggest alternative routes. Parking can be made more efficient through instrumentation and mobile apps.

Reducing trip time. With the help of analytics and ICT, traveler information systems and real-time route planning can plot multi-modal routes for travelers. Smart city transportation networks direct people when and where to switch from a bus to the subway, for example, to arrive at destinations at the lowest cost or fastest time. And traffic and weather alerts can be delivered via smartphone applications to alleviate commute times.

Empowering people with choice and control. Smart transportation gives people the power to make better transportation decisions. In smart cities, multi-modal fare cards are used to pay for all forms of city transportation or parking. And data gathering instrumentation and open data policies empower them with their own transportation information. People create ridesharing apps to optimally pair passengers and drivers, neighborhood-specific parking and traffic maps, apps that publish wait times for parking lots and so on.

Empowering people with choice and control. *Smart transportation gives people the power to make better transportation decisions.*

Figure 7.4

Improving public safety. Smart transportation has a strong link to public safety. First responders require mobility to perform their lifesaving work, and ICT can make their jobs easier by optimizing traffic lights when necessary and empowering them to see potential traffic snarls in real time so they can select the most efficient travel routes.

Workability

Increasing cities' competitive advantage. The quality of cities' transportation infrastructure is a major factor in business and industry investment decisions. Business and industry often depend on reliable employee travel and/or transport of goods. Transportation networks that offer reliability are sought out.

Becoming more attractive to talent. Professionals, like businesses, consider mobility when deciding where to locate. Cities with efficient transport will see their businesses thrive, thereby increasing the tax and employment base.

Sustainability

Reducing pollution from transportation. Pollution is a problem in both the developed and developing worlds, and transportation is a major contributor. Smart technologies and practices can significantly reduce transportation's environmental impact. Traffic management creates a more efficient road network and reduces travel time, reducing vehicle emissions. And smart public transit is easier and more convenient, attracting more riders and reducing reliance on automobiles. Smart cities also encourage the use of electric vehicles by example, choosing them whenever possible for their own fleets and providing charging stations in public buildings.

Improving transportation budgets. Cities spend billions on their public transportation systems, and yet they are often inefficient, with capacity not in line with demand. Smart technologies unleash the savings and efficiency potential of transportation investments. For example, information from embedded smart devices can be analyzed to determine subway system expansion needs with respect to highest transit priority, future demand needs – and then servicing that demand at the lowest cost.

Additionally, analytics can make the most out of expensive transportation assets. Sensors and monitors can report on the actual condition of infrastructure so that operators can make better decisions, servicing equipment based on actual condition and not on a guess. This kind of asset management can squeeze many extra years of use from an investment, and all without compromising equipment or passenger safety.

> ***Increasing cities' competitive advantage.*** *The quality of a city's transportation infrastructure is a major factor in business and industry investment decisions. Pictured here is a light rail station in Shanghai – one of Asia's leading commercial, financial and transport hubs.*

Figure 7.5

Reducing trip time:

CROSSRAIL PROJECT CONNECTS LONDON'S MAIN BUSINESS CENTERS

With the goal of improving rail capacity, reducing traffic congestion and reducing public transit travel times in London, Crossrail Ltd and Transport for London (TfL) – the companies responsible for delivery and rail operations in London, respectively – began construction of a new 118 kilometer east-west rail line. The line will, for the first time, produce a direct connection between all of London's main business centers, linking Heathrow, Paddington, the West End, the City and Canary Wharf.

Up to 24 trains per hour will operate in the central section between Paddington and Whitechapel during peak periods, with each train able to carry 1,500 passengers. An estimated 200 million people will travel on Crossrail each year.

When Crossrail opens in 2018, it will increase London's rail-based transport network capacity by 10 percent and dramatically cut journey times across the city. It has been estimated that Crossrail will generate an economic impact of about £42 billion.

Smart City Council member Bechtel is the delivery partner for the central section of the project including the tunneling and underground stations.

> ***Reducing trip time.*** *When Crossrail opens in 2018, it will increase London's rail-based transport network capacity by 10 percent and dramatically cut journey times across the city. The image above shows the Canary Wharf Station aerial view looking east towards Woolwich.*
>
> ***Figure 7.6***

Instrumentation and control

As we turn to the transportation targets, this first one highlights the many types of smart devices that help cities monitor and control traffic – roadway sensors, smart streetlights and GPS devices to name just a few.

Implement optimal devices and other instrumentation for all transportation modes. Deploying the right devices in the right places — covering all modes of transport — provides the data smart cities use to analyze traffic in real time. In some cases, optimal instrumentation may mean a smart device for every vehicle, for instance, a GPS tracker for every bus. In other cases it may mean a smart device "every so often." For example, a roadway sensor placed every so often as needed to provide a picture of traffic on city highways and byways. Gathering and analyzing data from all modes of transportation within a city enables multimodal optimization.

Connectivity

The data collected from a city's smart transportation network often impacts more than just transportation operators. A fire crew racing to an apartment blaze will want to know about a blocking accident so they can take an alternate route. Likewise, long waits at a city ferry terminal may be something the communications office needs to know in real time so they can alert the traveling public.

Connect devices with citywide, multi-service communications. It's not enough to embed smart devices throughout a transportation network. The data the devices gather needs to be channeled through a citywide communications system so it can be analyzed and acted upon.

Interoperability

Cities can rarely afford an out-with-the-old, in-with-the-new overhaul of their transportation systems, much as they might want to. The targets in this section highlight some of the ways cites can make sure they're making decisions today that will bode well into the future.

Adhere to open standards. Insisting on open standards will increase choice and decrease costs, as products can be mixed and matched from different vendors.

Use open integration architectures and loosely coupled interfaces. Cities that adopt open integration architectures make it much easier and simpler to share data between applications.

Prioritize the use of legacy investments. As you well know, transportation systems can be a huge investment and most cities can ill-afford to scrap equipment that still has lifetime value. So as cities add intelligence to their transportation network, it makes sense to use existing equipment and systems whenever possible to avoid unnecessary spending and stranding assets.

Enable multi-channel access to an integrated customer transportation account. One goal of a smart transportation system is to encourage people to use it – so making it incredibly convenient will be a big factor. A couple ways smart cities can do that is to enable people to 1) pay for all city transportation services with a single account and 2) enable access to this account through multiple channels – integrated fare cards, cell phones, websites, on-vehicle transponders, etc.

A single account covering multiple modes of transportation and offering multiple channels of access lowers barriers to mass use. Increased usage boosts efficiency and revenue and decreases road congestion. Although it is unlikely a city can integrate all modes of transport at once, it's a goal worth working toward.

Adhere to open standards:

OFF-THE-SHELF SOLUTION HELPS MANAGE CHINA'S HIGH-SPEED RAIL LINE

To complete the 120-kilometer Beijing-to-Tianjin line in time for the 2008 Olympic Games, the China Ministry of Railways selected solutions from Council member Invensys to help run its passenger information system. The Wonderware® System Platform is off-the-shelf, standardized and scalable software, which contrasted with previous systems China used that were based on proprietary solutions that were expensive, hard to configure and difficult to maintain.

With the first leg complete, the Ministry is now deploying the high-speed line throughout China. When completed in 2020, it will carry both passengers and goods and be able to reach distances of 4,000 kilometers (2,500 miles) in a day.

But it is a massive and complex undertaking involving 12,000 kilometers of rail line, 800 stations and the collaboration of more than 60 different third-party vendors for each station's facilities management system. Interoperability was obviously an issue, but because the Invensys platform is based on open standards, every vendor can communicate seamlessly with each other and new features can be plugged in and expanded to new stations in a very short time.

More than 220 stations across 15 high-speed rail lines are controlled by Invensys today. Once complete, more than 800 stations will be running the solutions throughout the rail network.

> ***Adhere to open standards.***
> *China's railway operators have a single, scalable platform for supervisory functions required to manage overall passenger facility operations in hundreds of stations around the country.*
>
> ***Figure 7.7***

Security and privacy

The security and privacy concerns that apply to other city infrastructures are equally important in the realm of public transportation.

Publish privacy rules. As we mentioned in the last section, transit authorities are moving to single account payment systems, which will generate data that can track where an individual has been and when. Some transit systems also use video surveillance for security purposes. Those are just two reasons why publishing privacy rules will help cities get in front of a potential consumer backlash.

Create a security framework. One of the realities of life today is that a driver never knows who's hopping on a bus or what's in the backpack he's carrying. And what about the package left behind on a subway seat? A security framework mitigates risk by taking a proactive approach and using ICT technologies to identify and address threats before they can cause damage.

Implement cybersecurity. Smart transportation systems collect all manner of data that could make them vulnerable to cyber attack – from smart card payment information to ridership details. Having strong cybersecurity measures in place will help ward off trouble.

Data management

With smart sensors, smart payment systems, GPS and all the other intelligent devices that are gathering data as part of a smart transportation system, the city and its residents are all better off when there's a plan for managing it.

Create and adhere to a citywide data management, transparency and sharing policy. Citywide data management plans make it easier to enforce the privacy and security best practices discussed in the last section. But they also can help improve data accuracy and lower costs by eliminating unnecessary duplication.

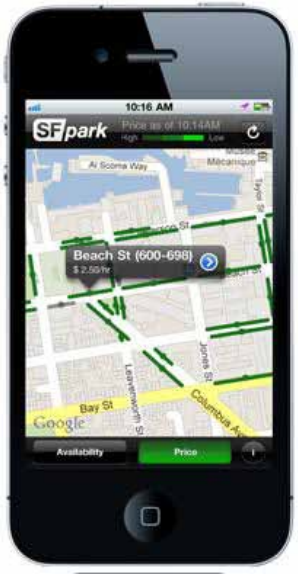
Computing resources

Transportation systems involve a lot of data, a lot of logistics, and a lot of detail that ICT can help cities get under control. The targets below illustrate some of the ways they can do that.

Consider a cloud computing framework. A cloud computing framework enables scalability of systems, reduces costs and improves reliability.

Use an open innovation platform. A lot of cities are seeing amazing results with open innovation platforms that empower developers to create apps that city residents can use. Smart parking apps, for instance, are very popular. Apps that people can use to synch up with bus and train schedules are too.

> ***Use an open innovation platform.***
> *Many cities are having great success with open innovation platforms that encourage developers to create apps. Parking apps like SFpark pictured here are very popular.*
>
> ***Figure 7.8***



Have access to a central GIS. City decision-making capabilities are greatly improved with a central GIS. A transit system, for instance, can see efficiency gains through more intelligent scheduling and routing.

Have access to comprehensive network and device management. To manage the large, scattered deployments of smart devices across the transportation infrastructure, smart cities rely on comprehensive device management programs that improve security and resiliency, deliver cost savings and enforce compliance with city data management, security and privacy policies.

Achieve multi-modal operational optimization:

WHY ADAPTIVE TRAFFIC SIGNALS GET A GREEN LIGHT IN PITTSBURGH

Carnegie Mellon University has worked with the city of Pittsburgh and East Liberty Development Inc. to deploy "adaptive traffic signals" for the city's busy East Liberty area. The pilot program saw reductions of 40 percent in vehicle wait time, 26 percent in travel time and 21 percent in vehicle emissions.

The traffic signal control technology promises to dramatically reduce harmful vehicle emissions and frustratingly long travel times through urban neighborhoods.

Pittsburgh Mayor Luke Ravenstahl cheered the pilot's success as "a breakthrough in making our city's traffic system work far more efficiently without having to resort to expensive widening roads, eliminating street parking, or re-routing. It makes the city more attractive to employers and residents alike."

> ***Achieve multi-modal operational optimization for transportation.*** *The traffic signal control technology promises to dramatically reduce harmful vehicle emissions and frustratingly long travel times through urban neighborhoods.*

Figure 7.9

Analytics

No surprise that analytics can have a major impact in a transportation network. This section includes some new targets that reveal how.

Achieve full situational awareness. Using the smart devices deployed across various transportation modes, smart cities use analytics to provide their transportation managers with a complete operating picture. This increases the reliability and resiliency of the infrastructure, and allows for the quickest possible incident response time. Full situational awareness also enables dynamic, multi-modal disaster and recovery plans.

Achieve multi-modal operational optimization for transportation. When it comes to optimizing transportation operations, the goal is to make sure the optimization takes place across all modes, in or near real time depending on circumstances. Cities that optimize transport modes individually limit the returns on their technology investments, since a change or incident in one mode will likely impact another. An example is a problem that shuts down a subway line, sending a big influx of riders to the closest bus.

There are many ways that multi-modal optimization improves transit operations, including:

- **Improved mobility**. Travel is as fast, efficient and safe as possible. Traffic lights are optimized to eliminate structural traffic problems. Or to find the best compromise to allow streetcars to pass with minimum delays for auto traffic. Likewise, data analysis might suggest a new bus route along a particularly crowded transit corridor. Or a smartphone app could alert drivers to the best route, sending them around congestion and accidents. Improved mobility is important to residents, of course, but is also critical for businesses that move people or goods around a city.

- **Cost savings.** In addition to the cost benefits of reduced congestion, multi-modal transport optimization brings cost benefits to cities through more efficient energy usage and improved customer experience. (As noted earlier, the better the experience the more willing people are to use public transportation.) In some scenarios system optimization can reduce costs through shared infrastructure – especially ICT resources – and by getting more out of existing infrastructure. It can also defer or delay the need for new roadways or additional buses by optimizing the use of what the city has in place already.

> ***Achieve multi-modal operational optimization for transportation.***
> *Having more transportation choices available improves the customer experience, which leads to more people using public transportation.*
>
> ***Figure 7.10***

Pursue predictive analytics:

CONNECTED BOULEVARD: THE WORLD'S SMARTEST STREET

Council member Cisco has teamed with the city of Nice, France, to pilot a next-generation smart street they are calling "Connected Boulevard."

Boulevard Victor Hugo, located in the center of Nice, is host of the proof-of-concept zone and almost 200 different sensors and detecting devices. In addition to these, it also plays host to "guest" devices such as mobile phones and tablets used in the streets that get connected onto its wireless mesh network.

Data captured through these "things" is being processed and analyzed to offer the city and its residents invaluable context-aware information on parking, traffic, street lighting, waste disposal, as well as environmental quality as experienced in real time. Early projections from pilot tests of smart parking services have shown a potential for up to 30 percent decrease in traffic congestion, significant air pollution reductions, combined with an increase in parking revenues.

Further benefits are also being realized from estimates in synchronizing street lighting on a need-basis. For example, by calibrating street light intensity with pedestrian and traffic peaks and real-time environmental conditions such as fog and rain, the city could potentially save 20 to 80 percent in electricity bills. On the environmental aspect, more accurate data of humidity and temperature levels, in addition to air particles are being processed for understanding context-critical patterns.

> ***Pursue predictive analytics.***
> *Boulevard Victor Hugo in Nice, France is host to a Connected Boulevard proof-of-concept zone that includes almost 200 different sensors and detecting devices.*
>
> ***Figure 7.11***

This is possible because Connected Boulevard is made up of more than just sensors and devices. The Connected Boulevard equips the city with the capacity to capture data from daily life through the hybrid network infrastructure of the city that includes Cisco WiFi network. The data is processed into real-time information and converted into intelligence with the help of context-aware location analytics, before being disseminated to serve multiple services in city operations and for city dwellers. It is an Internet-centric "always-on" platform designed to be resilient, extensible, highly secure and agile, through four interoperable layers:

Layer 1: Sensors and networked devices with mesh technologies

Layer 2: Data capture, processing, storage and analytics at distributed points across the city

Layer 3: Central data collection, including computing, storage and analytics, combined with integrated and open standard application programming interfaces

Layer 4: New and innovative applications and services

As Nice Mayor Christian Estrosi said, "For Nice to continue welcoming millions more visitors and companies while ensuring a high quality of life, using Internet intelligence is key. Many more things are going to get connected between people, with and between objects, creating valuable interactions and processes including that of public administration. Our ability as a city to harness this data is crucial to understanding what's going on in real time and to enhance a multitude of services for city-dwellers."

- **Flexibility.** Multi-modal transport optimization can be a tool that smart cities use to accomplish specific transportation goals. If pollution is a major problem, then a city can effectively optimize its transport system to promote bus use over private car use, and subway use over bus use. Or if a city suffers from rush-hour bus congestion, it can optimize its transport system to increase subway use during that time.

Achieve asset optimization. The goal is to ensure a city can extract maximum value from its transportation infrastructure and instrumentation investments. This includes calculating precisely which transportation assets should be replaced or repaired and when, to achieve maximum return on investment.

Pursue predictive analytics. The importance of using analytics to predict when elements of a transportation infrastructure are close to failure can't be overstated. Consider the value of predictive maintenance, for example, in relation to the integrity of critical infrastructure such as bridges and highways. Not only can predictive maintenance save money, it can also save lives.

Enable dynamic, demand-based pricing. Smart cities have systems in place to use dynamic, demand-based pricing as a tool to influence customer behavior. As cities better understand people's transportation behavior through instrumentation and analytics, they can influence that behavior by changing prices throughout the day to accomplish their transportation goals.

For example, a city with crippling morning smog can analyze vehicle use at that time and tailor parking prices for vehicles based on distance traveled. Or a city with high road congestion can toll the road with variable pricing and/or alter its bus and subway pricing in targeted areas to reduce traffic. Cities have different transportation circumstances and priorities, and different political operating environments, so the use of dynamic pricing to influence behavior is likely to differ from city to city.

Provide flexible transportation options:

FRENCH CITIES CUT DRIVERS' COSTS BY 90 PERCENT WITH INTELLIGENT CAR-SHARING

Syndicat Mixte Autolib is an electric car-sharing program established by the city of Paris and 46 surrounding municipalities to relieve traffic congestion, reduce noise and air pollution and provide people with more flexible transit options.

Implemented by logistics company IER, the intelligent system based on Council member Microsoft's Windows Embedded provides connectivity between the in-car system, registration and rental kiosks, charging stations and a central management system.

Available around the clock, the solution has reduced carbon dioxide emissions by 1.5 metric tons annually and replaced 25,000 privately owned gas vehicles. By using Autolib, former car owners have cut their transportation costs by approximately 90 percent annually. Autolib subscribers also enjoy an enhanced driving experience with GPS navigation, free parking and personalized settings.

The flexible solution also simplifies implementation and minimizes deployment risk, which makes it easier for Autolib to implement new features and services.

> ***Provide flexible transportation options.*** *Microsoft Windows Embedded provides connectivity between the Autolib in-car system, registration and rental kiosks, charging stations and a central management system.*

Figure 7.12

ADDITIONAL RESOURCES

Target: Achieve full situational awareness

Situational awareness keeps Dublin commuters on the move

Collaboration between the city of Dublin and Council member IBM is helping keep 1.2 million residents moving efficiently through Dublin's extensive network of roads, tramways and bus lanes. Integrating data from a citywide network of sensors with geospatial data means the city's road and traffic department is able to better monitor and manage traffic in real time.

Target: Use an open innovation platform

London Transport manages 2.3 million website hits a day with new data feed

Transport for London (TfL) decided to open its real-time data to partners and organizations so they could develop citizen-centric web applications to help relieve congestion and ease commuting for the traveling public. In just six weeks, TfL, Microsoft and the local developer community created an application programming interface that floats real-time data onto the cloud using Microsoft's cloud services, saving TfL millions of pounds.

Sustainable urban transport best practices

The Transit-Oriented Development (TOD) Standard

An effort by the Institute for Transportation and Development Policy (ITDP)m the Transit-Oriented Development Standard outlined in this white paper draws on international expertise to come to a common understanding of what constitutes urban development best practice in promoting sustainable urban transport.

Public transit funding mechanisms

A decision-support framework for using value capture to fund public transit

Local and state governments provide 75 percent of transit funds in the United States. With all levels of governments under significant fiscal stress, any new transit funding mechanism is worth consideration. The report from the Mineta Transportation Institute is intended to assist practitioners in gauging the legal, financial and administrative suitability of Value Capture mechanisms for meeting project-specific funding requirements.

TRANSPORTATION TARGETS

*In the checklist below, targets specifically pertaining to the transportation responsibility are in **bold,** universal targets are not.*

TECHNOLOGY

Enabler	Transportation Targets How smart cities deploy and use ICT to enhance their transportation networks	Implementation Progress None Partial Over 50% Complete
Instrumentation & Control	Implement optimal instrumentation **Supplement: for all transportation modes**	
Connectivity	Connect devices with citywide, multi-service communications	
Interoperability	Adhere to open standards Use open integration architectures and loosely coupled interfaces Prioritize use of legacy investments **Enable multi-channel access to an integrated customer transportation account**	
Security & Privacy	Publish privacy rules Create a security framework Implement cybersecurity	
Data Management	Create a citywide data management, transparency and sharing policy	
Computing Resources	Consider a cloud computing framework Use an open innovation platform Have access to a central GIS Have access to comprehensive device management	
Analytics	Achieve full situational awareness Achieve operational optimization Pursue predictive analytics **Supplement: integrate all transport modes for multi-modal transportation optimization** Achieve asset optimization **Enable dynamic, demand-based pricing**	

Figure 7.13

CHAPTER 8

WATER AND WASTEWATER

Few people need to be reminded of water's importance. Along with energy, it is essential for everyday life. Water provides sustenance, supports industry and irrigates fields. But city administrations are struggling to meet rising demand from growing populations while contending with issues such as water quality, flooding, drought and aging infrastructure.

This chapter will give cities tools to apply smart technology for an economical and sustainable water supply. It begins by outlining urban water realities. Next it explains the benefits cities can achieve by increasing the intelligence of their water systems. Finally, it talks about the technology targets cities should aim for to gain those benefits.

We need water for human consumption, of course. And to produce food. But not everyone realizes we need large volumes of water to produce energy. Thermoelectric power plants boil water to create steam to drive electricity-producing turbines. In 2005, U.S. power plants withdrew four times as much water as all U.S. residences, accounting for 41 percent of total water use.

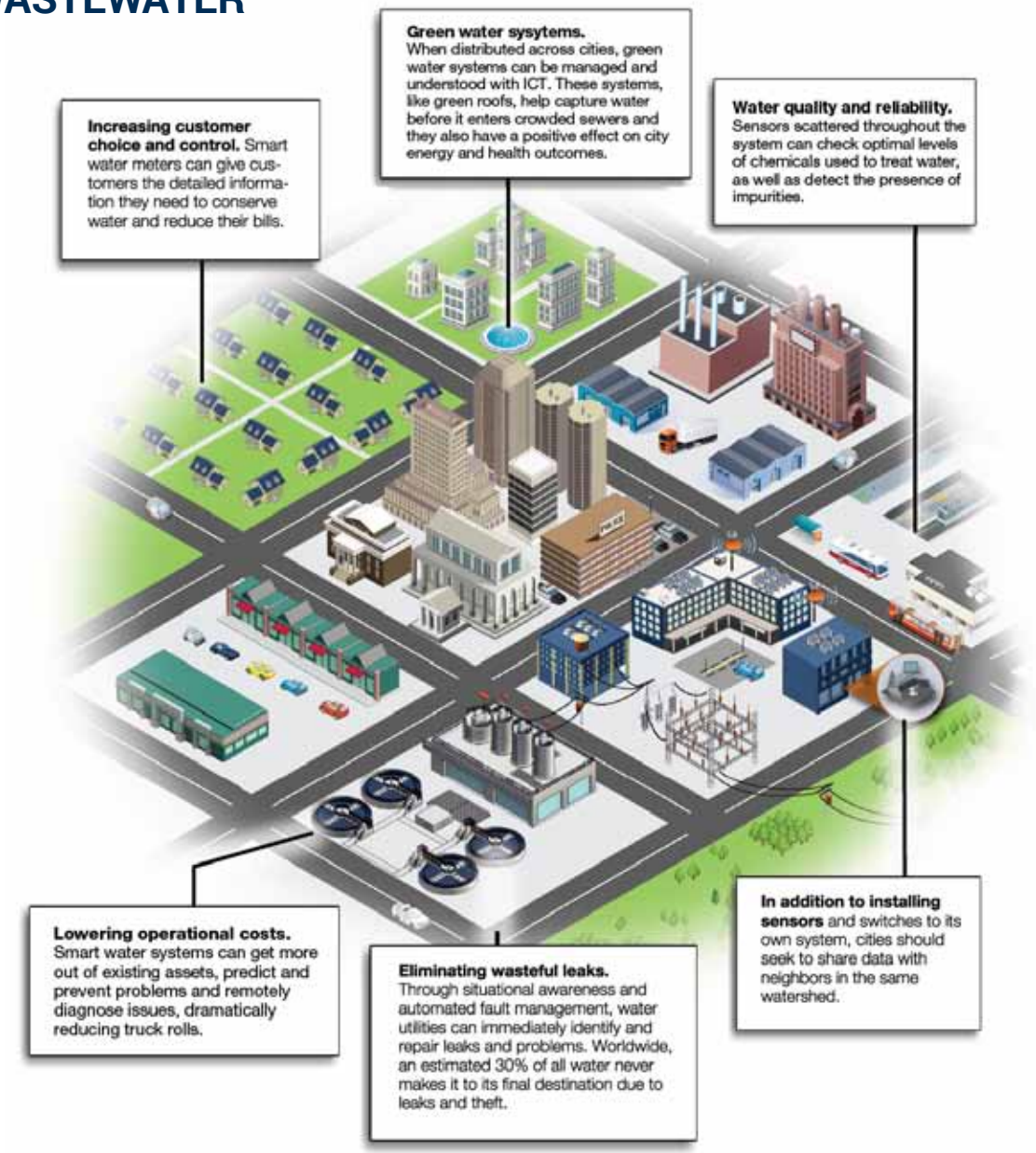
The so-called "energy-water nexus" works in both directions. It takes a lot of water to create electricity. It takes a lot of electricity to pump and treat water. Worldwide, we use an average of 7 percent of total electricity to pump and treat water and wastewater, but the percentage can be much higher.

But perhaps this next statistic explains the challenge best of all. According to the United Nations, about two-thirds of the world's population – 4.6 billion people – will face water -stressed conditions in the next decade.

The energy-water nexus. *In the U.S. in 2005, power plants withdrew four times as much water as all U.S. residences, accounting for 41 percent of total water use.*

Figure 8.1

WATER AND WASTEWATER



> ***Water targets and benefits.***
> *Due to population growth and climate change many cities face severe water challenges. Smart water systems can make dramatic improvements to the cost, safety and reliability of urban water supplies*

Figure 8.2

Figure 8.3

RISKS TO URBAN WATER SUPPLIES

Think you don't really need to worry about water in your area? Think again. Here is a partial list of the issues confronting urban water supplies.

Sea levels on the rise. For coastal cities, water quality will be further eroded by rising sea levels, which can increase salt concentrations in groundwater and estuarine rivers.

Flooding on the rise. Increased flooding will affect hundreds of millions of people who live close to coastlines, flood plains and deltas. Even inland cities face the problem of flooding as a result of more intense rainfall or snowmelt.

Storms on the rise. Hurricanes, tornadoes and other extreme weather events will become more frequent and rainfall more intense in many areas.

Droughts on the rise. Meanwhile, some regions will receive ***less*** rainfall than usual, leading to droughts more severe than in the past.

Fresh water on the decline. Higher temperatures reduce the amount of water stored in mountain snowfields. They also dry out the soil, which then soaks up more water, reducing the recharge of underground aquifers. The result could be reductions in available water for drinking, household use and industry.

Water quality on the decline. Water quality will become a concern for some cities. Changes in rainfall patterns may change the watershed, affecting quality.

Aging infrastructure. Water and wastewater infrastructure in cities around the world is aging and must be replaced to protect its efficiency and the quality of its product.

Competition from agriculture. According to the World Economic Forum, to meet demand from growing populations we will need to grow and process 70 percent more food by 2050. Yet as early as 2030 we will be confronting a water shortage of approximately 40 percent due to a toxic combination of rising demand and climate-change-driven shifts.

Competition from recreation. In some parts of the world, boaters, skiers, fishermen, campers and other outdoor enthusiasts have mounted strong protests when cities attempt to get more water from popular lakes and rivers.

> ***Smart water systems.*** *Every city must use smart technology to preserve and enhance its water supply while keeping the cost of water as low as possible.*

Figure 8.4

Why make water systems smart?

Smart cities use information and communications technology (ICT) to achieve a sustainable, efficient and clean water supply. Most people refer to an ICT-enabled water system as a "smart water system" or a "smart water network." Smart water is driven by three urgent realities:

1. **Water is scarce.** Cities around the world suffer from water shortages. In addition, population growth and extreme weather patterns that create droughts and floods are expected to increase in the coming decades, making water an even more precious resource.

2. **Water is at risk.** Drought, flooding, salinization and other factors can wreak havoc on a water supply. (See list on previous page.)

3. **Water is underpriced.** Water today is often priced far below the level that would accurately reflect its scarcity. This price/value imbalance will rectify as water scarcity becomes more apparent. As a result, the price of water will rise significantly in the future.

Already we see regions where water periodically becomes scarce. We see regions where water is prohibitively expensive. For these reasons and many other reasons, every city must use smart technology to preserve and enhance its water supply while keeping the cost of water as low as possible. ICT can contribute in at least seven ways:

1. **Map and monitor the physical infrastructure.** Most water utilities do not know with great precision where their pipes and valves are located. In particular, they don't know the actual condition of that infrastructure. ICT gives a highly accurate picture of location and "health."

   "Possessing a clear and comprehensive picture of the entire infrastructure can save a water company tens or hundreds of thousands in repairs each year," explains the Smart Water Network Forum, an industry forum that acts as an advisor to the Smart Cities Council. "Survey-quality GPS, sometimes combined with electromagnetic or ground-penetrating radar, can map pipe infrastructure, creating three-dimensional maps that show exactly where the pipe is, correcting the widespread errors in existing maps, and ensuring that repair crews will find the pipe when they dig."

2. **Accurately measure what is consumed.** Smart water meters can give customers highly accurate records of their consumption while also helping utilities spot "non-revenue water" (NRW) that is being lost to defective equipment, leaks and theft.

3. **Monitor drinking water quality.** A smart water system can have sensors placed strategically throughout the network to detect contaminants. Those sensors can monitor the acidity and alkalinity, watch for biological indicators, measure chlorine and other chemicals and watch for heavy metals, then alert human operators when problems arise so they can intervene quickly to mitigate threats.

4. **Present, perfect and predict conditions.** Using data from the first two examples above, a smart water system can ***present*** current conditions to give operators full situational awareness; ***perfect*** the system by optimizing it; and ***predict*** leaks, floods and equipment failures. "Utilities can achieve better operations through better knowledge and tighter control of the network's extensive and complex assets," explains the Smart Water Network Forum. Modern "dashboards" and tools can "improve the efficiency, longevity and reliability of the underlying physical water network by better measuring, collecting, analyzing and acting upon a wide range of events."

5. **Make better use of diffuse and distributed non-traditional water resources** through recapture, recycling and reuse and through better planning. Water is so much broader than pipes and treatment plants. Rain falls everywhere – on our rooftops. Into our soil, gardens and grass. On our roads. This water can all be captured and put to use with the help of ICT. Instrumentation diffused into these "green water systems" can store water, while advanced analytics are critical to managing this distributed resource. You can have the insight to understand where your green water systems are, how they are performing and how the water they capture can be best deployed.

6. **Better prepare for storms.** Some parts of the world – North America for instance – must confront challenging water quality and storm water regulations. And many parts of the world are faced with flooding that is reaching new extremes. A smart water system can not only monitor flooding, it can predict events in time to prepare for flood control and disaster management.

7. **Harness the energy and nutrient resources in water and wastewater.** ICT helps us capture the full potential of water. Beyond its own value as a scare resource, water systems house nutrients and even energy. Technology enables us to reduce and recapture excess kinetic energy in water supply piping, recover energy and nutrients in wastewater, and avoid the damaging dumping of nutrients into carefully balanced ecosystems.

> ***Present, perfect and predict.***
> *A smart water system can not only monitor flooding, it can predict it in time to prepare.*
>
> ***Figure 8.5***

THE NETHERLANDS IS TAKING BETTER CARE OF STORM AND FLOOD WATER

The Netherlands is working with Council member IBM to transform flood control and the entire Dutch water system. The need is high. Of the total Dutch population, 66 percent live in flood-prone areas. More than 4,000 square miles (26 percent of the country) is below sea level.

The financial stakes are high as well. The ongoing cost to manage water, including anticipating flooding, droughts and low water levels is up to €7 billion each year and expected to increase €1- 2 billion by 2020. The project with IBM is expected to reduce costs by up to 15 percent.

The Rijkswaterstaat (the Dutch Ministry for Water), the local Water Authority Delfland, Deltares Science Institute and the University of Delft are working with IBM on the "Digital Delta" program. They will investigate how to integrate and analyze water data from a wide range of data sources, including precipitation measurements, water level and water quality monitors, levee sensors, radar data, model predictions as well as current and historic maintenance data from sluices, pumping stations, locks and dams. The initiative will provide water experts with a real-time intelligent dashboard. That dashboard will combine, process and visualize data from multiple organizations – data that today is kept in separate "silos."

The new management system will address concerns ranging from the quality of drinking water, to the increasing frequency and impact of extreme weather-related events, to the risk of floods and droughts. By modeling weather events, the Netherlands will be able to determine the best course of action.

Digital Delta is a cloud-based system. "As flooding is an increasing problem in many regions of the world, we hope that the Digital Delta project can serve as a replicable solution for better water management anywhere in the world," said Jan Hendrik Dronkers, director general of the Dutch water ministry.

> ***Take better care of runoff, storm, flood and wastewater.*** *This Dutch storm surge barrier is just one piece of Holland's vast flood control system. The country is working with Council member IBM to use ICT to transform flood control management.*

Figure 8.6

Water realities

Before we look at specific targets for the water responsibility, let's quickly consider four realities that affect when, where and how a city should approach the transformation of its water system.

1. **Smart cities "close the loop" around local watersheds.** A watershed is the land area that drains into a particular river, lake or ocean. "Closing the loop" refers to reducing (or even ending) the import of water from other watersheds while taking full advantage of the water available within the loop. Giving preference to locally available water allows a city to be more confident in the sustainability of its water program.

   ICT helps cities close the loop by maximizing the potential of non-traditional sources. The idea is to supplement traditional water sources such as reservoirs and aquifers by capturing storm water runoff, gray water and purple water and by tapping natural systems like wetlands, rivers and lakes. ICT can oversee and optimize the capture of water from these sources. Closed-loop systems also use different grades of water for different needs. For example, treated wastewater isn't suitable for drinking but may be perfectly suitable to water crops.

2. **Smart water requires collaboration.** Perhaps more than any other city responsibility, water is a regional issue. The water source that city residents use to quench their thirst may be the same that a factory uses for its operations or a farmer to water his crops 100 miles away. Water is tied into vast watersheds that link many population centers. Because of that, a smart water vision requires a collaborative approach between cities and a lengthy list of stakeholders. The list includes other cities in the watershed, regional or national government entities that may have regulatory authority, utilities, the private sector, agricultural organizations, citizen and community groups, etc. In some cases, international collaboration may be necessary.

3. **Smart water requires smart policy.** There are many ways that local, regional and national governments can enhance the prospects for smart water. One instance: policy improvements that clear the way for public-private partnerships to help with the financing. Another is mandates for efficiency, conservation, leak reduction or water quality. Yet another is working with suppliers to craft a careful business case that demonstrates the return on investment.

> ***Smart cities "close the loop" around local watersheds.*** *A watershed is an area of land where all of the water that drains off of it goes into the same place. "Closing the loop" means giving preference to water from the local watershed, which allows a city to be more confident in the sustainability of its water program.*
>
> ***Figure 8.7***

Whatever steps a city takes, it should NOT mandate a specific technology. Rather, it should mandate the results it wants, and then work with advisors and suppliers to determine the best way to achieve that result.

4. **Smart water may need creative financing and staffing.** Many city budgets are under great pressure. Even if a city can make a strong business case for rapid payback, it may not have the funds to finance the project. Fortunately, several alternative mechanisms have arisen to lighten that load. For instance, some suppliers will sell software-as-a-service (SaaS) on a monthly fee basis. This eliminates the need for the city to make a big capital purchase and install, maintain and update all the hardware and software on its own. Instead, the supplier handles all that in the cloud, and the city simply pays a monthly charge. In many ways, this is similar to leasing a car instead of buying it.

   Another option is a risk-sharing contract. The city pays a reduced fee to the supplier, and then shares a portion of the saved costs or additional revenue back to the supplier.

   It is worth noting that some developing countries have funding available for infrastructure projects, often thanks to grants and programs from development banks. Utilities in those regions have the chance to leapfrog the developed world by jumping straight to a state-of-the-art smart water system.

   Even cities with adequate funding may lack adequate in-house ICT skills and personnel to run a sophisticated smart water system. Here again, SaaS offers a solution, since the supplier provides the bulk of the needed personnel and spreads the cost by making the service available to many cities at once.

Dependencies for water and wastewater

Planning improvements in water and wastewater infrastructure will need to take into account dependencies on other city systems and services. Looking at just a few of these dependencies, it is easy to see how smart water services are heavily influenced by local government policies and how closely they are aligned with communications and energy systems in a smart city context. Contaminant warning systems rely on communications and energy systems. And pumps that move water throughout a city infrastructure require power. Flood control systems (e.g. pumps or gates) require resilient energy systems to operate.

> ***Smart water requires smart policy.***
> *There are many ways that governments can enhance the prospects for smart water. One instance: policy improvements that clear the way for public-private partnerships to help with the financing.*

Figure 8.8

WATER AGENCY BUILDS "BORDERLESS" INFRASTRUCTURE TO IMPROVE COLLABORATION

California Natural Resources Agency manages the state's natural resources, including water. One of its largest departments is the Department of Water Resources (DWR), with about 3,500 employees. DWR supplies and manages the water delivery systems, provides flood protection through improvement of levees, inspects 1,200 dams and helps coordinate the state's integrated water management.

To accomplish those tasks, department personnel need to access and manipulate large data sets to model the effects of the environment on the water system. "Many of our missions require close collaboration with other federal, state, and local government organizations, subject matter experts, and the people of California," says CEO Tim Garza.

But DWR had limited ability to share data outside the department, which made it difficult to make timely decisions.

The agency wanted a new data center infrastructure that could adapt easily to support changing business needs. The immediate need was for borderless collaboration with all stakeholders, including local, state and federal government and private sector entities.

The solution the agency chose was a borderless infrastructure based on Council member Cisco's Data Center Business Advantage solutions and Cisco's planning, design and implementation services.

Results enabled secure collaboration by creating 20 distinct security zones, reduced total cost of ownership for the network by 30 percent and accelerated network performance by 40 percent.

> ***Smart water requires smart collaboration.*** *California Department of Water Resources required a secure way to share data with other water management agencies. New "borderless infrastructure" from Cisco created 20 distinct security zones, making it easy for multiple departments to collaborate safely.*

Figure 8.9

Benefits of a smart water system

In this section we highlight benefits that smart water systems can deliver and their impact on livability, workability and sustainability.

Livability

Promoting water quality and reliability. Smart cities use ICT to protect the safety and reliability of their water supply. Remote sensors can detect impurities, protecting water supply from the intentional or unintentional introduction of contaminants. The affected areas can often be isolated automatically, preventing the spread. Meanwhile, the system alerts human operators so they can deploy repair crews to fix the problem.

Increasing resilience. Smart security measures help protect water infrastructure from external cyber threats. Video cameras and access cards can provide physical security. Automated fault management can ensure problems are found and dealt with before they affect a wide area. In a disaster scenario, analytics can immediately tell cities what equipment needs replacing, and can prioritize tasks for maintenance crews so water delivery is restored as quickly as possible.

Increasing customer choice and control. ICT can empower customers with information about when and where they are using water, plus tools to help them control that use. This allows them to change behavior and make trade-offs to lower their bills.

Reducing damaging floods and overflows. Full situational awareness informed by weather data helps cities see exactly where floods and overflows are occurring. Some systems can even predict floods in advance, so emergency crews can be dispatched in advance. Technology also allows cities to more effectively plan flood prevention efforts.

Saving energy on building cooling. Green roofs and other green water systems not only capture water for use before it enters a crowded sewer, they also serve to cool the buildings and streets and other infrastructure in which they are housed. This can save energy on building cooling while simultaneously reducing the dangerous urban heat island effect.

Workability

Increasing economic development. Smart water can differentiate a city in the competition for business and investment. Smart water is financially attractive to industrial consumers in particular, since they are often the largest users of a city water supply. Water-intensive businesses often decide whether to expand and where to relocate by looking first at a region's water availability.

Lowering operational costs. ICT solutions can dramatically reduce costs for both water providers and customers. Cities can optimize their water infrastructure for efficiency, saving the cost of wasted resources. Advanced analytics, using data from smart water meters in homes and businesses can identify ways customers can reduce consumption and save money on water bills.

Sustainability

Eliminating wasteful leaks. Smart water meters and sensors reduce water loss. Through situational awareness and automated fault management, water utilities can immediately identify and repair leaks and problems. Most cities that install smart water networks discover they have been losing ***at least*** 10 percent to leaks and percentages as high as 50 percent are not unusual.

Getting the maximum value from existing infrastructure. Building entirely new water systems is not an option for most cities. With ICT, cities can make their existing systems far more productive.

Enhancing sustainability:

THE GREENING OF AN INDUSTRIAL CITY IN THE SAUDI DESERT

The Royal Commission for Jubail is a special-purpose government agency empowered to develop and operate industrial cities. Council member Bechtel has provided engineering and construction management services to the Royal Commission since its inception in the 1970s.

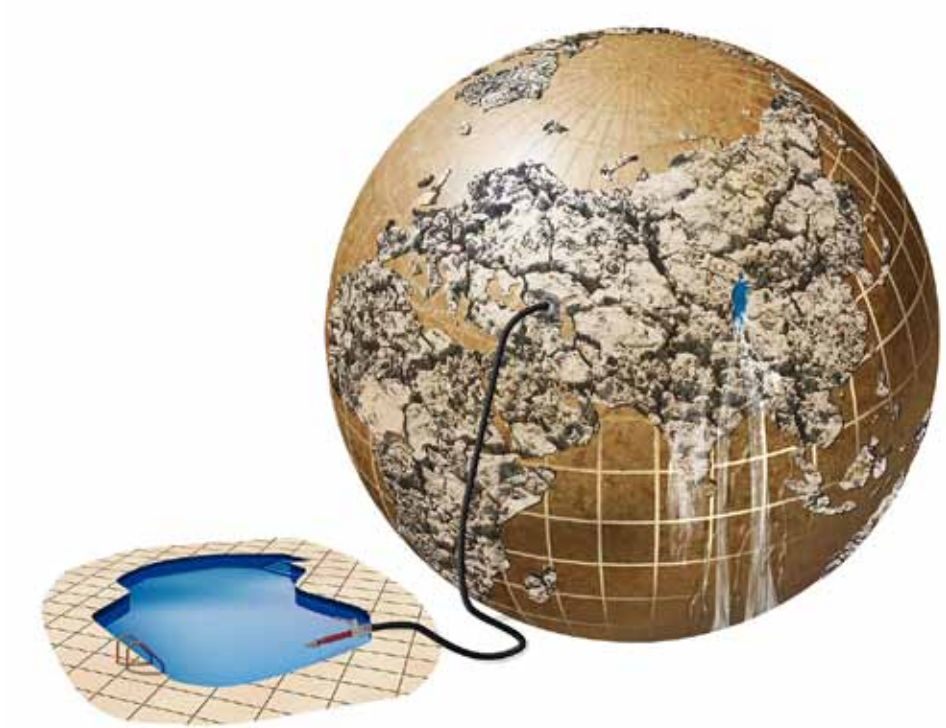
Jubail's mission is to diversify and expand the Saudi economy through major heavy industrial development while simultaneously being a "green" city providing a very high quality of life for the city's inhabitants. Of course, Saudi Arabia is a desert country with limited water resources, making this a difficult objective.

Over the last 30 years, Jubail has grown to become the largest petrochemical industrial complex in the Middle East and now has a resident population of about 150,000 people. Jubail has also become one of the greenest cities in the Kingdom with extensive parks, open spaces and tree plantings. Despite the lack of water, this has been achieved by highly efficient water and wastewater treatment systems using the latest technologies.

The city appears to be an oasis in the desert and provides highly attractive landscapes, parks and waterfront areas for the city's residents. As a result, the city is becoming an ever-more attractive destination for young Saudi families, attracted by the promise of good jobs and a green environment.

> ***Enhancing sustainability.*** *Jubail's mission is to diversify and expand the Saudi economy through major heavy industrial development while simultaneously being a "green" city providing a very high quality of life for the city's inhabitants.*
>
> ***Figure 8.10***

THE COMPELLING CASE FOR SMARTER WATER



Non-revenue water (NRW) – water that is produced but lost before it reaches the customer – is a major challenge for water utilities around the world. NRW has a significant financial impact on utilities and their customers. It also represents the loss of a precious resource.

NRW occurs for a variety of reasons:

- Unmetered consumption (where water meters do not exist so usage can't be accurately measured)
- Authorized but unbilled consumption (firefighting, for instance)
- Apparent losses (water theft and metering inaccuracies)
- Real losses (leaks and bursts)

A 2011 study by the Smart Water Networks Forum (SWAN), a Council advisor, compiled NRW losses in urban centers around the world. The findings were staggering. The NRW in Guayaquil, Ecuador topped the list at 73 percent, but Adana, Turkey wasn't far behind at 69 percent. NRW ranging from 30 to 50 percent were not uncommon. Conversely Singapore, which is recognized as a leader and innovator in smart water, reported NRW losses of just 4 percent.

As Navigant Research analyst Neil Strother states: "Losses from NRW represent $14 billion in missed revenue opportunity each year, according to the World Bank. The economic case for better water metering is compelling."

> ***The compelling case for smarter water.*** *Losses from non-revenue water – which can include everything from water theft to leaks and billing irregularities – represent an estimated $14 billion in missed revenue opportunity each year, according to the World Bank.*
>
> ***Figure 8.11***

Navigant has forecast that the global installed base of smart water meters will reach 29.9 million by 2017, up from just 10.3 million meters in 2011. By the end of the forecast period, Navigant anticipates that 3.3 million smart water meters will be shipped each year, representing an annual market value of $476 million.

And smart water meters are only part of the larger market. In 2011, Lux Research said that the market for technologies to inspect and repair the world's aging water infrastructure was approaching $20 billion worldwide and growing at a healthy 10 percent. It reported that many municipalities were desperately seeking cost-effective new ways to maintain their pipe networks. Lux claimed that the most successful solutions would be those that can monitor the entire water infrastructure and reveal the sections in most urgent need of repair.

"Outdated water infrastructure and record deficits are both fueling demand for low-cost inspection and repair solutions – namely software and sensor technologies that can provide a snapshot of a utility's entire infrastructure," said Brent Giles, a Lux Research senior analyst. "Without this holistic view, utilities cannot prioritize the most critical repairs – and may end up throwing money down the drain to address the leaks that are visible today rather than the ones that could prove catastrophic tomorrow."

Water targets

Many technologies and best practices can help cities develop a smart water system. Five targets specifically relate to water and wastewater and will be discussed in detail below. We'll also talk about several of the universal targets as they apply to smart water.

Implement optimal instrumentation and control across the watershed. We've added on to this universal target to remind you that most cities will need information that extends beyond their city boundaries. A smart water network uses sensors to capture data on the condition of the water and the equipment. These devices are installed in both traditional and non-traditional segments of the watershed – from the pipes and pumps to green water systems in gardens or rooftops that collect storm runoff or grey water. As noted above (and as illustrated in the case study from the Netherlands), cities will want to collaborate to gather data not just within city limits, but from the larger watershed as well.

Smart water networks also utilize sensors that monitor water quality. This may include tracking different grades of water to ensure they are properly routed for the appropriate end use.

In addition to sensors for the physical infrastructure, some cities will want to consider smart water meters. In regions with conservation mandates, smart meters can give customers the detailed information they need to curb consumption. Smart meters can also reduce the need for additional sensors on pipes, pumps and switches.

Connect devices with citywide, multi-service communications:

TIANJIN ECO-CITY – SMART COMMUNICATIONS FOR SMART METERS

Tianjin Eco-City is a flagship collaborative project between Singapore and China. Established in 2007, it is built on the vision of being "a thriving city which is socially harmonious, environmentally friendly and resource-efficient." Located in the city's Binhai New District, the community will cover a land area of about 30 square kilometers. When completed in 2020, it will house approximately 350,000 residents.

Tianjin has some of China's strictest building energy-efficiency standards. Each apartment comes with an underground parking space, and government officials say that charging stations and subsidies for electric cars are planned.

In June 2013, Council member Itron completed the installation of 25,000 smart meters for water, heat and gas. The pilot project measures, collects and analyzes data from the meters to produce actionable intelligence. For instance, residents see graphical data to learn about their energy and water usage. It also helps simplify the billing process and provides detailed consumption information which reduces billing disputes.

"With this project, Itron is providing China's only unified platform that manages water, heat and gas data together under one system," said Mingus Yu, general manager, Water and Heat, for Itron in China. "Through this successful deployment, Itron is demonstrating its commitment to supporting the Chinese government's smart city plan."

Both Singapore and China see Tianjin as a way to demonstrate their commitment to sustainability.

> ***Connect devices with citywide, multi-service communications.*** *Itron installed 25,000 smart meters for water, heat and gas in China's Tianjin Eco-City. The unified platform manages water, heat and gas data together under one system.*

Figure 8.12

Connect devices with citywide, multi-service communications. This universal target applies equally to water. It is worth reminding, however, that most cities should NOT build a communications network just for smart water purposes. Instead, they should seek to piggyback on an existing network. Or share costs with other departments to build a system they all can use. For instance, in Tianjin China, a single communications network carries the signals for smart meters of several different kinds. (See sidebar on previous page.)

Create and adhere to a citywide data management, transparency and sharing policy, including water usage data. In the Universal chapter, we discussed the merits of a citywide data management policy. In this chapter, we want to recommend additional rules that apply specifically to water.

Cities may not own their own municipal water utility, but they will want to have access to overall usage data provided by the local utility. It's important to ensure that the data conforms to the citywide data management policy, even if it originated elsewhere. Cities will also want to encourage utilities to grant water customers access to their own consumption data so they can see hour-by-hour how, when and where they use water. Armed with this type of information, they can make choices and tradeoffs that can reduce their water usage and their utility bills.

From a smart city perspective, water usage data is invaluable for long-range planning, for making zoning decisions, for water efficiency programs, for low-income assistance programs – and for setting an example by reducing water consumption in city facilities.

Consider a cloud computing framework. With the cost of cloud services declining, this universal target can make sense for cities large and small. It is particularly germane to the water sector in North America. In that part of the world there are few large water companies. Instead, water is managed by more than 18,000 small- to medium-sized organizations. Few of them have the budget for a large ICT staff and powerful server farms. Yet they can get the same power and benefits as larger organizations by turning to software-as-a-service running in the cloud.

Have access to a central GIS. A central geographic information system (GIS) improves decision-making capabilities citywide, hence its inclusion as a universal target. Two reminders germane to water: 1) In many parts of the world the water system is well over 100 years old and many water utilities don't know exactly where all the pipes and valves are located. 2) A city water department should seek to share costs with other departments if it needs to build a GIS system from scratch. A central GIS enables efficiency gains through more intelligent scheduling and routing, provides improved accuracy of essential records and boosts resiliency of key assets.

Achieve full situational awareness across the watershed, informed by weather data. Situational awareness is a universal target. When it comes to the water responsibility, it means getting a complete view of what's happening across a watershed. Such insight is essential for cities that want to 'close the loop' and promote sustainability by relying on their local watershed rather than importing water from elsewhere. That situational awareness should be further expanded by including local and regional weather data. Weather data can help give an accurate view of current conditions and can help predict future problems.

Achieve operational optimization:

LONG BEACH WATER OPERATORS SEE THE BIG PICTURE IN REAL TIME

The Long Beach, California water department is responsible for keeping the city's 487,000 residents adequately supplied with clean, good-tasting water. It is also responsible for the safe delivery of wastewater to its nearby sewage treatment facilities. It's a complex system consisting of nearly 30,000 different data points.

Operating its remote facilities and treatment plants efficiently requires Long Beach Water to use sophisticated technology to help maintain communications over the entire system in real time.

To enable its control room staff to effectively monitor and manage more than 90 remote telemetry units and its groundwater treatment facility, the water department uses a comprehensive Wonderware® solution from Council member Invensys.

The system is PC-based and uses the Microsoft Windows operating system with Wonderware's InTouch® human machine interface (HMI) software, which provides real-time visualization capabilities to monitor and control different sites.

The department polls the 40 remote sites throughout the water system an average of once every minute to ensure efficient operations. The data is stored in a Wonderware Historian, enabling the water department's main office to have simultaneous access to multiple data inputs from pumps, valves and equipment throughout the city.

Operators have a complete picture of the city's water system processes at any given time, thereby improving overall performance. With this level of visibility, subtle inefficiencies and any water-quality problems can be corrected immediately. And additional data critical to operations, such as where a leak on a pipeline has occurred, can be transferred back to the central site in real time.

> ***Achieve operational optimization.*** *Long Beach Water operators have a complete picture of the city's water system processes at any given time.*
>
> ***Figure 8.13***

Achieve operational optimization for sustainability, efficiency, cleanliness and safety. Operational optimization is a universal target. We have extended it to emphasize its value in a smart water network. Here are examples.

- **Optimize water capture.** A city might discover it is overdrawing from one source, and underdrawing from another. Correcting the situation creates a more optimized operation and a more sustainable water supply.

- **Optimize water distribution.** Analytics can ensure water goes where it is needed, when it is needed. Demand and supply can be balanced, so that water is distributed, consumed and reported with maximum efficiency. With smart meters providing data on consumption at customer premises, water pricing can move to a variable model to acknowledge that water is more expensive to procure in certain seasons and certain times of the day.

- **Optimize water use.** Smart devices can monitor conditions and assign different water grades. Some grades might be acceptable for your garden, but not for your cooking.

Automate fault and leak management. A smart water network can automate many parts of the leak management process. Leak management systems automate both the prioritization of repair work and the dispatch of crews. They make water systems more resilient to natural disasters and intentional damage.

Pursue predictive analytics. This universal target applies to water in powerful ways. By analyzing the data from a smart water infrastructure and combining it with weather data, cities can predict problems, such as areas prone to flooding. In some cities – including Rio de Janeiro – smart systems can monitor incoming storms and predict where floods will occur later that day, so emergency steps can be taken in advance.

Pursue predictive analytics.
By analyzing the data from a smart water infrastructure and combining it with weather data, cities can predict problems, such as areas prone to flooding.

Figure 8.14

Achieve operational optimization:

FLORIDA CITY OPTIMIZES WASTEWATER MANAGEMENT WITH RENEWABLE ENERGY FROM WASTE

Planning for continued long-term growth and expansion of its international airport led the City of Sanford, Florida to a decision to build a state-of-the-art wastewater treatment plant and recycled water distribution center.

Historically, Sanford had disposed of its wastewater treatment sludge (biosolids) by land application on a city-owned 1,868 acre rural site. Regulatory issues and environmental concerns resulted in a decision to install a natural gas-fired biosolids dryer to produce only Class A biosolids. Soon after the dryer decision, natural gas prices rose to a historic high, demonstrating the characteristic volatility of natural gas prices. This, and predicted long-term price escalation, set the stage for Sanford to consider alternative solutions.

The Sanford Utility Department sought to identify a method of biosolids management and disposal that would be long-term, cost effective, regulatory compliant and environmentally superior. Operating and capital budget constraints were major concerns.

To meet the challenge, Council member MaxWest Environmental Systems proposed to design, permit, finance, build, own and operate an integrated biosolids gasification system. Biosolids from the city's other plant would be trucked to a receiving station for combined dewatering, drying and gasifying. The proprietary MaxWest System utilizes energy embedded in biosolids as a source of renewable heat energy to dry biosolids to Class A standards, replacing the use of natural gas. Over the life of the 20-year contract, Sanford could save up to $10 million.

> ***Achieve operational optimization.*** *Visitors to the utility department in Sanford, Florida, USA will see a commercially operating regional biosolids disposal system with financial and environmental benefits to the host utility and surrounding wastewater systems.*

Figure 8.15

ADDITIONAL RESOURCES

Target: Implement optimal instrumentation across the watershed

Smart water metering solution reduces water usage by 10 percent in Australian city

Kalgoorlie-Boulder, Australia is a semi-desert, arid area, with low rainfall. It is situated 600 km east of Perth, has a population of about 35,000 people and has no locally available, natural water supply. All the water is piped from Perth. After installing a smart water metering solution from Council member Itron, the Water Corporation of Western Australia was able to reduce the city of Kalgoorlie's water use by 10 percent and eliminate occupational safety and health risks. The system provided the ability to detect leaks and empower customers with consumption data.

Target: Achieve operational optimization for sustainability, efficiency, cleanliness and safety

Nurturing Ireland's emerging blue economy by listening to sensors in the sea

The Irish Marine Institute plays a role that straddles marine science and economic development. And as sensors have become cheaper and more sophisticated, the Institute envisioned their widespread deployment in the ocean as part of a "smart ocean" strategy. Working with Council member IBM and others, the Institute is using real-time data streamed from sensor-enabled buoys in Galway Bay to develop analytical and predictive models that help the maritime community interact more intelligently with their ocean environment.

Target: Achieve full situational awareness across the watershed

A layered view of data technologies for the water distribution network

This brief white paper from Council advisor SWAN highlights the entire system of data technologies connected to or serving the water distribution network. For discussion purposes it separates the various components into layers, each of which can be made more intelligent as the water network evolves into a smart water grid. highlights the entire system of data technologies connected to or serving the water distribution network. For discussion purposes it separates the various components into layers, each of which can be made more intelligent as the water network evolves into a smart water grid.

WATER AND WASTEWATER TARGETS

*In the checklist below, targets specifically pertaining to the water and wastewater responsibility are in **bold,** universal targets are not.*

TECHNOLOGY

Enabler	Water and Wastewater Targets: How smart cities deploy and use ICT to enhance their water infrastructures	Implementation Progress: None	Partial	Over 50%	Complete
Instrumentation & Control	Implement optimal instrumentation **(Supplement: across the watershed)**				
Connectivity	Connect devices with citywide, multi-service communications				
Interoperability	Adhere to open standards Use open integration architectures and loosely coupled interfaces Prioritize use of legacy investments				
Security & Privacy	Publish privacy rules Create a security framework Implement cybersecurity				
Data Management	Create a citywide data management, transparency and sharing policy **(Supplement: including water usage data)**				
Computing Resources	Consider a cloud computing framework Use an open innovation platform Have access to a central GIS Have access to comprehensive device management				
Analytics	Achieve full situational awareness **(Supplement: across the watershed, and informed by weather data)** Achieve operational optimization **(Supplement: for sustainability, efficiency, cleanliness and safety)** Achieve asset optimization **Automate fault and leak management** Pursue predictive analytics				

Figure 8.16

CHAPTER 9

HEALTH AND HUMAN SERVICES

Advances in information and communications technologies (ICT) will transform the delivery of essential health and human services in powerful ways – and smart cities will ride the wave to ensure a better life for residents.

Let's imagine Los Angeles in the year 2030. An ill student is home in bed, following her algebra instructor's lesson over her smartphone. The instructor asks the class to solve for X, and our student raises her hand miles away to solve the equation in real time. Later that night, through an app on the same phone, she downloads her algebra homework assignment and in a virtual classroom she and her fellow students work together to apply the day's lessons.

She finishes her homework and opens up a new app – one that transmits data from her ongoing radiology treatment to her specialist in New York. She uses the health devices her hospital supplied and sends her data off in a matter of minutes. Downstairs, her mother is online accessing her daughter's Medicare records through the same portal that she has used to receive job training and employment referrals.

Welcome to the future of health and human services delivery, enabled by advanced technologies that will help smart cities improve the well-being of their citizens.

But before we dive too far into this chapter, let's deal with some definitions. In the Readiness Guide we consider human services those that cities provide to support the well-being of residents – their health and welfare, their education, the clean air they breathe and even the food they eat. Whereas in previous chapters we showed how ICT makes infrastructure smarter, in this chapter we explore how ICT empowers people to be smarter and healthier. The importance of smart human services can't be understated – after all, an educated and healthy city is a wealthy and successful city.

Making health and human services smarter

For our purposes, we have identified four interrelated and codependent categories of human services that ICT can transform to improve outcomes for city residents. As you look to transform these health and human service areas, it is important that you work with both public and private organizations and infrastructure in your city as often some of the assets involved are not owned by the city.

1. **Public health is the macro, citywide view of health.** Epidemiology, air quality, UV radiation, health research and development, population health management, food safety, health literacy and other large-scale issues are the concern of city public health agencies. Smart public health uses ICT to improve outcomes for citizens and cities alike. City agencies can use sensors to collect data on air quality, noise pollution, UV radiation, diseases and a host of other factors that impact public well-being. They can also proactively receive health information directly from citizens, by encouraging them to share their health feedback and experiences through smartphone apps. This data can then be analyzed to detect trends and potential problems – and to inform city decision-making – which might include anything from zoning laws to emission standards to mobilizing health providers to respond to an outbreak.

2. **Health is how cities support the mental and physical well-being of residents.** Today the traditional ways cities approached healthcare are being challenged by several factors, all of which have converged to place an enormous strain on already tight budgets:

- Non-communicable diseases and disorders like heart disease, diabetes, obesity, stress, mental health problems and so on have grown significantly in the last decade, and are often concentrated in urban environments.

- Many regions of the world have inadequate health services that are strained by increasing demand at the same time populations are aging and people are living longer.

- Urban populations continue to swell around the globe; over half of all people now live in cities and the trend is expected to continue.

The emerging discipline of "smart health" uses technology to overcome these challenges (and greatly improve outcomes) in these ways:

- It broadens and deepens access to health services.

- It treats health holistically, attacking health considerations proactively, across a broader range of city services and departments, and by focusing on prevention and healthier living.

- It supports better cooperation, collaboration and productivity between multidisciplinary and often geo-dispersed teams of health professionals.

Smart health uses technology to improve citizen access to healthcare. Remote delivery of health services via smartphones, computers or video devices – often referred to as telemedicine or mobile health – makes it possible for a patient to receive advice and treatment from a doctor without having to leave home or work . And the doctor can assess and treat conditions in real time and with maximum efficiency. This is one example of how smart cities use ICT to improve health – reaching more people in less time and using fewer resources without compromising the quality of health outcomes. Here's another: Using ICT to integrate health data from all city departments and agencies into a single health history portfolio. That way the patient's health data is easily accessible wherever they go to seek health services, reducing the likelihood of lost or misplaced files and making healthcare delivery more efficient for all concerned.

Additionally, natural user interfaces and analytics can "learn" about patients as they grow a health history and suggest tailored and specific health interventions – of course, within the limits of city security and privacy standards and with a person's permission. A patient showing signs of hypertension, for example, might receive life-saving information about heart attack risk and prevention.

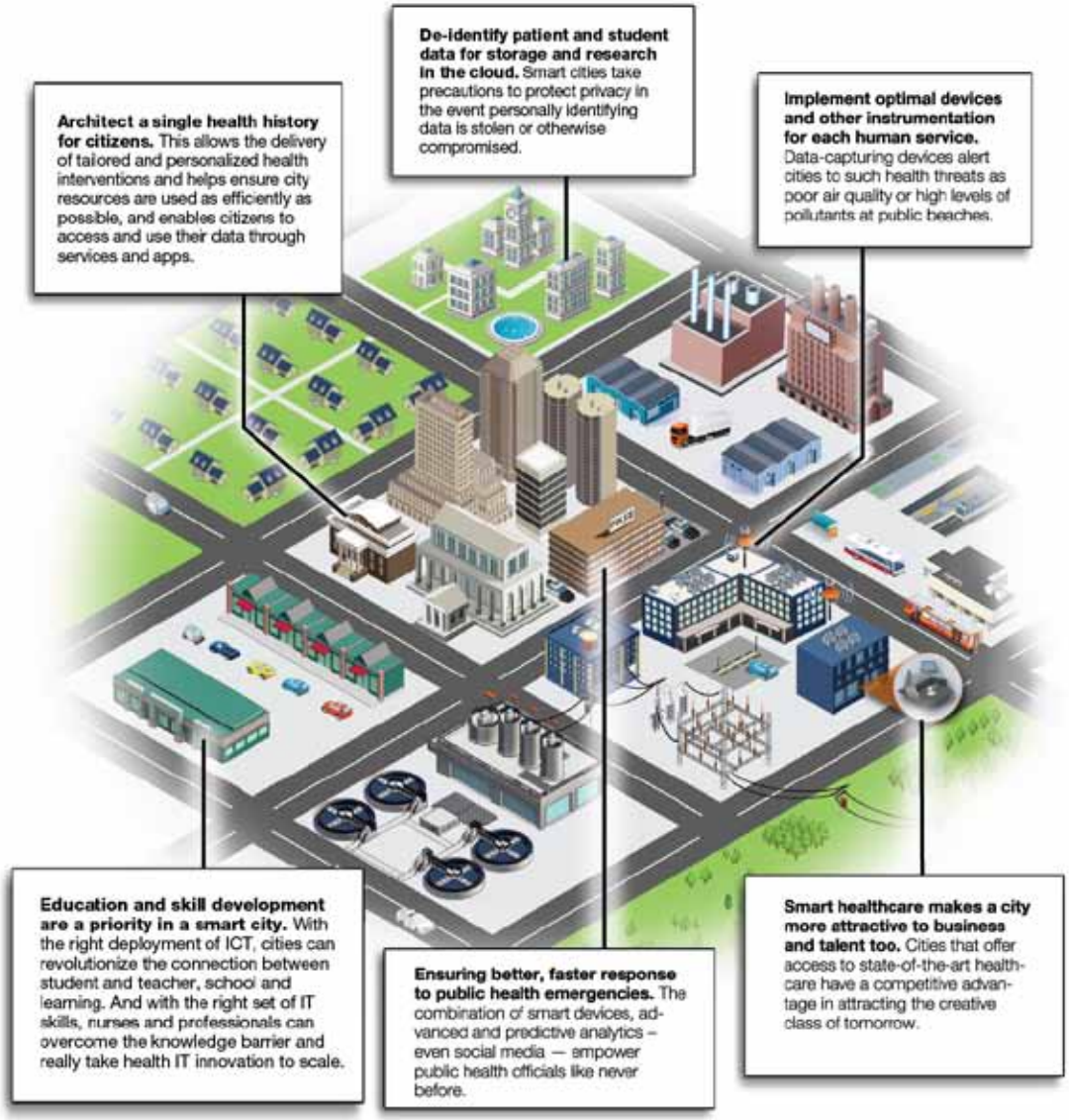
There's also the convenience factor. A mother gets a text on her smartphone that it's time for her child's vaccination; she can make and/or reschedule the appointment on her phone or on a web portal. In so many ways, information can be a powerful tool in health – and ICT can help get it to the people who need it, when they need it.

3. **Human services refer to a new and broader spectrum of easily accessed services that help people live better lives.** These include services to help people deal with substance abuse, domestic violence, HIV/AIDS, nutrition and physical fitness. It includes helping the homeless find beds to sleep in, disabled people find accessibility features across cities and dysfunctional families get counseling services.

While it is common for cities to treat health and human services separately, smart cities integrate a client's human services history into their health portfolio for better outcomes and greater efficiency. An example might be a homeless person showing up at a shelter seeming distraught or mentally disturbed. A shelter worker accessing the person's health history profile might discover he had been prescribed medication by a mental health professional some months back but the prescription had lapsed.

4. **Education and skill development are a priority in a smart city.** They provide opportunities for all ages and all levels, ranging from toddler story hours at the public library to computer classes at the senior center. K-12 education, workforce training programs and higher education are all essential. But today education is mostly stuck in the physical world. With the right deployment of ICT, cities can revolutionize the connection between student and teacher, school and learning.

HEALTH AND HUMAN SERVICES



> ***Smart health and human services is about using ICT to improve outcomes.*** *This includes everything from improving access to medical advice via telemedicine to integrating patients' health and human services history into a single, easily accessible online portfolio.*

Figure 9.1

BROADBAND PUTS PATIENTS AT HOME FACE-TO-FACE WITH HOSPITAL CLINICIANS

ICT technology developed by a UK consortium allows patients with chronic illnesses to consult with hospital clinicians in the comfort of their own homes. Not only does the technology allow the patients to avoid the often painful, time-consuming and expensive process of traveling to the hospital for outpatient services, advocates say it could save the National Health Service (NHS) millions of pounds a year.

The Assisted Living Innovation Platform uses a set-top box linked to a patient's home television and standard broadband connection, allowing hospital specialists to consult with their patients face to face. Using technology similar to Skype, the set-top box is a more advanced video conferencing unit complete with web camera that sits on top of the TV. The patient can see the clinician on their TV screen and the clinician can see the patient on their computer screen in the hospital. The system also delivers educational materials related to a patient's condition direct to their television. Patients can also use it to access a 24-hour "telehealth" hub staffed by nurses who can refer patients to specialists as needed.

Analysis of the telemedicine project, which was supported in part by the UK Technology Strategy Board, an adviser to the Smart Cities Council, found:

- The net saving to NHS from use of the system by a patient with chronic obstructive pulmonary disease of moderate severity is anticipated to be between £3-4k per patient per year.

- Of the first 150 calls triaged through the 24-hour hub, 33 percent resulted in an avoided admission and 9 percent in an avoided GP visit. Another 13 percent were admitted but care was streamlined as a result of targeted treatment.

> ***Connect all devices with a citywide communications system.***
> *The UK's National Health Service (NHS) estimates 70 percent of its total expenditure is committed to helping people manage their long-term conditions, such as diabetes. Remotely connecting patients with hospital clinicians via a television hookup can improve the efficiency of NHS and the patients' quality of life.*
>
> ***Figure 9.2***

Dependencies in health and human services

When planning improvements in the public health arena, it's important for cities to recognize dependencies between healthcare services and other city systems and services.Clearly, public healthcare services rely heavily on a city's public safety, communications and water systems. One example: The health of a city's population is at risk if municipal water supplies are contaminated.

On the human services front, consider the dependencies between education and communications, energy systems and government administrative services. For example, enhancing communications technologies and access to them can help conquer the "digital divide" that challenges low-income students. The same communications technologies can improve access to remote education services. Local government policies are needed to support such programs.

Improving patient satisfaction. *With telemedicine, patients can reduce the amount of time they have to take off work to travel to a doctor's office and sit in a waiting room.*

Figure 9.3

Benefits of health and human services

Before we examine this chapter's targets in detail, consider how smart health and human services enhance livability, workability and sustainability:

Livability

Improving patient satisfaction. One of the primary benefits of telemedicine is the increased satisfaction it delivers to patients – especially the elderly and mobility-challenged, but others too. Imagine if instead of taking time off work, making a trip to the doctor's office and then sitting in a waiting room, you could transmit your health data on your own time, and your physician could review it with you via a video feed. Telemedicine eliminates much of the hassle associated with healthcare.

Improving the delivery of health, education and other human services. City services are often underused because those most in need of them may not know they are available, aren't sure they qualify, or don't know how to access them. An integrated, personalized citizen portal ensures easy, on-demand access to information people need.

Ensuring better, faster response to public health emergencies. The combination of smart devices, advanced and predictive analytics – even social media – empower public health officials like never before. They

can monitor the outbreak of a disease or a hazardous fuel spill in real time, predict how it will spread and alert the public instantly through a wide range of communications channels.

Broadening access to healthcare. As cities grow larger, medical resources and access to expertise are stretched further and further. But ICT helps doctors reach as many patients as possible, improving health outcomes across cities.

Improving the precision and accuracy of health interventions. Analytics can help cities provide health warnings and educational outreach to the very people who need them. Not only is precision an efficient use of resources, it can save lives by encouraging behavioral change and promoting healthier decisions.

Preventing diseases and disorders before they emerge. ICT unearths an understanding of city populations that city health managers can use to build targeted prevention campaigns. What's more, ICT can deliver these campaigns directly to citizens' fingertips so that information is widely digested and acted upon, helping reduce critical problems like obesity, heart disease and hypertension to name just a few.

> ***Reduce long-term health costs.*** *Cities can take steps to reduce the cost of healthcare by encouraging preventive actions and educational campaigns.*

Figure 9.4

Workability

Improved public health means fewer work hours missed. A 2012 study estimated that illness cost the United States economy around $576 billion dollars a year. Cities that use ICT to bolster awareness of public health issues and promote remedies optimize their citizens' well-being, which translates into a more productive workforce and a stronger economy as a result.

Smart education makes a city more attractive to business and talent. Cities that make education a priority and use technology to empower current and future workers with a superior education and continuing online education and training – particularly in high-demand fields such as math, science and technology – can capitalize on this demand to draw new businesses and investment that bolsters the local economy.

Smart healthcare and social services make a city more attractive to business and talent too. Cities that offer access to state-of-the-art healthcare and social service programs have a competitive advantage in attracting the creative class of tomorrow. Put simply, if you're a top talent, you're not going to locate your family somewhere they'd have to leave when they needed quality health and human services.

Sustainability

Telemedicine is cost effective. Medicaid and other organizations recognize telemedicine as more cost effective than traditionally delivered medical care. By promoting its use, cities can ensure that medical providers can perform more great work with fewer resources.

Reduced long-term health costs. By deploying smart devices that measure and monitor public health conditions, and then using that information to inform decisions citywide, cities can take steps to reduce the cost of healthcare through preventive actions and educational campaigns.

Telemedicine and smart learning mean less travel. Improved service delivery that utilizes ICT cuts down on travel, which promotes the conservation of energy resources.

> ***Telemedicine and smart learning enhance sustainability.*** *Improved service delivery that utilizes ICT cuts down on travel, which promotes the conservation of energy resources.*

Figure 9.5

Smart education makes a city more attractive to business:

DEEPER STUDENT INSIGHTS LEAVE A DEEP IMPACT

For the Hamilton County, Tennessee Department of Education, the essence of educational intelligence is insight through granularity. And it's one reason the county's graduation rate has increased and standardized test scores are up too.

The department started down the educational intelligence. path a few years ago, when it began looking into why its students were consistently scoring below state benchmarks on standardized tests. Administrators didn't get far before realizing they lacked the kind of detailed, granular data that would be necessary to understand the factors that contributed to the poor performance, much less act on the problem.

What little performance data Hamilton County had been receiving came from state scoring reports (as part of No Child Left Behind), which provided a lumpy, aggregate measure of whether the county's 40,000 students were on track.

Implementing smart performance tracking technologies from Council member IBM, Hamilton County educators developed a performance modeling tool that extracts individual student data from the county's 78 schools and uses it to create predictive profiles, which help to flag those students in need of proactive intervention by teachers or counselors. Using built-in algorithms, the model determines which factors are the strongest predictors of a student failing or dropping out.

Identifying those students labeled "fragile" or "off-track" is just the beginning of a process whose ultimate aim is the success of the student.

> ***Smart education makes a city more attractive to business.*** *Using analytics and performance modeling tools, educators in Hamilton, County, Tennessee have determined how to identify at-risk students and implement processes to help them succeed.*

Figure 9.6

Health and human services targets

As you'll see in the pages that follow, there are two targets specific to this health and human services chapter and they will be discussed in detail. We'll also explain how other universal targets apply to health and human services.

Instrumentation and control

Health and human services use instrumentation and control in two slightly different ways, but the primary mission remains the same as in other city responsibility areas. It's all about data collection.

Implement optimal devices and other instrumentation for each human service. Implementing the right data-capturing devices across all of a city's health and human services responsibility areas is the objective here. Given the new and different types of services involved, different kinds of instrumentation will be required.

For instance in a smart city, public health departments deploy passive data-collecting devices across the urban environment. These devices collect input on a variety of environmental and health parameters – air quality, UV radiation, noise pollution and disease management among them. Instrumentation can include smartphones and apps that allow people to directly participate in city public health monitoring by providing feedback about conditions and experiences. The goal is to provide data that cities can analyze to identify threats, problems and trends, allowing them to improve outcomes in a cost-effective and people-friendly way.

Meanwhile in the healthcare, social services and education arenas, devices collect data from people for the most part. These include devices that may monitor how patients in a study are responding to a new medication or ones that record academic progress in a new teacher's classroom. The purpose is to provide actionable data that can be analyzed for trends or problems.

Data-capturing devices are critical for the telemedicine systems mentioned earlier. Patients use devices to acquire data on their radiology or pathology treatments in the comfort of their homes and then transmit it to remote care providers; the greater efficiency can save time, money and resources. Similar savings can occur when health professionals remotely monitor patients with chronic conditions like diabettes or heart disease. And the opportunity to use ICT for real-time, interactive checkups allows physicians to deliver emergency medical help that can save lives where more time-consuming traditional medicine may be too late.

In education, there are many ways to improve outcomes through ICT. Applying data analytics to test results, attendance and graduation rates can help pinpoint problems and trends. Today's smart devices combined with all manner of web apps and social media tools connect students to teachers, to other students and to diverse learning opportunities in ways never imagined a few short years ago. In one example, school-owned smartphones that allowed a 24/7 wireless connection to teachers improved algebra proficiency results by 30 percent.

Privacy and security

Nowhere perhaps is privacy and security more critical than in health and human services. Citizens must be able to completely trust the public agencies that maintain files with what may be very sensitive personal information. These targets outline how smart cities handle this.

Publish privacy rules. Even though there are often very specific laws regarding how health information is handled, smart cities still need to be very transparent about their commitment to safeguarding the privacy of all citizens.

Create a security framework. Mitigate risk by taking a proactive approach to security – identifying and addressing threats before they can cause damage.

Implement cybersecurity. Cyber crimes are on the rise and this is another critical step toward protecting data that may reveal sensitive personal information about citizens served by health and human service agencies. Implementing cybersecurity early on maximizes protection while minimizing costs.

De-identify patient and student data for storage and research in the cloud. Before storing health and human services data in the cloud, it's imperative to remove any personally identifying information that ties an individual to specific data. That helps protect a person's privacy in the event the data is stolen or otherwise compromised.

By taking these steps, cities will do much to assuage potential privacy concerns that could become a barrier to telemedicine or other advances in health and human services technologies.

Connectivity

We talked earlier about how public health agencies use smart devices and other instrumentation to collect data about air quality, disease outbreaks and the like. Collecting it is only a starting place.

Connect devices with citywide, multi-service communications. Connecting the smart devices deployed around cities for public health data-capture to a citywide communications system is important for realizing improved public health outcomes in the same way that smart gas or water meters must be connected to optimize those infrastructures. Water quality monitors that detect a chemical leak that could contaminate a popular swimming beach isn't useful unless the information is communicated in real time to all of the city departments that might need to get involved.

> ***De-identify patient and student data for storage in the cloud.*** *Remove any personally identifying information that ties an individual to specific data before storing it in the cloud to help assuage potential privacy concerns that could become a barrier to telemedicine or other advances in health and human services technologies.*

Figure 9.8

Create a security framework:

REDUCING IT MANAGEMENT WORRIES IN HEALTHCARE DELIVERY WITH IP ADDRESS SOLUTION

Every day in Stockholm, Sweden, nearly 21,000 people visit a doctor; about 3,500 people are admitted to the city's seven hospitals; and about 80 children are born. They are the concern of hospital administrators, doctors, nurses, physician's assistants and midwives.

The IT managers at Stockholms Läns Landsting, the Stockholm County Council may not know the names of any of these people on any given day, but they are concerned for them too, because the medical care they receive is dependent, in part, on the directory services infrastructure.

That infrastructure includes about 1,000 server computers and 50,000 client devices, mostly desktop PCs. And it's growing. Those computers require management and maintenance of various sorts from hardware replacements to software updates.

But with its existing system it was possible for computers to be misidentified with incorrect or multiple addresses. This would be a problem for any enterprise, but it was a special problem for a network focusing on healthcare delivery. Olle Rundlöf, Directory Services Server Manager at Stockholm County Council, makes the problem clear with a single example: "Imagine a hospital's office PCs undergoing a regular, scheduled update," he says. "Now, imagine a surgeon's PC in an operating room being misidentified as one of those office PCs and updating and rebooting itself during a crucial moment in a surgical operation."

The Council migrated to a solution from Smart Cities Council member Microsoft and adopted the IP Address Management in Windows Server 2012 to gain the security and near-total availability that it needs. The solution also reduces time spent managing the address space and allows it to adopt new devices and solutions as it's ready to do so.

> ***Create a security framework:*** *A system that could misidentify computers with incorrect or multiple addresses would be a problem for any enterprise, but it was a special problem for a network focusing on healthcare delivery.*

Figure 9.9

Data management

To reinforce the privacy and security strategies highlighted in the previous section, smart cities will want to make sure all departments are following the same rules.

Create and adhere to a citywide data management, transparency and sharing policy. Again, due to the sensitive nature of data involving health and human services, it goes without saying that a policy needs to be very explicit about who owns which data sets, who has access, how it can be shared and when it should not be shared.

When cities adopt an open data policy for non-sensitive information, they unleash enormous possibilities. In conjunction with a strong and clear privacy policy, city health and human services data can be used to create new health, social services and education apps – an easy win for cities and residents.

Architect a single health history for citizens. Smart cities integrate personal health data from their different agencies and departments so that patients can enjoy the benefits of a single health history. A single health history is critical for the delivery of tailored and personalized health interventions and promotes the efficient use of resources. And this repository can be more than passive storage – it can be an online, security-enhanced storage, sharing and services platform that citizens can access.

Computing resources

There's nowhere in a smart city that computing resources aren't a major player. Below is a quick refresher on four targets to consider in a health and human services context.

Consider a cloud computing framework. Cloud computing has become more affordable and more prevalent. Smart cities of all sizes may see advantages in the cloud's scalability, reliability and cost. However, as we mentioned earlier, before uploading personally identifiable health and human services data to the cloud, steps must be taken to "de-identify" it.

Use an open innovation platform. An open innovation platform empowers innovators. And the possibilities in the health and human services arena are limitless. In New York City, for example, residents can download an app that provides all sorts of useful information about local restaurants – including what grade they received in their most recent health inspections.

Have access to a central GIS. With health and human service agencies spread out in many parts of a city, a GIS will prove useful for smart cities. A central GIS enables efficiency gains through more intelligent scheduling and routing, provides improved accuracy of essential records and boosts resiliency of key assets.

Have access to comprehensive device management. It's important to include devices used by health and human services workers in the field – smartphones, laptops, etc. – as part of a city's device management system to ensure they comply with city data management, security and privacy policies.

> ***Use an open innovation platform.*** *App development possibilities in the health and human services realm are limitless. This app provides details on recent health inspections at New York City restaurants.*

Figure 9.10

Consider a cloud computing framework:

SCHOOL DISTRICT USES DATACENTER SERVICES TO REDUCE COSTS, IMPROVE EDUCATION

Tainan City Education Center is responsible for the technology needs of the Taiwan city's 275 public K–9 schools. This includes Internet connection infrastructure; IT education to help students achieve high levels of technology literacy, and value-added services to assist the schools' teachers and administrators, such as electronic administration, educational technology recommendations and self-service application development.

Each school has traditionally hosted its own server infrastructure, and the large number and geographic distribution of the schools has made it challenging and costly to provide a consistently high level of IT support.

The education center has begun migrating to a new centralized IT infrastructure based on a private cloud model developed in consultation with Microsoft Services Consulting. Microsoft is a Smart Cities Council member.

Education center officials anticipate that the new infrastructure will save the city US$344,000 per year in hardware and support costs, and it will reduce the district's carbon emissions by 2,610 tons annually. In addition, teachers can take advantage of cutting-edge technology to improve classroom materials, and students have increased access to educational resources.

> ***Consider a cloud computing framework.*** *Migrating to a new centralized IT infrastructure based on a private cloud model is expected to save Tainan City US$344,000 per year and improve educational resources in classrooms.*

Figure 9.11

WIRELESS VIDEO SOLUTION HELPS HOSPITAL PATIENTS COMMUNICATE WITH DOCTORS

Bradford Royal Infirmary and St Luke's Hospital are teaching hospitals in the United Kingdom that serve the healthcare needs of 500,000 citizens, of which 22 percent are from black or minority ethnic (BME) origins. Many of them do not speak or understand English, a situation that often resulted in patient communication problems at the hospitals.

With over 900 beds and 5,200 staff collectively, these two busy hospitals deal with over 120,000 accident and emergency (A&E) attendances a year, nearly 50 percent of whom are estimated to be from the BME communities.

Effective communication between doctors, nurses and patients is vital, but interpretation services were inconsistent. For face-to-face consultations, clinicians used in-house interpreters or hired interpreters from their professional register who specialized in a core set of languages. However, these interpreters were not always available at short notice, so clinicians were often forced to communicate via patients' relatives and friends. The alternative was to use a telephone interpreting agency, but this approach was expensive and unpopular with medical staff because it lacked the visual interaction needed in a patient consultation.

In addition to inconsistency and expense, these methods of interpretation had other disadvantages. Using nonprofessionals increased the risk of misinterpretation, which could create potential risks when delivering medical care. Similarly, using a male interpreter could be embarrassing for women, particularly if their condition was of a sensitive nature.

> ***Innovating with ICT.*** *A wireless video solution allows two UK hospitals to provide much-needed interpretive services to patients on a timely basis, providing a better patient experience with less risk of incorrect treatment or cultural offense due to language issues – and also reducing hospital costs.*

Figure 9.12

That's when they came up with the idea of video interpreting. They already used wired and wireless networks from Council member Cisco, so they consulted experts from the Cisco Healthcare Team to help design a wireless-based video solution. A proof of-concept was subsequently arranged to thoroughly test the Cisco solution and gather feedback from both clinicians and patients.

The result is a fleet of trolley-based interpreting endpoints, which are powered by battery packs, allowing easy transportation to any hospital location. The trolley offers a simple keyboard and screen with video communication. Using a mouse, clinicians select the language they require and the preferred gender of the interpreter. The system uses one of the hospital's 350 Cisco wireless access points to connect to a dedicated team of interpreters who constitute, in effect, a small contact center. To help ensure quality of services, video interpreting services are segregated from other traffic on the wireless network.

The primary focus is to make hospital services more accessible to non-English speakers, but a hospital official estimates the solution will reduce interpretation costs by 30 percent.

Analytics

The four targets highlighted here demonstrate how analytics are particularly important as cities monitor trends and developments in public health.

Achieve full situational awareness. Smart cities use monitoring devices to take the pulse of the city and its people. Situational awareness aids that effort by increasing the reliability and resiliency of the public health infrastructure and those monitoring devices, allowing for quick response to incidents that threaten public health and well-being.

Achieve operational optimization. Analytics help cities ensure the best possible public health outcomes. For example, they may reveal a sudden shift in air quality in a particular part of a city that requires corrective action. Or analysis of health records may reveal an abnormally high number of lung cancer cases in a community, prompting an investigation by public health officials.

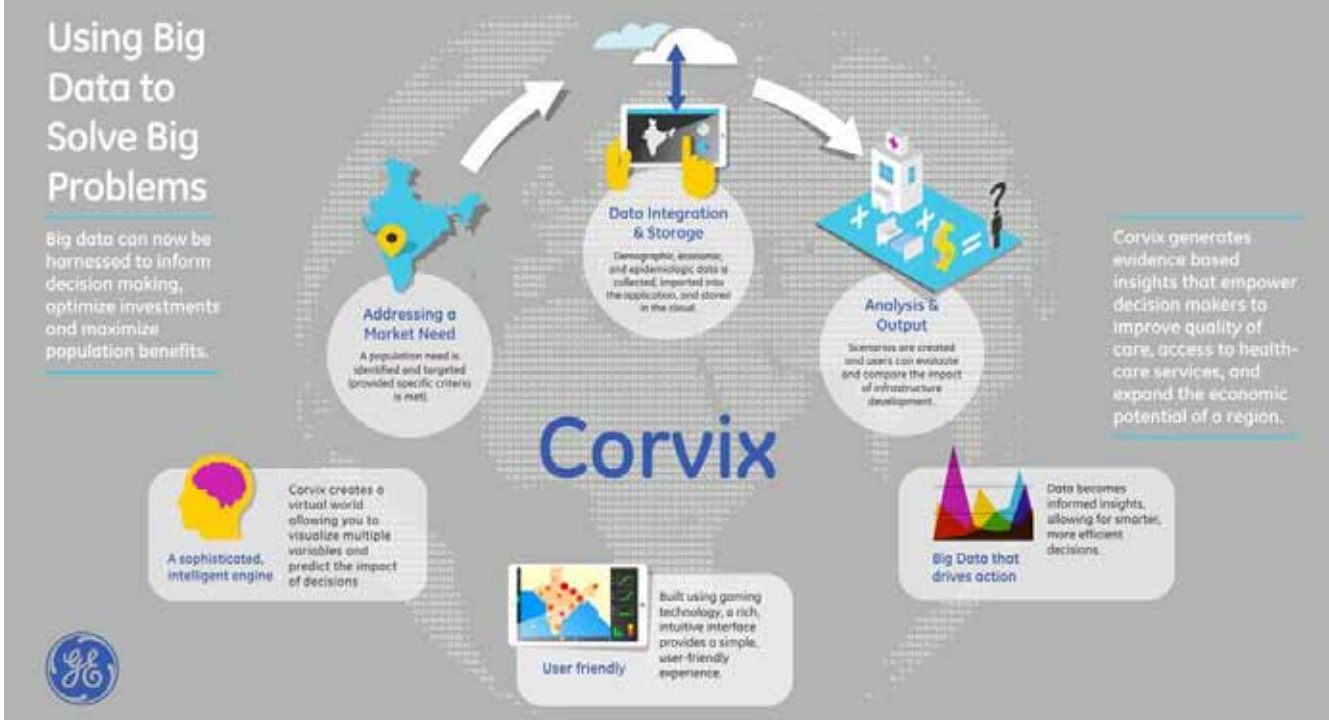
Achieve asset optimization. The objective here is to ensure maximum value is extracted from a city's investments in health and human services infrastructure – which includes everything from computers in offices to field devices that monitor things like water quality at public beaches. Calculating precisely which assets should be replaced or repaired and when helps achieve maximum return on investment.

Pursue predictive analytics. Analyzing health and human services data to spot patterns and trends and take action before situations worsen can make a city more livable. By monitoring the path and characteristics of a virus, for instance, public health officials can predict where it will strike next and alert residents how they can protect themselves.

Predictive analytics also has implications for smart healthcare. As patients build a personalized, single health history, predictive analytics can alert them and their physicians when they are at risk of developing a given health problem. Or, these analytics can help patients understand what their own health might look like in the future, providing patients with an incentive for behavior changes – and empowering them to prevent disease and other problems before they cause damage.

Pursue predictive analytics:

USING BIG DATA TO SOLVE BIG HEALTHCARE ISSUES IN THE CLOUD



A team from Council member GE has gathered demographic, economic, and epidemiological data and built a system, called Corvix, to simulate, improve and expand the treatment of heart disease.

"We are converting big data into intelligent data," says Mitch Higashi, chief economist at GE Healthcare. "We are creating digital clones of human beings and they live out their lives in the cloud. It's almost like running different versions of the future. How does the population health trajectory change over time? We can accelerate getting to the right answer."

The team is testing the system in the Indian state of Andhra Pradesh.

Higashi says that the system seeks to find an "optimal solution" to a problem, a point where the most "players" receive the most benefit.

Healthcare, for example, has a number of stakeholders, from patients and government officials, to doctors, equipment makers and hospitals. The GE system could help planners build hospitals in the right place for the right price and fill them with the right equipment so that the most people can live longer and better lives. "Quality-adjusted life-years is one of the outputs of the model," Higashi says. "That's the utility measure we use."

Data scientists and health economists at GE Healthcare spent two years developing the system.

> ***Pursue predictive analytics.***
> *Data scientists and health economists partnered with a national lab for help building a new operating system for Corvix that converts data sets into virtual beings.*
>
> ***Figure 9.13***

ADDITIONAL RESOURCES

Target: Implement optimal instrumentation

Air quality agency automates permitting; higher efficiency leads to better air quality

Bay Area Air Quality Management District (the Air District) regulates air pollution in the San Francisco Bay Area. Regulatory oversight for a diverse set of 25,000 businesses has required the Air District to make its business processes smart, efficient and automated. The Air District worked with Microsoft and Vertigo Software to implement a foundation for an automated, online permitting and inspection system. It expects the solution to help it cut permit processing time from 45 days to a matter of minutes for simpler applications.

Target: Create a security framework

Nurses on the go: Moving sensitive information securely from remote locations

The Visiting Nurse Service of New York (VNSNY) is dedicated to home and community-based healthcare. It has approximately 18,000 employees, including nurses and other healthcare professionals who use tablets to record information from their home health visits. Realizing it needed a way to securely transfer data, including patients' health information, to company systems, VNSNY implemented WebSphere MQ software from Council member IBM.

Target: Achieve operatonal optimization

Big data solution transforms healthcare with faster access to information

Ascribe, a leading provider of IT solutions for the healthcare industry, wanted to help clinicians identify trends and improve services by supplying faster access to information. However, exploding volumes of structured and unstructured data hindered insight. To solve the problem, Ascribe designed a hybrid-cloud solution with built-in business intelligence tools based on Council member Microsoft's SQL Server 2012 and Windows Azure.

HEALTH AND HUMAN SERVICES TARGETS

*In the checklist below, targets specifically pertaining to the health and human services responsibility are in **bold,** universal targets are not.*

TECHNOLOGY

Enabler	Health and Human Services Targets: How smart cities deploy and use ICT to enhance health and human services	Implementation Progress: None	Partial	Over 50%	Complete
Instrumentation & Control	Implement optimal instrumentation				
Connectivity	Connect devices with citywide, multi-service communications				
Interoperability	Adhere to open standards Use open integration architectures and loosely coupled interfaces Prioritize use of legacy investments				
Security & Privacy	Publish privacy rules Create a security framework Implement cybersecurity **De-identify patient and student data for storage and research in the cloud**				
Data Management	Create a citywide data management, transparency and sharing policy **Architect a single health history for citizens**				
Computing Resources	Consider a cloud computing framework Use an open innovation platform Have access to a central GIS Have access to comprehensive device management				
Analytics	Achieve full situational awareness Achieve operational optimization Achieve asset optimization Pursue predictive analytics				

Figure 9.14

CHAPTER 10
PUBLIC SAFETY

From the standpoint of the average citizen, public safety is one of the most visible and perhaps most understood of city responsibilities. We see aid vehicles on highways and byways, lights flashing as they race to the scene of an accident. We watch firefighters on the nightly news risking life and limb to save people from a burning building. And we pass police officers on bikes and on foot as they patrol city streets.

In the Readiness Guide, public safety includes all the infrastructure, agencies and personnel that cities call on to keep their citizens safe — police and fire departments, emergency and disaster prevention personnel, courts, correction facilities, neighborhood watch groups, fire hydrants and squad cars. It's a lengthy list that may include infrastructure and resources from other city departments and non-city agencies and even private citizens.

Smart cities empower these agencies and personnel with information and communications technologies (ICT) to create "smart public safety" and greatly improve safety outcomes. The brief scenario at right illustrates the smart public safety concept.

> ***Enabling smart public safety.*** *Smart cities empower their public safety agencies and personnel with ICT to improve safety outcomes.*

Figure 10.1

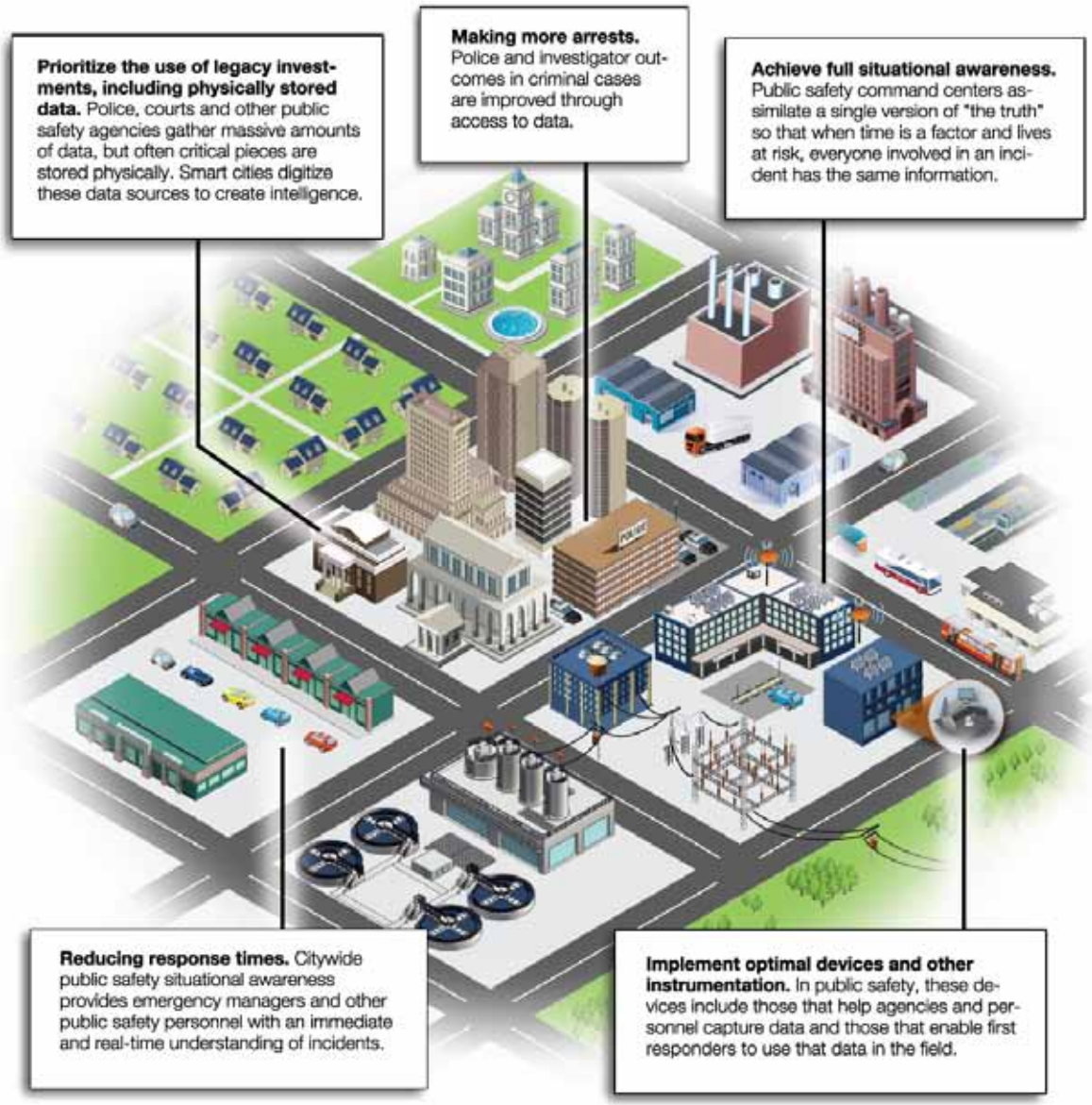
Figure 10.2

In 10 minutes, a tornado will touch down in a suburb of Eindhoven in the Netherlands. Wind and audio sensors deployed across the city have been tracking the super cell as it moves towards a densely populated area.

Eindhoven's command center mobilizes fire and emergency management personnel and resources with a single command, and these personnel move into position. The tornado touches down, damaging several homes. As the tornado dissipates, the two public safety agencies begin their combined search and rescue and triage operations seamlessly – each knowing which resources the other has brought to bear thanks to a citywide communications network. That means they aren't wasting time duplicating effort.

Through their mobile devices, the fire and medical first responders stay current on conditions across the neighborhood as it is explored by their colleagues. At the end of the operation, quick response time and efficient division of labor between agencies are credited with saving lives and resources.

PUBLIC SAFETY



Smart public safety is about using intelligence. *This intelligence is what helps people make better decisions – from determining when and where crimes are most likely to occur to when a wildfire will threaten homes.*

Figure 10.3

It's about the data

At its core, smart public safety is all about the use of "intelligence" – information that helps people make better decisions. For example, intelligence might hint at the identity of a criminal. Or it might suggest to emergency personnel that a wildfire is likely to occur on the outskirts of town. This kind of public safety intelligence creates immeasurable value not only to first responders, but to city residents and businesses too. As cities become safer, people are happier and healthier, businesses take note and tax revenue increases.

Let's look at four specific ways ICT-enabled smart cities improve public safety outcomes:

- Generating their own public safety data
- Accessing the universe of relevant data
- Correlating data sources to create intelligence
- Delivering intelligence to decision makers

Generating public safety data is a first step in realizing intelligence. Many cities will have much of this data as well as mechanisms for generating it in place already. It's what we call legacy information, or legacy investments. Think of your own criminal database and records that include fingerprints, mug shots, video evidence and so on. Smart cities augment existing sensors with others to obtain all relevant information in their environment. Sensors might include CCTV, other video sensors or audio sensors.

But this data alone isn't enough to create actionable intelligence. Cities must augment it with many other data sources, traditional and non-traditional. In fact, accessing the universe of relevant public safety data is absolutely critical for improving safety outcomes. Public safety requires close cooperation and data sharing across city departments. Police might need access to drivers' license records from a licensing department. Or fire personnel might need to understand weather data from a meteorological agency housed in an energy department.

> ***Using ICT to create intelligence.*** *After being held at gunpoint on a city street, Shayan Pahlevani co-founded a company that makes the free CrimePush app that lets smartphone users push a button to report a crime in progress.*
>
> ***Figure 10.4***

Accessing the universe of relevant data aids decision making. Other states, provinces and regions keep records. National governments and their agencies keep records. Even international organizations like Interpol keep records. And helpful, relevant information can come from non-traditional sources as well – consider the wealth of data that exists in social media. Indeed, by 2030 every city asset, across much of the world, might be sending data in an Internet of Things. Smart public safety agencies seek access to all of it, for every new piece of data that a city has access to makes their intelligence that much stronger and that much more precise.

Accessing all of this information is both a big task and a critical one. Fortunately, ICT and good interoperability and data management policy can help. Already, standards exist that can ensure that the data cities collect and use is interoperable.

Smart cities employ ICT to correlate data and create intelligence. Computing power and analytics transform otherwise useless piles of data into decisions, insight and foresight. For example, armed with this intelligence smart cities predict crime, so that their law enforcement agencies can better protect citizens and make more efficient use of resources.

Additionally, thanks to the open government movement discussed in the Universal chapter, we're seeing more and more crime data making its way into applications that everyday citizens can use. Buying a house and want to make sure you're in a safe neighborhood? On vacation in a new city and want to steer clear of crime-infested areas? Chances are there's an app that can help.

Finally, smart cities deliver this intelligence to decision makers. Public safety intelligence is about saving lives and property, so it must be accessible "no matter where, no matter what." With ICT, smart public safety agencies can disseminate intelligence to multiple departments and thousands of employees so there is a common operating picture.

On the law enforcement side of public safety, intelligence will often lead to arrests, and the involvement of city courts and corrections systems. ICT plays a role in these systems as well. Proper data management systems can help courts make effective use of the enormity of information that they hold. Public defenders can level the playing field with private lawyers and their large staffs with the help of ICT.

Figure 10.5

Dependencies in public safety

Cities contemplating Improvements in public safety will want to take into account public safety's dependencies on other city systems and services. For example, police, fire and emergency services all rely on communications, transportation systems and energy. In normal daily operations, police and fire departments rely on communications and energy systems to maintain real-time situational awareness of activities taking place across a city. And in the urgent case of a natural disaster, first responders will rely on the resilience and reliability of communications, electrical power and transportation systems to help them establish command and control, gain situational awareness, coordinate inbound aid resources and potentially outbound evacuations.

More to smart public safety than meets the eye

As we mentioned earlier, public safety may be one of the more visible and best understood of city responsibilities. But many may not realize how the benefits stack up when cities make it smarter. Here are some highlights that align with our livability, workability and sustainability goals.

Livability

Reducing response times. Citywide public safety situational awareness provides emergency managers and other public safety personnel with an immediate and real-time understanding of incidents, allowing them to respond more quickly.

Making more arrests. Police and investigator outcomes in criminal cases are improved through access to data. Analysis of the universe of relevant public safety data can unearth links between suspects, crimes and other incidents that result in higher case closure rates – meaning fewer criminals on the street.

Lowering crime rates with more resolution and more prevention. Smart public safety lowers crime rates in two ways. First, it empowers police to realize better outcomes, with more cases solved and more arrests made. Second, through analytics it allows for the identification and prevention of threats before they cause harm.

Making people 'feel' safer and mitigating pain and suffering. There is an intangible but very real value to the feeling of safety in a community – when people feel safer, their lives seem more livable. Through improved outcomes, smart public safety also delivers a freedom from the pain and suffering that crime and other incidents cause to citizens.

Workability

Attracting business and talent. Lower crime rates and resiliency to natural disasters like fires and floods aid cities in the competition for businesses and jobs, and they help ensure that once businesses do locate in a city, they can operate safely.

Mitigating reduced earnings and lost productivity. Crime and disaster can result in injuries to employees and damage to business infrastructure. Improved public safety means that not only do smart cities become more attractive to business, but businesses that operate in smart cities are able to do so more securely and with fewer safety-associated costs and risks.

Ensuring fewer business resources go to crime prevention. Crime forces businesses to spend more money than they otherwise would to pay for security and insurance. When crime rates are lowered through smart public safety, businesses win.

Sustainability

Creating operational savings and enabling better resource deployment. To put it simply, smart public safety agencies cost less. In one estimate, a hypothetical public safety agency with $350 million in operating costs can save up to $60 million annually through smart technologies and best practices. Savings rise to $200 million when society, other agencies and victim costs are considered.

Avoiding criminal justice and correction costs through crime prevention. Unleashing analytics on an integrated public safety information database increases cities' crime prevention capabilities. When prevention efforts are empowered, cities spend less on prosecuting and jailing criminals.

Creating higher property values and increasing tax revenue. As neighborhoods across cities become safer, property values rise and increase the prosperity of their residents. This in turn expands the tax base for smart cities' governments.

Public safety targets

The technology targets described in this chapter can help cities develop a smart public safety infrastructure that uses intelligence to protect lives and property and save resources. There is one new target specific to public safety we'll introduce in this chapter, and we'll also highlight how public safety intersects with the universal targets discussed earlier.

Instrumentation and control

In a smart city, first responders use and obtain data in the field, and therefore they must have a two-way relationship with command centers. That is, police, investigators, firefighters and EMS technicians must not only input data to a command center, they also need to interact with the command center and others in the field. This two-way relationship requires devices that can display information in useful ways, and devices such as video feeds that can transmit data to storage. This target addresses that need.

Implement optimal devices and other instrumentation. In public safety, these devices include those that help agencies and personnel capture data and those that enable first responders to use that data in the field.

For many cities, a large part of capturing data will be surveillance devices, for instance those deployed in neighborhoods or precincts designated as high-risk areas. Some cities may even prefer to adopt a citywide surveillance system to enable more detailed awareness. Importantly, these surveillance networks should produce evidence-quality video. Data-capturing instrumentation is also likely to include audio and pressure sensors in critical areas, or devices purposed for disaster prevention and awareness – weather instrumentation, water sensors and so on. It is likely that some of this instrumentation is the province of other city responsibilities; one of this Guide's universal targets recommends smart cities share infrastructure when possible.

Connectivity

Communications are a critical part of a smart city's public safety strategy, as this target explains.

Connect devices with citywide, multi-service communications. To be effective – and that's absolutely what a smart city wants in its public safety system – two-way communication is essential. So is a citywide communications system that loops in all the personnel, smart devices, databases and ICT systems that have a role in public safety outcomes. As we mentioned earlier, a city might require multiple networks and share them when appropriate, but the key is to ensure all devices are able to communicate effectively on a citywide network.

> ***Connect devices.*** *A citywide communications system that loops in all the personnel, smart devices, databases and ICT systems that have a role in public safety outcomes is essential in a smart city.*

Figure 10.6

Connect devices with citywide, multi-service communications:

WIRELESS MESH COMMUNICATIONS GIVE ROCK HILL POLICE AND FIRE ACCESS TO CRITICAL DATA IN THE FIELD

Wireless mesh communications technology from Smart Cities Council member ABB deployed in Rock Hill, South Carolina allows city police officers to spend two more hours per day in the field.

That's because their cars are like mini-offices. With routers mounted in police vehicles, officers have high-speed access to criminal records, including mug shots, right in their vehicles. Within seconds they can perform a background search from a laptop computer or pull up mug shots and fingerprint profiles to help identify a suspect quickly. With the ability to create and file reports from their laptops, each officer spends an average of two additional hours each day in the field protecting the community.

Rock Hill fire department vehicles are equipped with mobile routers enabling firefighters to download documentation such as building blueprints and hazmat data on their way to an emergency call so they are better prepared upon arrival.

"We're really pleased with the fact that Rock Hill is not just staying abreast, but is actually on the cutting edge of the latest technology, and that the implementation of this technology provides a direct benefit to our citizens," said Rock Hill Mayor Doug Echols.

> ***Connect devices with citywide, multi-service communications.*** *Rock Hill fire department vehicles are equipped with mobile routers enabling firefighters to download documentation such as building blueprints and hazmat data on their way to an emergency call so they are better prepared upon arrival.*

Figure 10.7

Interoperability

Interoperability is key in smart public safety because it opens up the world of data and helps generate integrated intelligence, as you'll read in the targets highlighted below.

Adhere to open standards. Open standards for data are a major step in creating actionable, life-saving intelligence for public safety decision makers. Smart cities adhere to data standards that ensure all of the data they collect – not just by public safety instrumentation and personnel, but across their responsibilities and departments – is handled the same way. Standards exist already for the recording, storing, transmission and use of data. Smart cities use the best and most widely adopted standards possible so they have easier access to data from other agencies. They also help promote the use of standards nationally and internationally so that more and more data from across the world can be efficiently shared.

Additionally, by requiring open standards in the procurement of public safety systems and equipment, cities increase the choices available to them and decrease costs because open standards mean products can be mixed and matched from different vendors.

Use open integration architectures and loosely coupled interfaces. There are a number of reasons for sharing public safety data within city departments. And in some cases public safety applications used by one department can be adapted for use by another. Both scenarios are made much simpler when open integration architectures are used.

Prioritize the use of legacy investments, including physically stored data. Earlier we mentioned how cities can avoid redundant and unnecessary investments in data-capturing devices. Police, courts and other agencies involved in public safety gather massive amounts of data, but often critical pieces – mug shots, arrest records, court files, fingerprints and the like – are stored physically. Similarly, some CCTV systems produce physical tape. Smart cities digitize these data sources, connecting them to the rest of the universe of relevant public safety data to create more robust intelligence.

Privacy and security

Even those responsible for safeguarding the public's privacy and security will want to deliver on ICT-related privacy and security targets as they move toward a smarter public safety infrastructure.

Publish privacy rules. By its nature, there is the potential for privacy red flags in much of the day-to-day work that public safety is responsible for. That's why it is so important to address the legal, privacy and ownership issues with a comprehensive privacy policy. Different cities will have different strategies for dealing with access to video, phone records, social network traffic and the like. But all will want to develop rules and governance protocols that are not only transparent but have been vetted with citizens and other stakeholders.

Data management

We mentioned in the last section the importance of privacy rules in the public safety realm; the targets here are an important follow on given the amount of often-sensitive data involved.

Create and adhere to a citywide data management, transparency and sharing policy. Data management policies make it clear what city departments can and can't do with the data they collect. This alleviates confusion, improves data accuracy, eliminates unnecessary duplication and reduces the likelihood of privacy or security breaches.

Computing resources

Advanced computing capabilities have dramatically changed the public safety playing field as these targets reveal.

Use an open innovation platform. Here's a prime example of why this target is so important. In May 2013, Council member AT&T hosted a Public Safety Hackathon to challenge developers to build prototype solutions for smartphones that could directly address first responder needs.

"We collaborated with fire, police and various first responders to host the first hackathon focused on public safety mobile applications. This helped to frame the problem for participants and provided them with the right guidance needed to develop relevant mobile apps for this audience," explained Alex Donn, developer evangelist with the AT&T Developer Program.

One of the winning apps took a "heat map" approach to show first responders locations most prone to certain types of crime. The app also invites citizens to report crimes and tracks the locations. Another app that came out of the hackathon helps coordinate volunteer responders.

Have access to a central GIS. Public safety's focus on location and on being able to act decisively in time-sensitive situations makes GIS critically important. It improves decision-making capabilities, enables efficiency gains through more intelligent scheduling and routing, provides improved accuracy of essential records and boosts resiliency of key assets.

Have access to comprehensive device management. This target is also extremely relevant in public safety, given the number of devices dispatched in the field and the serious problems that could occur if they end up in the wrong hands. A comprehensive device management system helps enforce compliance with city data management, security and privacy policies.

> ***Have access to comprehensive device management.*** *Public safety data in the wrong hands could lead to massive problems. Protecting data with device management software reduces the risk.*

Figure 10.8

WHY HAYWARD STREAMLINED NETWORK TRAFFIC ONTO A SINGLE, FLEXIBLE PLATFORM

Like many cities, Hayward, California's IT department faces growing demand for services while budgetary resources recede.

Located in California's Bay Area, Hayward has a population approaching 150,000 and is the third largest city in Alameda County. The city's network provides vital technology support to its onsite and remote staff, as well as a number of important community services for city residents.

The network is the hub of all activities that keep it moving forward, including mission-critical public safety systems. As demand has grown and with technology continually evolving, the city administration realized its infrastructure was at risk of becoming outdated and complex, which was making it too costly to scale, let alone maintain.

Hayward began looking for an answer that would result in a network capable of scaling the services and applications to more effectively support staff and the public. At the same time, the city needed a streamlined solution to reduce complexity and cost..

Council member Cisco's Nexus 5500 and 2200 Series Switches provided a platform to accomplish exactly what the city needed: new technology that would update and simplify its infrastructure and result in overall sustainability.

Using the Cisco solution to converge the data and storage networks improved how the network is managed and created a robust, more compact architecture that is very efficient. Streamlining the network traffic onto a single, flexible platform has improved the network's overall performance and enabled the city to handle its existing load and boost capacity. The change transformed the total network footprint into a smaller configuration that required less space, power and cooling.

> ***Computing resources.*** *Converging its data and storage networks improved how the city of Hayward's network is managed and created a robust, more compact and more efficient solution.*

Figure 10.9

Analytics

There's a big story to tell about the impact analytics can have in the public safety sector, as the targets below explain.

Achieve full situational awareness. In smart public safety, full situational awareness (also referred to as a "complete operating picture") is created and maintained through the use of city command centers. Command centers are so important because they assimilate a single version of "the truth" so everyone involved in a situation is working off the same information. When time is a factor and lives are at risk, you want to be sure that the left hand knows what the right hand is doing. You want thousands of employees, and a handful of different agencies and city departments, to have the exact same information.

Command centers deploy analytics capabilities across the universe of relevant public safety data – the discipline often referred to as Big Data. They correlate, in an automated way, these hundreds or thousands of data sources, criminal profiles or social media streams, for instance, to create intelligence. And they use this intelligence to render a complete operating picture for public safety personnel – actionable intelligence that helps keep people safe (themselves included). This correlation of data is an ongoing and automated process, so new data is always informing the constantly evolving public safety picture across the city.

Command centers also provide unified threat assessment functionality and are responsible for the coordination and control of incident response and management. With this real-time understanding, emergency managers can assess safety needs and prioritize actions and resources. Because it is a central command, there is authority to deploy resources across agencies, departments and service boundaries to achieve desired outcomes without jurisdictional issues. This is critical because often in emergency situations, other city departments must be part of the response – for example, transportation or public health.

> ***A complete operating picture.*** *When time is a factor and lives are at risk, cities want to ensure that everyone working on an incident response has the same information.*
> ***Figure 10.10***

Achieve full situational awareness:

MADRID REDUCES PUBLIC SAFETY RESPONSE TIMES BY 25 PERCENT

On March 11, 2004, Madrid suffered a major terror attack when several commuter trains were bombed. As with the 9/11 attacks in the United States, this tragic incident highlighted the need for greater coordination among first responders. "The different emergency entities — the police, the fire department, the ambulance service and the mobile police — intervened independently, and all of them had disparate communication systems and technologies," says Fernando Garcia Ruiz, head of innovation and development, Department of Security for the City of Madrid. There was no way to organize a unified response to incidents, and there was a lack of centralized command and control.

A key lesson was that more than one major incident can happen simultaneously, and emergency assets may be needed in more than one place. Different incidents may be related, or have nothing to do with one another – without a clear overall picture, it may be impossible to tell if there is an important pattern emerging. This potential for complexity poses a significant challenge for emergency managers. They not only need to coordinate activity, but also require a thorough understanding of everything happening in the metropolitan area so as to properly allocate limited resources to provide the best response to each incident. In addition, proactive measures such as limiting access to impacted areas, or crowd and traffic control for public events, has to be included in the mix.

> ***Achieve full situational awareness.*** *The combination of forward-looking system design and end-to-end integration gives emergency managers in Madrid the tools needed to not only deal with today's threats, but also handle rapidly evolving situations and technologies as they emerge.*

Figure 10.11

The need, therefore, was not only for top-down coordination, but also for the ability to capture and integrate information to give managers the understanding and insight required to quickly make the right decisions.

In the aftermath of the bombings, the Madrid City Council took action to better protect the public by commissioning an advanced emergency command center for the city—the Centro Integrado de Seguridad y Emergencias de Madrid, or CISEM.

The mission was ambitious: reduce emergency response time, integrate information, standardize procedures and protocols, provide seamless coordination and planning, enable shared use of resources, optimize information management and promote prevention through better planning.

Indra, a regional systems integrator specializing in the public sector, teamed with Council member IBM to provide the integrated, service-oriented IT infrastructure that would make CISEM a reality, along with needed business process transformation to enable coordination among all of the stakeholders.

Now the combination of forward-looking system design and end-to-end integration gives emergency managers in Madrid the tools needed to not only deal with today's threats, but also handle rapidly evolving situations and technologies as they emerge. Any sensor input — video, data or voice — from any source can be readily incorporated into the data stream and accessed by anyone who needs it.

Situational awareness is now at an unprecedented level. The single, unified view of status and events reduces confusion and enables far faster and more effective decision making. Managers are now better able to deploy the right assets the first time, reducing response time by 25 percent. Council

> ***Achieve full situational awareness.*** *Indra, a regional systems integrator, teamed with Council member IBM to provide the integrated, service-oriented IT infrastructure that made CISEM a reality.*

Figure 10.12

Achieve operational optimization.
ICT helps level the playing field for public defenders who often don't have the funds for research that private attorneys do. With analytics and operational optimization, city courts can transform the way they access information.

Figure 10.13

Achieve operational optimization. This target offers savings potential for cities' public safety agencies. Along with full situational awareness, analytics can unearth new insights into how cities deploy their public safety resources, thereby generating savings.

Operational optimization also holds great promise for city court systems. Courts have access to an enormous quantity of data, often so much so that the data can be difficult to make use of. Public defenders often have much smaller staffs than the lawyers they are up against, and these larger staffs can devote much more time and energy to research that wins cases. ICT levels the playing field. With analytics and operational optimization, city courts can transform the way they access information, improving outcomes for not just the courts, but the cities and the people that they represent and protect.

Pursue predictive analytics. The insights analytics provide can lead to better public safety planning and decision-making by projecting trends and predicting outcomes to the point that they can even prevent some crimes from occurring. Full situational awareness allows cities to allocate their resources more efficiently for incident response and management. And they can simulate, for example, a potential natural disaster and take steps to mitigate some of the likely devastation before the disaster occurs.

All of the applications of analytics discussed in this section deliver tangible operational savings. Better planning, decision-making, predicting and resource allocation all lead to money saved for public safety agency operations budgets.

Achieve operational optimization:

THAI LAW ENFORCEMENT AGENCY OPTIMIZES INVESTIGATIONS WITH BIG DATA SOLUTION

Established under Thailand's Ministry of Justice, the Department of Special Investigation (DSI) is a national law enforcement agency dedicated to stopping serious criminal activity. DSI needed better tools for mining large sets of structured and unstructured data to improve investigation processes and reduce manual procedures.

The agency's large data sets included more than 1 million records gathered from multiple sources in both structured and unstructured formats, such as images, videos and documents.

"It was very difficult to mine through the data, and the results were too broad with unclear targets," says Police Colonel Yannaphon Youngyuen, Deputy Director of the DSI. "This often forced us to send personnel to the actual crime scenes, which cost us a lot of time and money."

DSI implemented a Big Data solution based on Council member Microsoft's platform and Apache Hadoop software to give investigating officers self-service business intelligence tools and data-management capabilities. With them, DSI has improved accuracy and shortened criminal case investigation time from two years to 15 days. DSI plans to implement its own private cloud to manage the security of confidential data.

> ***Achieve operational optimization.*** *DSI needed better tools for mining large sets of structured and unstructured data to improve investigation processes. The Microsoft Big Data solution it implemented has dramatically shortened time spent on criminal investigations.*

Figure 10.14

ADDITIONAL RESOURCES

Target: Pursue predictive analytics:

Miami-Dade Police Department: New patterns offer breakthroughs for cold cases

Florida's Miami-Dade Police Department recognized that reducing street crime is key not only to its citizens' quality of life, but also to the vitality of an essential economic driver – tourism. By using advanced models to analyze cold robbery cases against its historical crime data, the department's robbery unit is uncovering insights that are key to solving theM. And as the successes mount, the unit's detectives are embracing a new crime-fighting tool as a way to give them a second chance on what used to be dead-end cases.

Target: Create a data management sharing policy:

Small city deploys big city crime-fighting tools

To begin responding to high-priority calls before an officer is dispatched, the Ogden Police Department needed improved access to the data in its many systems. The department chose Fusion Core Solution, a web portal based on Council member Microsoft's platform and Esri ArcGIS mapping software. Department analysts now can provide important information to officers who are en route to a call, thereby increasing officer safety and effectiveness and reducing call handle times.

Target: Pursue predictive analytics:

How digging through the deluge of social media data could lead to safer cities

A data scientist at Pacific Northwest National Laboratory, a Council advisor, has created a social media analysis tool capable of analyzing billions of tweets and other social media messages in just seconds. The idea is to discover patterns and make sense of the data – and ultimately – surface useful information that can enhance public safety and health.

PUBLIC SAFETY TARGETS

*In the checklist below, targets specifically pertaining to the public safety responsibility are in **bold,** universal targets are not.*

TECHNOLOGY

Enabler	Public Safety Targets How smart cities deploy and use ICT to enhance public safety	Implementation Progress None Partial Over 50% Complete
Instrumentation & Control	Implement optimal instrumentation	
Connectivity	Connect devices with citywide, multi-service communications	
Interoperability	Adhere to open standards Use open integration architectures and loosely coupled interfaces Prioritize use of legacy investments **(Supplement: including physically stored data)**	
Security & Privacy	Publish privacy rules Create a security framework Implement cybersecurity	
Data Management	Create a citywide data management, transparency and sharing policy	
Computing Resources	Consider a cloud computing framework Use an open innovation platform Have access to a central GIS Have access to comprehensive device management	
Analytics	Achieve full situational awareness Achieve operational optimization Achieve asset optimization Pursue predictive analytics	

Figure 10.15

CHAPTER 11

PAYMENTS

Payments sit at the heart of a city's economic activity and success– in fact, they are so ingrained we often take them for granted. Yet payments form the core of every economic flow including salaries, consumer spending, business procurement and taxes and must be an important focus area for cities around the world. This chapter will help you understand how smart payments can play a crucial role enhancing your city's livability, workability and sustainability.

Cities generate an estimated 80 percent of global GDP according to the World Bank, accounting for a large majority of global transactions. There are many things a city can do to encourage the kind of smarter payments systems that can unleash economic growth while upgrading livability. For instance:

- Setting an example through the use of smart payment systems for city government
- Launching a pilot or demonstration project to prove the case
- Integrating its own systems with payment networks to make it easier for consumers and businesses to conduct commerce globally
- Working to "digitalize" its own disparate payment mechanisms into an integrated whole (licenses, social service payments, transit payments, parking meters, etc.).
- Encourage "tourist-friendly" payment mechanisms
- Set policies that create incentives for the installation of smarter systems

This chapter a) provides an introduction to payments for smarter cities; b) explains the benefits of a smarter approach to payments; c) highlights the key trends and challenges cities need to address; and d) suggests solutions smart cities can implement to gain those benefits.

Understanding payments

Payments link a payer (provider of money) and a payee (provider of goods and services), thereby enabling commerce. To serve as the bridge between the payer and payee, payments must address four issues:

1. **Security:** Guaranteeing that one's money can be transferred safely has always been a key issue. It has driven innovations for centuries, from cash to cards and now to digital wallets. In today's digital world, security is increasingly about ensuring no one gets access to your electronic payment instruments to spend your money.

2. **Finality:** For centuries, a guarantee has maintained the integrity of payments – that the payee gets compensated and the payer gets the goods and services. That trustworthy promise to pay was initially provided by gold or silver, then with cash, then with checks, and now with electronic payment systems.

3. **Interoperability:** A key element of success for any payment mechanism is to be seamlessly usable by any payer and payee. It is about getting the maximum number of participants onto your ecosystem so your payment mechanism can be used

> ***Interoperability.*** *A key element of success for any payment mechanism is to be seamlessly usable by any payer and payee.*

Figure 11.1

anywhere, anytime and in any payment situations, thereby enabling all economic flows. For city leaders, for instance, interoperability ensures that travelers can come to your city and easily buy and spend in local shops.

4. **Speediness and convenience:** Implementing best practices on the first three issues would be simpler if time had not been of essence. But neither merchants nor customers like to wait. Therefore payments not only have to ensure security, finality and interoperability, they also have to be fast and convenient.

These four key issues have long driven innovation, resulting in transitions from precious metals to cash to checks to electronic payment systems. Tomorrow, payments in smart cities will continue to focus on these four crucial dimensions as new developments change the landscape and challenge existing systems.

Looking into the future, payments will see transformative new solutions. One example might be the seamless integration of payments with customized offers based on past purchases, personal tastes and location. Another might be biometric payments, which could allow customers to be recognized by their iris or fingerprint, making payments truly trustworthy and invisible.

PAYMENT FACTORS

Cash	Paper or coins exchanged at the point of sale
Check	Paper written for a specified amount and payable to a specified person that can be exchanged for cash at a bank. Includes personal, teller, certified, cashier's and travelers check as well as money orders
Debit Card	Card linked to bank accounts. Funds withdrawn from account at the time of transaction
Charge Card	Card with a specified line of credit. Transactions are authorized in real time and the customer is billed monthly. Balance must be paid in full each month
Credit Card	Card with a specified line of credit. Transactions are authorized in real time and the customer is billed monthly. The balance may be paid in full, or if the consumer makes a partial payment, interest will be billed
Prepaid Card	Card with funds pre-loaded either centrally and/or by the cardholder. The customer may spend up to the amount loaded onto the card
Private Label Card	Charge or credit card that can be used only at a specified location or merchant, rather than on a payments network such as MasterCard, Visa or American Express
Credit Transfer / Direct Credit	Credit transfers and direct debits are electronic transfers directly from one account to another, both push and pull, as well as wire transfers
Contactless Card	Is not inserted at checkout. Instead, the user holds it within five centimeters of the terminal and payment information is sent wirelessly.

Figure 11.2

Trends shaping tomorrow's city payment systems

Major trends are affecting cities and raising challenges for payments. These trends make smarter payments even more critical, both as an economic enabler but also as the source of significant benefits.

Digitalization: Smartphones and other digital devices are everywhere in cities. But digitalization can go far beyond where it stands today. For instance, where pay-by-weight waste collection is in place, a simple chip could automate payment. The digitalization trend triggers many challenges for payment in cities, such as development of the required connectivity, interoperability and robust security.

Ubiquity: Consumers are no longer constrained to stay at home or at the office to connect to the world. Consumers are increasingly doing anything, anytime, anywhere. This "freedom to roam" raises issues for payments, such as ensuring security and providing sufficient bandwidth to manage explosive increases in volume, while at the same time introducing new services and solutions.

Convergence: Urban consumers now have much more than music and pictures on their smartphones – they may also have their payment instruments and loyalty cards. Because they connect to the Internet from multiple devices, they cannot store and use local data – instead, that data needs to follow them around. Payment systems will need to provide secure and convenient solutions based on cloud computing.

Transparency and control: Citizens are taking control. They are closely monitoring their spending, tracking best deals, checking the food ingredients. Multiple new services are arising to empower citizens to make better choices – for instance by delivering recommendations or price comparisons. And this also applies to public institutions in general, with a growing expectation from citizens to have transparency on the efficiency of public policies, as well as an increasing public concern around high government spending in a period of sluggish economic growth. Payments will be a strong enabler for providing the necessary transparency and control.

Customization: Consumers want to be recognized as individuals, with applications, offers and services tailored to their needs. They want to receive relevant offers at the right time, for example at the point of sale while shopping.

> ***Convergence:*** *Citizens are increasingly mobile and connected. They also use multiple devices for that connection. They expect a consistent payment experience across all channels.*

Figure 11.3

This represents a significant challenge as it requires finding the appropriate balance between privacy and behavioral analysis.

Efficiency and cost reduction: Although more and more people live and work in cities, governments are expected to be more cautious with their budgets, putting strong pressure on cost. At the same time, they have to deliver continuous improvements to their quality of service. Payments are heavily impacted by the challenges of efficiency and cost optimization.

Benefits of smarter payments

City leaders will benefit from fostering payment innovations. Smart payment systems enhance livability, workability and sustainability for residents and visitors alike. Let's examine how.

Livability

Urban inhabitants are increasingly connected and mobile. And they are increasingly on the lookout for efficiency, savings and lifestyle enhancements. They need the right payment solutions to support them. With those solutions, the city's livability is improved in many ways, including:

Seamless and highly secure form factors. Connected, mobile citizens will benefit from innovative digital payment form factors. Examples include digital wallets that give them a single interface for all their payment mechanisms, loyalty programs, transportation tokens, movie tickets and so on. And the ability to use that wallet on any device, any place.

A fully advanced smart city will foster development of such form factors and extend them to the city's key services. A resident's key information will thus be stored in a one-stop, highly secure interface. Using technologies such as near-field communications (NFC), contactless wallets of the future will be the repositories for ID cards, social and health programs, transportation cards, sport subscriptions, etc. Livability will be enhanced by having everything at hand and recognized in a second.

Fully customized service. Digital payment instruments enable city administrations to capture citizens' behaviors in an anonymous way. By doing so, they can instantly deliver the right offer, service or information. Your favorite restaurant can offer you a customized deal for your favorite meal. You can pay for it and have it prepared even before you enter the place. Or imagine New York during Black Friday: public transportation companies could leverage payment data analytics to adapt transportation capacity in real time, thus allowing a smooth journey for users.

Reduced time and inconvenience. Managing citizens' frustration towards public services is often a challenge for city leaders. Smart payments can help by offering faster, more convenient solutions for their city transactions. As an example, consumers in Delhi no longer have to travel to their city's utility office during office hours and stand in a queue to pay their bills. They can now pay from home, on their bank's website. In South Korea, consumers can now do their grocery shopping during their daily commute at the city's subway stations. Using their mobile phones, they can shop and pay at Tesco's virtual grocery stores and the groceries are delivered by the time they reach home. In London, services such as PaybyPhone enable consumers to pay for parking from their cellphone; consumers no longer have to worry about having sufficient change. They can even top up the meter remotely, saving a trip back to the parking spot.

> ***Near-field communications (NFC).*** *Using NFC technologies, contactless wallets of the future will be the repositories for ID cards, social and health programs, transportation cards, sport subscriptions and the like.*

Figure 11.4

Reducing time and inconvenience:

PARKING PAYMENTS GO MOBILE

PayByPhone is a mobile application providing an innovative payment solution for city parking and transport services. And it offers a lot more than just payment, with value-added services that enhance livability for citizens and visitors while saving costs for city administrations.

Anyone, whether resident or visitor, can simply scan the parking meter's NFC sticker and download or open the mobile application. The driver can then pay for the parking, monitor its payments, extend the parking session, be reminded if the session expires and even locate his car if lost. And all that remotely. Payment is made through a credit card. Parking is controlled through mobile terminals and using car identification numbers: city parking is fully digitalized, saving huge costs.

> ***Reduced time and inconvenience.*** *Cities can save money while enhancing livability for residents and visitors alike with the convenient PayByPhone mobile application.*

Figure 11.5

360-degree lifecycle payment systems. Yesterday, the term "payment" meant just the transaction itself, the gesture where a payer gives money to a payee. Tomorrow, the actual transaction will be a small and invisible part of the total 360-degree lifecycle experience. Citizens will be able to easily:

- Check and compare prices
- Benefit from special offers
- Screen product components and features to enhance decision making
- Order anything anywhere anytime
- Have it shipped directly to home or prepared and packed even before they enter the shop
- And many other value-added benefits that will come

Workability

It is a key priority for city leaders to create the best possible economic environment to foster prosperity. Payments are a core component of economic success. They increase a city's appeal to talent, to businesses, and to tourists. Smart payments enhance workability by:

Creating a business-friendly environment. Smart payment systems are critical to allow businesses to compete on the global stage. They make a city more friendly to business in several ways, including:

- *Increasing the velocity of money.* By enabling quick disbursements, individuals get quick access to their salaries and benefits so they can spend them at city merchants.. M-Pesa, a successful payment innovation in Kenya, has made it quick and easy for employers to pay workers through mobile remittances, even for people who do not have banking accounts. M-Pesa accounts for around 15 percent of total consumer payments in Kenya.

- *Enhancing security and reducing fraud.* The migration to smarter payments is a tremendous protection for business and consumers alike. For instance, a sufficiently secure debit card can be cancelled and reissued without any impact on its balance if stolen. By having the right acceptance tools and payment instruments, a smart city enables authentication of payer identity and solvency. Merchants know if customers are trustworthy. And they can be paid quickly to reduce working capital requirements.

- *Streamlining business*. Payment is a key dimension of streamlined back office operations and enhanced efficiency. And smart payments can revolutionize the front office too. Facilitating payment has always been key to converting prospects to customers. Thus businesses greatly benefit from innovative payment instruments, from contactless to wallet solutions and NFC devices, since they simplify the transaction to make it almost instantaneous.

- *Advanced customization.* Smart payment solutions have another key benefit: leveraging Big Data and predictive analytics to target the right customer.

Creating a welcoming atmosphere for visitors. Travelers have different needs than residents. Coming from afar, they need convenient and interoperable payment solutions. They also need helpful information in an unknown environment. In order to attract travelers and tourists, cities will need citywide payment systems that can interoperate with those from other parts of the world. For instance, just by using their mobile commerce wallets, visitors could be recognized as such, contacted in their language, and provided with relevant information, since the system will know the hotel they are staying at, their plane departure times, etc. Integrating their hometown payment instrument into the smart city systems will enable them to navigate seamlessly as if they were at home.

Smoothing integration into the world economy. With the rise of electronic and mobil commerce, the reachable customer base now extends from the city to the country and out to the world. Businesses greatly benefit from advanced payment solutions to make and receive cross-border payments. Solutions exist to send or receive payments from anywhere in the world while minimizing the risk and reducing the cost.

> ***Creating a welcoming atmosphere for visitors.*** *To make the most of globalization, city leaders need to ensure they can welcome business travelers and tourists from around the world by offering them a seamless payment experience, as if they were in their home country.*

Figure 11.6

MOBILE SHOPPING IN KOREA – BRINGING STORES TO CONSUMERS

A major retailer in South Korea set a challenging goal: to become the number one grocery retailer without adding new physical stores. Instead, they created "virtual" stores, starting with the city's subway stations.

Displays at virtual stores are the same as physical stores. Wall-length billboards are installed in stations, designed to look like shelves and displaying images and prices of common products. Each sign includes a QR code; consumers shop by scanning products. Their order is then delivered within the day.

This strategy makes productive use of commuters' waiting time, while simultaneously saving shoppers' time spent going to the supermarket. The retailer helped consumers use their idle commute time by bringing the store to them. With this innovative solution, the retailer has become the number one player in the online market and second in physical stores.

> ***Bringing stores to consumers.*** *The shoppers in this Korean subway station are not looking at physical products. Instead, they are viewing a wall of life-like pictures. They scan the products they want, which are delivered to their home or office within the day.*

Figure 11.7

Sustainability

Doing more with less. Cities make and receive huge payment volumes: paying suppliers, civil servants' salaries, delivering benefits to citizens, collecting taxes, fines and payments for public services usage. This makes payment systems an important area for improvement.

By providing new benefits – for instance, quicker payments – a city can often save money and gain more visibility into its own operations.Cash creates huge costs for cities. Just imagine the cost of collecting cash and coins from all city parking lots and terminals. By digitalizing disbursements and collections, a city generates significant savings and increases operational efficiency. For example, electronic disbursement of salaries and benefits has been found to reduce the cost of disbursement up to 60 percent, according to MasterCard research. Reducing the level of cash in a city's ecosystem also reduces the grey economy, as digitalization provides cities with more transparency and control over payments and increases public collections.

Improving planning. Payments are an incomparable source of insight on residents' ways of living, commuting and consuming. Through analysis of that payment data, city governments can adapt city infrastructures and services to citizens' preferences while decreasing inefficient spending. For instance:

- Putting a new post office at the best location possible to maximize its use, based on insights gained from shopping patterns
- Tailoring transportation and other public services based on shopping data

Increasing transparency and control. With advanced payment systems, cities can get more visibility and control over civil servants' spending; or over the use of public benefits. For instance:

- *E-procurement.* Moving the entire procurement process to an integrated electronic platform. This lets the city get real-time access to a supplier database and historical price comparisons. The Korean On-Line E-Procurement System (KONEPS) claims to have delivered an estimated $8 billion in savings in 2010. And the SmartPay program of the U.S. General Service Administration saved an estimated of $70 per transaction ($1.7 billion annually) when electronic payments replaced written purchase orders.
- *Virtual cards.* Generate cards on-the-fly that are usable only for a specific amount and with a specific supplier. This avoids the loss of control over expenses when multiple people get corporate cards or access to payment instruments. Likewise, travel and expense (T&E) can be loaded and controlled remotely and given to city employees for specific purposes.
- *Benefits cards.* Prepaid instruments to deliver benefits to citizens, giving much greater control over the usage of funds. For instance, usage can be limited by time in the day, category of merchants, or geographical area. Prepaid instruments can be used for all kinds of city programs, including student benefits, cafeteria cards, childcare subsidies, pensions, etc. The city of Toronto claims to have saved roughly $2.5 million by eliminating paper checks, while increasing livability for recipients.
- *Prepaid cards for unbanked citizens.* Solutions to guide financially excluded citizens down the path to inclusion. Cities could provide their financially excluded citizens with prepaid products serving as bank accounts to seamlessly collect remittances and make payments.

Doing more with less:

TORONTO'S BENEFITS CARD

The city of Toronto faced a growing need to streamline the disbursement of social benefits. And to reduce the cost of collecting the funds for those recipients, since one in four do not have a bank account to receive direct bank deposits.

To face this challenge, the city developed the Instant Issue City Services Benefits program: a new MasterCard prepaid card that can be instantly issued with secured printing, personalization and encoding, at any one of the 15 Toronto Employment and Social Services offices. Funds are loaded on the prepaid card, which is then usable anywhere by the recipient.

Switching from direct deposits and check cashing services generated huge savings for both recipients and the city. Published estimates claim more than $250 a year can be saved for a single client receiving $600 a month. The city itself expects net savings of at least $2.5 million annually by eliminating the cost of issuing checks.

Finally, this new digitalized instrument also provides the city of Toronto with a powerful tool to get more insights on social assistance recipients and their specific needs through the understanding of their spending behaviors.

> ***Doing more with less.*** *By switching to prepaid cards, Toronto will save millions of dollars over the old method of writing checks and making direct deposits. In addition, the prepaid cards are easier for recipients who do not have a bank account.*

Figure 11.8

Supporting public policies. Environmental challenges increase the needs for innovative solutions to reduce waste, reduce emissions, save energy and foster green transportation. Payment is central to making solutions accessible. Some examples:

- Near-field communications (NFC or contactless) car battery charging stations enabling electric vehicle users to easily pay and recharge
- Tolling payment solutions with automatic detection of car registration plates
- City parking payment solutions
- Pay-by-weight waste collection including a simple NFC chip in garbage bags that automate payments
- Smart payment devices connected to household energy consumption to help citizens make the most of their solar panels

Increasing transparency and control:

ELECTRONIC DISBURSEMENT IMPROVES CONTROL AND REDUCES FRAUD

Disbursements of benefits are moving from cash to electronic payments, and the South African Social Security Agency (SASSA) is one such example. Instead of issuing social grants as cash, it deposits money into recipient's bank accounts that they can then access using a MasterCard debit card.

This payment system supports biometric verification of the recipient. Funds are only released into the recipient's bank account after that verification. By using this electronic disbursement solution, SASSA aims to eradicate fraud and illegal collection of grants while also lowering its payment costs by 60 percent. (MasterCard research)

> ***Increasing transparency and control.***
> *By switching to a payment system that enforces biometric verification, the South African Social Security Agency reduced fraud and reduced costs while also making it easier for recipients to access and spend their money.*

Figure 11.9

Supporting public policies:

HONG KONG'S OCTOPUS CARD ENCOURAGES MASS TRANSIT

Many cities seek to be more sustainable by encouraging the use of mass transit. One way to do so is to switch to convenient, innovative payment solutions. In a growing number of cities, transit systems are using smart payment solutions to facilitate users' daily life and enrich their experiences.

In 1997, Hong Kong launched the Octopus Card, a reusable contactless stored-value smart card for making electronic payments in online or offline systems. Initially designed to collect fares for local mass transit systems, the card has grown to be used in supermarkets, restaurants, parking meters, service stations, etc.

Today, Octopus claims more than 20 million cards in circulation, nearly three times the population of Hong Kong. Roughly 95 percent of Hong Kong's population aged 16 to 65 uses the cards, generating 12 million daily transactions.

This success story led to the development of similar products in other geographies such as London's Oyster card.

> ***Supporting public policies.*** *One increasingly popular way to encourage the use of mass transit is to create smart cards for payment. Hong Kong's Octopus card can be used not only for any kind of mass transit, but also in shops and restaurants.*

Figure 11.10

Payment targets

The best practices and targets listed below will help cities foster smart payments. One target -- *"Ensure access to robust banking services"*— is specifically related to payments. We will also address several targets from the Universal chapter and how they apply to payments. If we fail to mention a Universal target below, that does not mean that it does not apply to payments. Rather, we simply felt it did not require additional explanation in the context of payments.

Instrumentation and control

Ensure access to robust banking services. Cities in the developed world may take convenient, ubiquitous banking as a given. In other parts of the world, however, it is a significant issue. Access to banking services is the key underlying prerequisite to smart payments. It has various implications, from the need for a network of capable ATMs (automated teller machines) to a sufficient number of bank offices. For citizens, having access to the banking system means they are equipped with a way to make payment.

City leaders need to ensure they give sufficient support to the development of a widespread, safe banking system. If cash and credit cards are currently the basic form factors, the city should encourage and assist residents to use smarter versions such as NFC-enabled cards and mobile phones linked to banking. Electronic payments are also key, as more and more transactions are done remotely. As an illustration, the city of Nice, France massively communicated the benefits of contactless cards. By pioneering that technology, the city created a favorable climate for adoption and blazed the trail for businesses and consumers.

Implement optimal instrumentation. There are at least two payment areas where cities need to ensure that the right devices are deployed:

- *Acceptance devices.* Parking meters, ATMs, utility meters, vending machines and point-of-sale terminals are increasingly used to make payments. Acceptance networks must adapt to emerging payment methods, such as contactless cards and phones, as well as electronic wallets.

- *Payment form factors.* Smart payment devices do more than paying. For instance, digital wallets gather all customers' existing payments cards in a single device and also combine them with rewards and loyalty cards. They also enrich their functionalities with innovative features to facilitate day-to-day life. In Hong Kong and London for instance, the mass transit systems rolled out contactless electronic cards that people can use to pay for transit, but can also use in shops.

> ***Implement optimal instrumentation.*** *In some parts of the world, convenient, ubiquitous banking is a significant issue. Access to banking services is a prerequisite of smart payments.*

Figure 11.11

Connectivity

Connectivity and telecommunications are crucial for the development of smarter payments. The smart cities model relies heavily on a fast, secure, real-time transfer of information.

Connect devices with citywide, multi-service communications. Smart cities need connectivity throughout to allow stakeholders to carry out transactions anywhere, anytime. Access to high-speed wireless Internet is a prerequisite. So is good coverage including areas such as subways and mass transit systems where people spend significant time. Everyone also benefits from a fast and secure network, as it decreases the risk of fraud and reduces processing time to create a seamless experience.

Interoperability

Cities must focus on interoperability to maximize the value of smart payments. Incompatible, proprietary standards are a recipe for failure.

Adhere to open standards (including across payment infrastructures). Adopting open standards across payment infrastructures has significant advantages. It ensures fast and broad participation, minimizes risk (through investment in tested standards) and drives procurement efficiency (by offering access to greater choice and lower prices). It also facilitates participation by foreign consumers, tourists and business travelers.

Open standards must be used at multiple levels including 1) the communications technology, 2) the interaction between payment devices and 3) the data exchanged between the devices. NFC is the perfect example. This contactless communications standard has been broadly adopted by leading merchants, issuers and city leaders around the world. Cities should give preference to global standards to make it easier to do business globally and to attract tourists from other countries.

Use open integration architectures and loosely coupled interfaces. Companies are increasingly adopting open integration architectures and exposing their APIs so that third parties can integrate with their systems. In the payments industry, companies such as Council Lead Partner MasterCard are adopting this approach. Cities should also adopt a similar strategy when developing their payment infrastructure. This approach will not only rapidly "bulk up" their payment ecosystem; it will also provide more value for all participants.

> ***Connect devices with citywide, multi-service communications.*** *Smart cities need connectivity throughout to allow stakeholders to carry out transactions anywhere, anytime.*

Figure 11.12

Adhere to open standards:

FRANCE'S FIRST "CONTACTLESS CITY"

A payment is contactless when you don't insert your card at checkout. Instead, you hold it within five centimeters of the terminal. Payment information is sent wirelessly and processed. Contactless cards are a faster, more convenient alternative for low-value purchases at fast food restaurants, convenience stores and transport terminals. They are also ideal for remote, unattended payments, such as vending machines, road tolls and parking meters.

The French government has long been keen to promote the concept. In 2010, the Minister for Industry, Energy and Digital Economy authorized 20 million euros to enable cities and local agencies to roll out contactless projects.

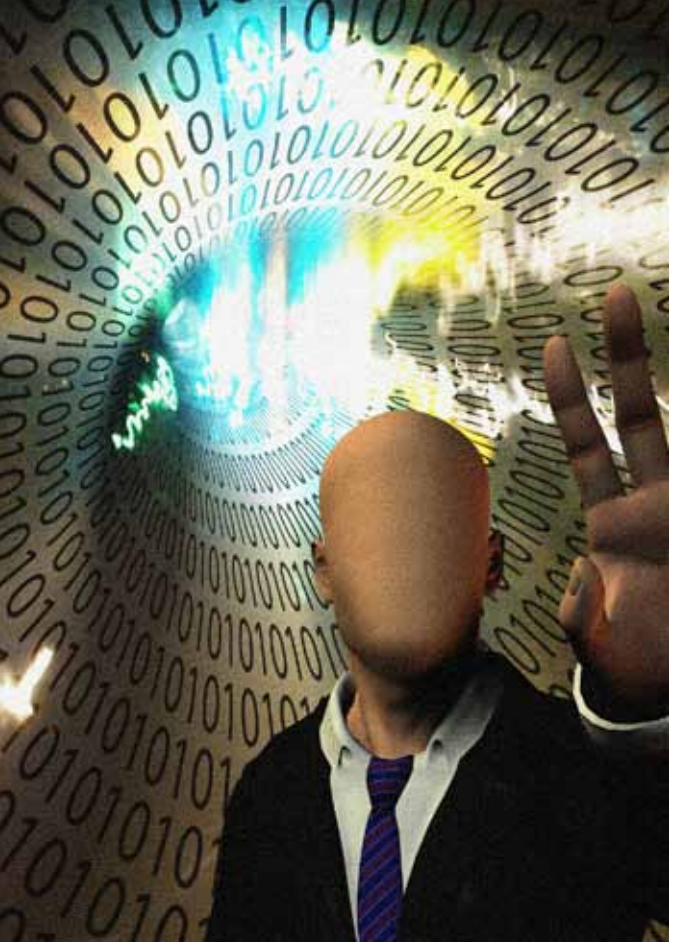
Nice became the first city in France to actively promote contactless cards. The project had the support of the national and local governments and continues to be developed in conjunction with mobile operators, banks, transport operators and the retail sector.

Customers in Nice can also use phones equipped with the NFC standard at thousands of merchant locations and on public transport. Additionally, they can use their handsets to read NFC information tags embedded in posters.

Nor are the benefits restricted to residents. Visitors to Nice are also able to use NFC-enabled mobile phones to pay at restaurants, supermarkets and local stores, as well as ride the city's buses and tramways. France has always been good at attracting visitors. More than 75 million tourists flock there every year, making it one of the most visited countries in the world. And now, led by Nice, one of the most "contactless."

> ***Adhere to open standards.*** *In 2010, Nice became the first city in France to actively promote contactless payment. The new payment system has become very popular with businesses, residents and visitors. It relies on open standards such as near-field communications (NFC).*

Figure 11.13



> ***Publish privacy rules (and apply them to the city's payment systems).*** *Smart cities ensure best-of-breed, high-speed broadband access across their geography to all or most buildings.*

Figure 11.14

Security and Privacy

As stated previously, a key goal of a payment system – smart or otherwise – is to enforce trust between participants. A security or privacy breach, therefore, threatens its overall integrity.

Publish privacy rules (and apply them to the city's payment systems). Cities must publish clear rules on privacy that apply equally to its payment systems. From a privacy perspective this includes:

- The respect of anonymity – data should not be "personified" when analyzed
- The type of information that can be captured from the client
- What can be shared
- Who has access to it
- How the information is stored and used
- How participants can access it and edit or delete it

Create a security framework. The city must define the levels of security required for payment, such as two-factor authentication or PIN numbers. Digital wallets are a good example. They secure several payment means, as well as other documents (loyalty cards, etc.) in a single application. This avoids having one's payment references in multiple locations. However, cities must recognize that overly stringent rules can discourage participation – you must strike the right balance. Remember as well that security specifics may already be defined by law or by commercial terms (such as the terms to participate in payment networks).

Computing Resources

With close to three trillion payment transactions globally every year, payments involve large volumes of data. True value can be derived from payment systems if that data can be analyzed to provide an enhanced experience.

Consider a cloud computing framework. Cloud computing is a valid consideration for every city responsibility, but it is virtually a requirement for smart payments. To be usable, the payment solution has to allow information to be securely stored yet accessible anytime, from any place and any device. Only a cloud computing framework can meet these stringent requirements.

Have access to comprehensive device management. Implementing smart payments will explode the number of devices and the volume of data on a city's network. Comprehensive device and network management will improve security, resilience and reliability of the payment system, deliver cost savings and enforce compliance with city data management, security and privacy policies.

Analytics

Analytics based on payments data can have a significant positive impact on local commerce. It can also inform and improve government policies.

Achieve full situational awareness (including local commerce trends). Develop a deep understanding of local commerce trends by analyzing payments data. Insights can include macro indicators like retail sales that help decipher the state of the economy and set policy direction. Micro indicators such as tourist spending behavior by city of origin can help identify places to target for marketing and promotional activities.

Achieve operational optimization. Capture and analyze transactional data to get useful insights – for example, citizen usage of public services to adapt and optimize service levels. Insights such as the number of people using the city's mass transit system (ticket purchase/validation) versus driving into the city (toll fee or parking payment) can help cities set customized policies that reduce congestion. An accurate monitoring of spending, for instance in post offices or licensing offices, can allow a better allocation of staff and an improved management of opening hours.

Pursue predictive analytics. Payments data can predict people's preferences and significantly improve the city's ability to plan for the future. Cities must develop and leverage this capability. For example, the city might adapt its development plan and infrastructure from the knowledge that people are shifting their spending from neighborhood convenience stores to larger stores at the city outskirts. Predictive models can also be set up to determine the most appropriate place to operate merchant locations or public services.

> ***Achieve full situational awareness (including commerce trends).*** *Analyzing payments data that includes macro indicators like retail sales help cities decipher the state of the economy and set policy direction.*

Figure 11.15

Three essential assets to achieve payment insights for cities

Council member Mastercard is a world leader in payments data and analysis. It suggests the three assets shown in the chart are essential to achieving deep insights from payments data. You may find it useful to pass along to your ICT staff as they begin to evaluate options.

Asset	Characteristic	Factors
Data Sources	**Get access to transaction data** • Directly or through partnership • Maximize quality and "representativeness" **Combine with other available data** • Structured or unstructured	Quality / representativeness Availability / diversity Confidentiality / compliance
Flexible Technology	**Ability to store, structure, cleanse and process** • With large databases • Including unstructured data **Sharing and analytics tools to deliver insights** • From basic to advanced, for business users to data scientists **Integration into existing tools and systems**	Ability to manage unstructured data including open source tools such as Hadoop Data cleansing process in place Data visualization tools Data analysis and mining tools
Expertise	**Ability to deliver value and insights** • Specialists in all aspects of Big Data • Conversion of data into actionable insights • Advanced analytics and statistical modeling	Organization structure to support Big Data Availability of analytics resources and skills Specialists in regulation, privacy laws and data usage

Figure 11.16

PAYMENTS TARGETS

*In the checklist below, targets specifically pertaining to the payments responsibility are in **bold,** universal targets are not.*

TECHNOLOGY

Enabler	Payments Targets How smart cities deploy and use ICT to enhance their payments	Implementation Progress None Partial Over 50% Complete
Instrumentation & Control	**Ensure access to robust banking services** Implement optimal instrumentation **(including acceptance devices and new payment form factors)** Connect devices with citywide, multi-service communications	
Connectivity	Connect devices with citywide, multi-service communications	
Interoperability	Adhere to open standards **(including across payment infrastructures)** Use open integration architectures and loosely coupled interfaces Prioritize use of legacy investments	
Security & Privacy	Publish privacy rules **(and apply them to the city's payment systems)** Create a security framework Implement cybersecurity	
Data Management	Create a citywide data management, transparency and sharing policy	
Computing Resources	Consider a cloud computing framework Use an open innovation platform Have access to a central GIS Have access to comprehensive device management	
Analytics	Achieve full situational awareness **(including local commerce trends)** Achieve operational optimization Achieve asset optimization Pursue predictive analytics	

Figure 11.17

CHAPTER 12

SMART PEOPLE

At its core, a smart city uses advanced technologies to improve livability, workability and sustainability. And the ultimate goal of this Readiness Guide is to help city officials build an understanding of these technologies – and how they fit together – to create ICT-enabled cities of the future. This chapter focuses on the "secret sauce" that turns the idea of a smart city into reality. In a nutshell, we're talking about people – elected officials, city planners, policymakers, citizens, business leaders, financiers and public-private partnerships.

No matter how integral technology targets are, a smart city vision will never be fully realized if those targets aren't planned, deployed and managed correctly. That's why we've identified what we're calling *supporting practices* for cities to consider as they plot a course towards the future. As you'll see in the pages ahead, these supporting practices are all dependent on people making smart decisions to get maximum value out of their technology investments.

The three supporting practices we'll drill down on in this chapter are:

1. **Policy and leadership.** This includes the management policies and leadership capabilities that cities use to plan for and support ICT investments. For example, ICT will benefit cities, their residents and businesses most when a comprehensive smart city plan has been created.

2. **Finance and procurement.** These practices help cities buy and pay for the technologies they need. Employing proven techniques can help a city get the right technology, at the right time, at the right price. One example is developing an integrated procurement plan for technology across all city departments.

3. **Citizen engagement.** This encompasses the outreach, inclusion and cooperation cities need to get the best results from technology investments. Experience has proven that for smart cities to work, citizens must be considered and consulted from day one and at every step along the way. Fortunately, social media and web portals make citizen engagement far easier today.

In the chart below you'll see supporting practices that will help cities realize the technology targets discussed in previous chapters. Unless otherwise noted, these supporting practices apply to every city responsibility area covered in this Guide. In the Ideas to Action chapter that follows this one, we will explore how cities can enact these policies to best achieve the technology targets and become smart cities.

SUPPORTING PRACTICES

Policy & Leadership	• Share infrastructure • Promote a smart city workforce • Consider the full lifecycle of built environments • Build and adhere to a multi-modal transportation plan • Develop a seamless and efficient NFC payment system
Finance & Procurement	• Adhere to a disciplined and integrated procurement plan for technology • Consider all funding mechanisms
Citizen Engagement	• Continuously pursue two-way communication with citizens on strategies for and benefits of ICT before and during their deployment • Offer an integrated, personalized citizen portal for services • Disseminate timely information about public safety, public health, transportation and other services that impact the public

Figure 12.1

Policy and leadership supporting practices

Build a comprehensive smart city plan. To borrow from Hollywood, creating a smart city in some ways resembles making a major motion picture. First you need a script with a plot that will capture the imagination and enthusiasm of its intended audience. You need to work with a studio to share resources and with other entities for location shots. You need a talented director, a quality cast and you need lots of extras – all of whom help bring the movie to life – as in lights, camera, action. For cities, the "script" is a comprehensive smart city plan. The studio and locations are shared infrastructure, and the cast and crew represent the smart workforce. Let's zoom in on these concepts.

The plan, which is continually evaluated and updated much like a movie script during rehearsals, encompasses all work streams in every single responsibility and enabler discussed in this Readiness Guide. The plan organizes city efforts and resources across departments, identifies and articulates city priorities and plans action steps to achieve the targets this Guide recommends.

A comprehensive smart city plan calls for 1) measurable targets for livability, workability and sustainability and 2) timely reports of progress toward those targets. The plan is articulated in ways that citizens and communities (the audience) will understand because they see its connection to their lives.

Arguably this may be the most important piece of the entire Readiness Guide since by definition a comprehensive plan will consider all the other aspects of an ICT-enabled smart city. A comprehensive plan sets the stage by:

- **Maximizing synergies and minimizing costs.** Considering the big picture can help a city find ways to share infrastructure and share costs – doing away with unnecessary duplication of ICT investments.

- **Identifying the best places to start.** Picking the "low-hanging fruit" – which are projects that have a big return for a relatively small investment in money and time – often makes most sense. If a city starts with those "big bang" projects, it can build momentum and public support. And it can potentially generate revenue for use on future projects.

- **Enabling cities to build separate projects.** With a plan in place, you can be confident everything will work together in the end because you're adhering to principles and standards that ensure interoperability and collaboration. With such a framework a city can move towards its targets one step at a time, knowing that individual projects will be compatible with each other, even if they are built separately at different times.

- **Increasing public support.** Since a comprehensive plan promotes the future benefits and paints a picture of the future improvements in livability, workability and sustainability, it can dramatically increase public understanding and support. It can also help rally support and financing from the private sector.

- **Attracting talent and business.** A smart city wants to woo today's mobile professionals and easy-to-relocate high-tech businesses, but both are increasingly choosy when deciding where to establish themselves. They are attracted to cities that have a strong, compelling vision for a better future and a path to get there, which is what your comprehensive plan lays out.

- **Emphasizing the need for change and change management.** Smart cities are visionary projects. As with all visionary projects, organizations undertaking them will be most successful if they are good at articulating and fostering change. Comprehensive smart city plans promote "change management" strategies that ensure minimum negative impacts and maximum positive outcomes in their pursuit of the smart city.

HOW DO YOU TRANSFORM A CITY? TRY ASKING SOME MAYORS

That's exactly what Smart Cities Council member IBM did in conjunction with its Smarter Cities Challenge grant program, a multi-year, 100-city initiative designed to get cities started on ambitious projects. IBM has donated $50 million in employees' time to work with city leaders.

As part of that effort, IBM harvested insights from participating mayors and put them in a report – How to Reinvent a City. Among the lessons for leaders from leaders:

Think like a CEO. When city leaders are trying to overcome inertia, it helps to radically rethink what a city is and does. Traditionally, mayors have defined their cities and their leadership roles within the parameters of politics and traditional public services. That's too narrow a view. Today, some of the more innovative leaders see their cities as businesses and themselves as chief executives.

Engage citizens and businesses on their terms. City leaders understand that citizen engagement is essential to understanding the wishes of their constituents – not to mention getting re-elected. But some of the typical methods yield unsatisfactory results. The public needs easy, open and continuous access to a wide variety of data and planning information, and people must be brought into a project early so they can participate in designing it.

Be bold and brave. Access to an abundance of data helps city leaders understand how things work and how they might work better, but unless mayors are bold they won't get big things done. Politics will get in the way. So it's essential for mayors to not only propose bold plans but to make it clear to those around them that they are deeply committed to making them work.

> ***Policy and leadership supporting practices.*** *Today, some of the more innovative leaders see their cities as businesses and themselves as chief executives.*

Figure 12.2

Share infrastructure. It doesn't take someone from the city budget office to see the value in reducing needless duplication and redundant spending. And that's what can happen when cities recognize interdependencies between departments and the value of cross-coordination. Actively seeking ways to share ICT infrastructure between city departments – and having backup plans in place should problems occur – simply makes sense.

Beyond reducing redundant spending and effort, benefits of sharing infrastructure between departments can:

- Uncover wasteful duplication
- Surface potential synergies and new solution opportunities
- Reduce arguments and friction
- Unearth and enforce best practices citywide

Another big benefit of sharing infrastructure is that a city can improve overall results by bringing multiple minds and multiple viewpoints to the table. Additionally, future expansion and applications are fast-tracked when infrastructure is shared because computing and information assets are no longer stranded in separate "silos."

In some cases, it may also make sense for a smart city to explore the benefits of sharing its infrastructure with the private sector. For example, this is important when it comes to broadband and cellular connectivity. Often it is private sector operators who are best suited to deploy and maintain these networks with a high degree of reliability, security and coverage.

> ***Share infrastructure.*** *Smart cities actively seek ways to share ICT infrastructure between city departments.*

Figure 12.3

Share infrastructure:

ONLINE SERVICES "FACTORY" ALLOWS CROSS-AGENCY ACCESS FOR CITIZENS

One of the roles of Direction Générale de Modernisation de l'État (DGME), the French agency responsible for modernization, is guiding French ministries and agencies in their e-government initiatives.

The problem DGME faced in the past was that many of its projects were built in silos with high associated costs. To respond to that challenge, DGME chose Council member Alphinat to develop an "online services factory" that allows delivery of cross-agency online services that focus on the needs of citizens and municipalities.

Alphinat's SmartGuide suite, combined with infrastructure and professional services from Bull, resulted in what's referred to as "My Online Services" -- a web-based, one-stop-shop capable of automating online service creation, deployment and maintenance while reducing custom coding and promoting reuse of components and existing ICT assets.

For the end-user, the measuring stick of success is its ease of use. In less than a year after its launch, three million accounts were created and the portal offers close to 1,300 forms, registers two million downloads per month and delivers a wide range of citizen-centric, cross-agency services such as change address declaration, voter registration, citizen census and grants requests.

And the objectives the DGME had set out in terms of quality of service to citizens have been met with convenient 24/7 access to government services that save time and eliminate redundant operations.

> ***Share infrastructure.*** *In less than a year after launch of the DGME online services factory, three million accounts were created giving citizens 24/7 access to a wide variety of services from multiple agencies.*
>
> ***Figure 12.4***

Promote a smart city workforce. It is one thing to enable the infrastructure of a smart city, but finding the highly trained workers in both the public and private sector that smart cities will need to operate that infrastructure will be challenging. Skilled ICT workers are currently in high demand. Because of that, policies and programs focused on building the skills necessary to install, maintain and optimize smart city technologies should be a priority.

Many options exist for promoting a smart city workforce, and cities should find those that best fit their own needs and circumstances. For instance, you may choose to:

- **Organize or partner with professional groups** to identify skills needed
- **Promote relevant licensing exams** and continuing education curriculums
- **Use a 'sustainable' designation** for professionals
- **Publish guidelines or create incentives** to include smart technology topics in public and private education and workforce training

Besides boosting the skills and competencies of city personnel, an active campaign to train and groom a smart city workforce will provide a competitive advantage to a city in the battle to attract business and jobs.

Consider the full lifecycle of built environments. Built environments progress through several life stages including planning, design, construction, operation, retrofit and end-of-life. Smart cities consider the full lifecycle of their built environments when enacting policies and making decisions relevant to buildings.

This is a key point because it ensures that cities get the most out of ICT deployments in

> ***Promote a smart city workforce.*** *Organizing professional groups to identify ICT skills needed is one way cities can promote a smarter workforce. Creating a sustainable designation for professionals is another.*
>
> ***Figure 12.5***

Promote a smart city workforce:

TRAINING MAY BE THE TICKET TO AN ICT WORKFORCE IN TODAY'S COMPETITIVE CLIMATE

An "ICT Skills Audit" released in May 2013 found 4,500 vacancies in Ireland's ICT sector. The reason? A severe skills shortage in the country's workforce.

"We have been increasingly concerned at the growing skill shortages in the sector, while recognizing an increasing, and untapped, opportunity to create a talent pipeline comprising of those job-seekers with transferable skills from declining sectors," said Peter Davitt, chief executive of the non-profit training promotion agency Fastrack to IT (FIT), which performed the audit.

According to the Irish Examiner, FIT works with government departments and national education and training agencies in Ireland and it has a number of IT companies on its board, including Smart Cities Council members. FIT runs training programs to "re-skill" workers and says it is on target to engage 30,000 people through its training "interventions" over the next three years.

And of course the situation in Ireland is not unique; all over the world companies are clamoring for workers with ICT skills. That means cities and other government agencies will have to be very competitive – or take a cue from FIT and establish aggressive training programs.

> ***Promote a smart city workforce.*** *Competition for skilled ICT workers will challenge many cities; making training opportunities available may be the best route to a skilled smart city workforce.*
>
> ***Figure 12.6***

their built environments. By considering the full lifecycle of built environments, cities are able to recycle and reuse data from built environments when planning for their replacements. This can save resources and ensure better outcomes for future building inhabitants.

Build and adhere to a multi-modal transportation plan. Smart cities build a holistic, integrated plan that encompasses all of their existing transport modes as well as those they want to pursue in the future. This integrated and multi-modal plan connects cities' technology investments in transportation infrastructure to ensure sharing, scalability, connectivity and efficiency. The plan takes into account shifts in population, demand and regional interconnectivity. Cities with an integrated transport authority will find it easier to implement a single, multi-modal transport plan. Those without a single authority will have to build coalitions and create both mandates and incentives for a combined plan.

Pursue the removal of regulatory barriers to telemedicine. The potential for telemedicine to improve access to and the cost effectiveness of a city's healthcare system is huge, but unfortunately regulatory barriers hinder its widespread adoption. Technology is often said to develop more quickly than the laws that govern and affect its use, and telemedicine is proof of that. Medical licensing, credentialing and malpractice protections often vary from country to country or even state to state, creating artificial barriers to telemedicine. For example, a doctor licensed in Texas with a certain type of radiological expertise may not be able to deliver services to a patient in dire need in Michigan without meeting a series of costly, redundant and time-consuming requirements. Insurance is another factor slowing adoption of telemedicine; the industry is not fully onboard with the concept yet.

The answer may be a united effort by smart cities and smart healthcare proponents to advocate for adoption of telemedicine at local and national levels so that citizens everywhere have access to the future of health delivery sooner rather than later.

Develop a seamless and efficient NFC payment system. Payment systems are a city economy's backbone: the core component enabling city merchants and public services to receive payments and citizens to circulate, shop, entertain in their everyday lives, benefiting from strong livability solutions. Smart cities create the momentum amongst key innovative payment stakeholders to implement seamless and efficient payment systems. Bringing together merchants, banks, telecom operators and payment instruments' providers is critical to set up the right model and kick off the roll-out of new and innovative payment solutions. Such systems need to develop consumer and merchant equipment in parallel and city leaders need to avoid falling into a chicken-and-egg situation.

Setting up a citywide public initiative onboarding all key stakeholders and leveraging public services to lead by example is a best practice to consider in order to enable innovations. As an illustration, in the French city of Nice, the Cityzi initiative successfully teamed the French mobile network operators, the major retail banks, the two international payment schemes and key city merchants to develop mobile payments-related solutions.

> ***Build and adhere to a multi-modal transportation plan.*** *Smart cities build transportation plans that include existing transport modes as well as those they want to pursue in the future.*

Figure 12.7

Finance and procurement supporting practices

Let's face it: Implementing smart city technologies in an era when so many cities are budget-strapped is going to be a financial challenge. But it doesn't have to be an insurmountable one. Cities will need to get creative, though. In this section we'll discuss how to develop a solid procurement plan and how cities should look beyond traditional funding mechanisms for their technology needs.

Adhere to a disciplined and integrated technology procurement plan. There are two key words here: disciplined and integrated. First, a city's procurement plan for smart city technologies should include a *disciplined* business case that identifies and quantifies costs and benefits over the project lifetime. Secondly, all city departments need to be *integrated* in the procurement plan to ensure economies of scale, best practices, elimination of redundant purchases and interoperability.

It's also important to think of your procurement plan as a living document, one that includes (and regularly updates) a technology roadmap that identifies the optimal sequence of investments and implementations. Of course, cities should start with whatever project they want and be flexible about taking on new projects and changing plans as needed. The important thing is that smart city projects are deployed so that they work together.

Your procurement plan should favor interchangeable hardware and software from diverse vendors to stimulate innovation and competition and to allow for interoperable systems. The plan should also establish selection criteria that go beyond just the "lowest price." It prioritizes for solutions that are the:

- Least prone to obsolescence
- Most easily expanded to meet future needs
- Most resilient
- Most cost-effective
- Easiest to install and use
- Most relevant to addressing the objective

Adhering to a disciplined procurement plan can dramatically decrease overall costs. It can also greatly extend the life and value of the technologies purchased because the plan will include provisions to ensure interoperability and open standards.

Consider all funding mechanisms. Too often cities consider only a single "traditional" method to finance the technology it needs. In some regions, that method may be funding from the central government. In other parts of the world, it may be municipal bonds. But in an era when so many municipal budgets are already strained, you'll need to explore the widest possible range of funding mechanisms. And the results may surprise you.

There are dozens of different ways to finance infrastructure. Among them:

- Public/private partnerships
- Performance contracting
- Philanthropic grants
- Development bank loans
- Pay-as-you-go
- Sale/leaseback
- Revolving funds
- Grant funding including refurbishment subsidies
- Guarantee schemes
- Utility incentives
- On-bill repayment through local utilities
- Local incentives and credit programs
- Reduced permitting time
- Density bonuses
- Pay-for-performance

To increase bargaining power, cities should also consider joint procurements and buying coalitions with other cities, states, regions, federal agencies and the military. By considering all financing options, a city may be able to afford smart city improvements years earlier than more traditional means might allow. The sooner installed, the sooner the city will realize the payback.

Consider all funding mechanisms:

CHICAGO MAYOR PROMOTES AN "INFRASTRUCTURE TRUST" PAYMENT MODEL

"We have a critical need in this city, which is we have a 21st century economy sitting on a 20th century foundation. And unless we modernize it, we won't get moving."

That's Mayor Rahm Emanuel explaining the idea behind his Chicago Infrastructure Trust, launched in April 2012 to provide alternative financing and project delivery options for transformative infrastructure projects. The plan is to construct innovative financing strategies and attract capital from private investors, among others.

One example is a proposed project called Retrofit One. It's an initiative between the city, Chicago Public Schools and the trust to provide funding for energy efficiency projects including lighting, windows, HVAC units and water pumping stations to reduce energy consumption.

Though the trust is just getting started, some are calling it "the next big thing" in financing urban infrastructure. And although the practice of governments getting the private sector to pitch in to pay for public assets isn't really new – that a city is getting aggressive about it is worth watching.

> ***Consider all funding mechanisms.*** *Chicago Mayor Rahm Emanuel launched the Chicago Infrastructure Trust to attract private investors to help finance public infrastructure projects.*
>
> ***Figure 12.8***

Citizen engagement supporting practices

Anyone who has run for public office understands that you don't win if you don't get enough people to support you. The same formula applies to a smart cities campaign. Your best chance for success is to win the support of the people who live and work in your city. Citizens are the priority stakeholder in a smart city and so much of a smart city is achievable only when citizens have bought into the vision actively and willingly. In this section we highlight two ways to make that happen.

Continuously pursue two-way communication with citizens on strategies for and benefits of ICT before and during their deployment. To develop a smart city that captures the interest and enthusiasm of the people who live in it, encourage them to help create the vision. Hold public meetings, organize neighborhood brainstorming sessions, try crowdsourcing, solicit ideas via social media or mobile apps – and take every opportunity along the way to inform and educate them on the exciting ways ICT technologies will transform their city and their lives for the better.

Maintaining this ongoing, two-way dialog between your city and its citizens will only improve the outcome. For example, citizens who are educated about smart water and energy meters are more likely to use them correctly. Citizens who are aware of mobile apps for reporting a pothole or ordering a city service are more apt to take advantage of them.

Being proactive about getting citizens involved not only brings in a broader perspective and builds trust, but it can also reduce potentially derailing opposition to technology implementation. For example, by understanding and addressing your city's most immediate problems through technology, you will build trust necessary to pursue longer-term projects in the future. Incredibly, some research even indicates that active two-way communication reduces tax delinquency, since citizens are more willing to pay when they believe their concerns are taken into account by government.

> ***Continuously pursue two-way communication with citizens on ICT strategies.***
> *Public meetings, social media and crowd-sourcing can help keep citizens in the know about smart city benefits.*

Figure 12.9

Continuously pursue two-way communication with citizens:

CITIZENS HELP FORT COLLINS DESIGN ITS FUTURE

Like many cities in 2010, the recession hit the city of Fort Collins, Colorado and it didn't have a lot of money to spend revising its long-term city plan.

As Mayor Karen Weitkunat told The New York Times, "We could do an urban design plan, but we didn't have the money to pay for any of it. It put a reality check on what we were here to do."

But that didn't stop the city, already labeled an innovator for some of the things it has done in energy. Here's how the Times describes what happened when Fort Collins decided to rewrite the urban planning model:

> *"So Fort Collins reached out as it never had before, seeking volunteers and input, and, just as crucially, ideas about how to finance a new future in an age of limits. And those reaching back, including some people and organizations who had never participated in city planning, from arts groups and beer brewers to technology entrepreneurs and professors at Colorado State University, created the city's new vision of itself — an ambitious and comprehensive plan, even by the standards of bigger cities in more prosperous times.*
>
> *Democratized by necessity, the process led to goals that went beyond the predictable safe streets and commerce that planners might have otherwise emerged. In a departure from the old command-down process — planners proposing, residents disposing in public planning meetings — ideas bubbled up in new ferment."*

> ***Continuously pursue two-way communication with citizens.*** *When the city of Fort Collins, hampered by budget constraints, took a new approach to long-range planning by reaching out to the community, it struck an interest with groups that had never before participated in city planning.*
>
> ***Figure 12.10***

Offer an integrated, personalized citizen portal for services. We've talked about how important it is for citizens to be involved in the pursuit and realization of a smart city. That's why it's crucial that cities create an integrated, comprehensive online portal for people to access their smart city services.

Today websites and mobile applications can recognize individual citizens and deliver personally tailored information to them. Such digital interactions with citizens allow smart cities to enhance their efficiency and effectiveness at the same time they heighten citizen satisfaction.

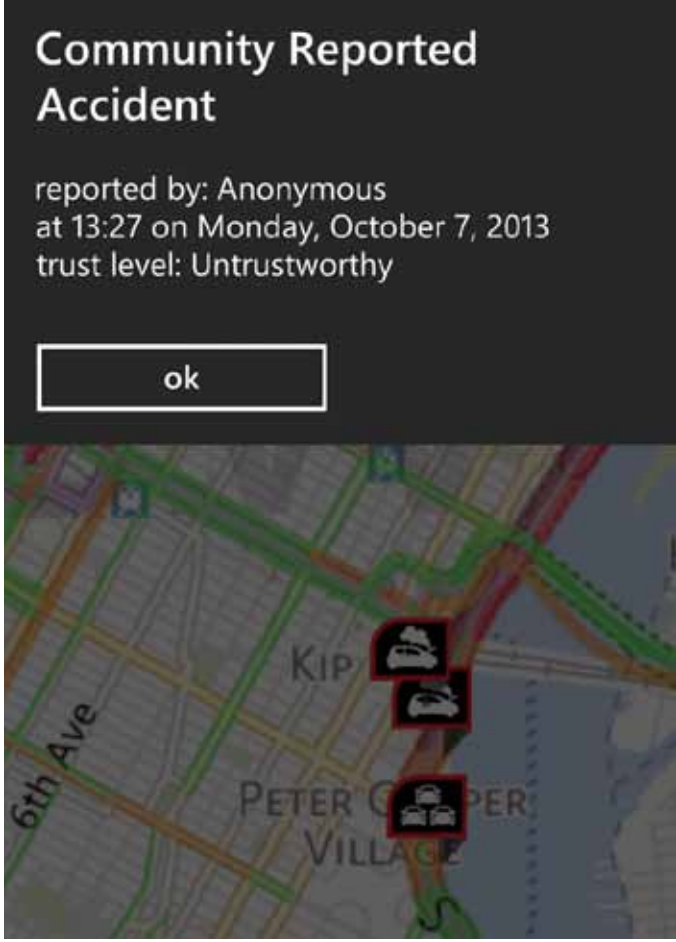
Until recently, it was far too expensive to personalize service for each resident. Today, however, the technology exists to personalize virtually every interaction. In the Web 1.0 world, governmental cyber services typically meant a series of websites. Those sites were typically designed from the point of view of the government. It was up to the citizens to navigate their way around to find what they needed, a chore that was often time-consuming and frustrating.

Now we have the ability to create personalized customer portals and personalized outbound messages. More and more citizens are coming to expect personalization, since they receive it in so many other parts of their lives. And when these portals are designed with mobile in mind, it helps people capitalize on the timeliness of their personalized data

Personalized cyber services increase citizen satisfaction and compliance while reducing mistakes and misunderstandings that can occur when they are forced to dig up information on their own.

Finally, as unified, single-window views of services are made available to citizens through personalized portals, it is important that cities ensure that the same care goes into giving city workers the proper tools to be responsive.

Disseminate timely information about public safety, public health, transportation and other services that impact the public. Smart cities can get more mileage out of their ICT investments when they use the information provided via instrumentation and analytics to inform the public about issues and events that could impact their lives and livelihoods. Publishing interactive crime maps is one example; sending alerts via social media when air pollution reaches a worrisome level is another; encouraging creation of apps that provide results of restaurant inspections or traffic updates is also useful.



Disseminate timely information about public safety, public health, transportation and other services that impact the public.
The INRIX Traffic app shown here on a Windows phone helps users decide which route is the best choice to get around traffic, including recommended departure times and arrival time updates.

Figure 12.11

Offer an integrated citizen portal for services:

BOROUGH'S CITIZEN PORTAL CUTS COSTS, IMPROVES SERVICES

As a leader in public sector IT, the London Borough of Newham wanted to improve its service delivery and digital engagement with citizens, while reducing costs. By sharing services with the neighboring local authority of Havering, Newham is pioneering a transformation in both councils using a trio of technologies from Council member Microsoft – Dynamics CRM, SharePoint Server and BizTalk Server.

Its online portal service, which is available to every resident, will encourage more people to conduct transactions online rather than at council offices. With reusable technology, the platform will contribute to Newham and Havering's target of more than £11 million cashable savings between them, without cutting front-line services.

The council is starting with its most used citizen services in initiating greater digital engagement with residents. These include service requests for waste bins and recycling, parking enforcement and revenues and benefits.

Potential exists for other authorities – including the London Borough of Waltham Forest – to join them, further improving efficiency and providing high-quality customer service.

> ***Offer an integrated citizen portal for services.*** *The Newham portal meets the challenge of delivering high-quality services with fewer resources, given the U.K.'s tight fiscal policies for local and regional government.*
>
> ***Figure 12.12***

ADDITIONAL RESOURCES

Attracting talent and business

Egyptian World Heritage site launches mobile portal to enhance and revitalize local tourism

The city of Luxor, Egypt, wanted to help its approximately 12,000 daily visitors get the most out of their trips. Making it easy for visitors to find tour guides, hotels, restaurants, transportation, and other services would help support the city's tourism industry — one of the most important segments of its economy. In 2012, the Egyptian Ministry of Communications and Information Technology (MCIT) launched the Luxor Mobile Portal, powered by Microsoft's cloud services.

Offering an integrated, personalized citizen portal for services

Polish cities' cloud-based web chat improves citizen access to services

Working with Council member IBM, eight cities in Poland have adopted a virtual web chat program to improve citizen services. The program developed by InteliWISE runs on the municipal websites and uses cloud-based virtual agents to help citizens who want instant access to information about government services without searching on the web or making a trip to city hall.

Engaging citizens on their terms

A virtual city hall in a shopping mall

Residents of Nice, France are remotely accessing city services confidentially and well beyond normal city hall operating hours – all from a popular shopping mall. The Nice Cote d'Azur Metropolitan Area and the City of Nice have joined forces with Council member Cisco to launch a worldwide pilot of the 'virtual city hall cabin' – transforming the delivery of services to citizens right from the Nice Etoile shopping mall.

Making citizen engagement "frictionless"

Demise of the public meeting

Governing Magazine chronicles the revolution that is occurring now that technology has made citizen engagement "frictionless." One example: How Austin, Texas city planners got creative with a "meeting in a box" initiative that was so successful it got 18,000 people involved in a planning initiative – way more than the usual suspects who typically weigh in on planning matters in Austin.

CHAPTER 13

IDEAS TO ACTION

In this chapter, you'll learn how a simple roadmapping process can put you on the path to a smart city. We've hinted at this next point before, but now we're just going to say it: Technology is the easy part. The hard part is turning ideas into action. Fortunately, help is at hand from those who have gone before. In reviewing hundreds of successful pilots and interviewing dozens of experts, several themes have emerged, which we have shared on the pages that follow.

If you've completed the other chapters in this Guide, you now have a set of targets to guide your smart city efforts. But you don't yet know where to apply those principles first or how to translate those concepts into on-the-ground realities. In these next pages, we'll explain how a roadmap can be the bridge between ideas and action. We'll cover:

- The importance of a roadmap
- The elements of a roadmap
- The process of building a roadmap
- Success strategies for a roadmap.

Please note that the Smart Cities Council does NOT believe in roadmaps in isolation. Rather, the roadmap should be linked to a city's vision document or comprehensive plan. We believe wholeheartedly in digital technology. But that technology should be in service to a city's larger goals.

The importance of a roadmap

Why a roadmap? The path to a smart city is a long one. It can easily take 5, 10, even 15 years to make smart technologies pervasive. It is essential to have a clear, consensus goal to motivate citizens. And clear targets to guide the course corrections that will be needed along the way.

As we use the term in this Guide, a roadmap is a simplified outline of the major steps to becoming a smart city. It is NOT a vision document or a master plan or a detailed project plan. Those other things come into play, but you also need a high-level, "30,000-foot view" of your future. As experts point out, academics think about the "why" of smart cities while technology companies focus on the "what." Yet you also need to figure out the "how"... and that's where a roadmap comes in.

Overcoming smart city hurdles

A roadmap can help you overcome obstacles to a smart city transformation. One such hurdle is human nature. People are naturally resistant to change. Yet we live in an era where change is constant. As a result, an entire management science has arisen around "change management" – around successfully transitioning companies to a desired future state.

Cities face a similar challenge... but they can't simply order residents to attend a change management seminar. Nor can they fire the ones who won't go along. Instead, city government must influence and inspire the population. A roadmap is a powerful tool in that effort.

Effecting change is made even more difficult by the stove-piped nature of most city governments. For at least the last 100 years, cities have been divided into departments, each with its

Figure 13.1

own specialty and each with a high degree of autonomy. Although it's not necessary to abolish departments to become a smart city, it is necessary for those departments to collaborate more effectively and to share resources. As you will read below, the roadmapping effort is a "forcing function" that obliges departments to work together.

Becoming a smart city is further compounded by overlapping boundaries. Urban challenges – crime, transportation, water supply, economic development, etc. – don't stop neatly at city borders. Jurisdictions overlap as well. Many metropolitan regions have dozens of cities and townships within their sphere. They also embrace hundreds of school districts, water districts, transit authorities, port authorities, human services agencies and other organizations. Consider the Greater Chicago metropolis by way of example. It crosses 14 counties in three states and contains approximately 350 municipalities, 350 school districts and 140 library districts.

Meanwhile, cities are also subject to rules and regulations from federal agencies, state or provincial governments, county or parish governments, public utility commissions and so on. And, to top it off, cities must contend with myriad advocacy groups, special interest groups, neighborhood associations, business associations and other groups whose agendas can sometimes be at cross purposes. The United States provides an example. By one count, it has roughly 20,000 municipal governments, 13,000 school districts and 37,381 special authorities.

As Brookings Institution scholar Bruce Katz explained in 2011, "an excess of municipal governments (and the general absence of metropolitan governments) means that there is no 'one stop shop' for the application of innovative technologies. The public institutions that make decisions about transport are different from the ones that make decisions about education or water. These separate entities rarely coordinate with each other to integrate technology (and share information) between themselves or with utilities and other private or quasi public entities."

Done right, roadmapping is a process that involves and pulls together these disparate groups.

Other roadmapping benefits

In addition to the advantages mentioned above, a smart city roadmap has these additional benefits:

- **Maximizing synergies and minimizing costs.** Considering the big picture can help a city find ways to share infrastructure and share costs – doing away with unnecessary duplication of ICT investments.

> ***Overcoming smart city hurdles.***
> *Urban challenges don't stop neatly at city borders as evident in the Greater Chicago metro area which crosses 14 counties in three states. Roadmapping can help pull together disparate regional groups.*
>
> ***Figure 13.2***

- **Identifying the best places to start.** Picking the "low-hanging fruit" – projects that have a big return for a relatively small investment in money and time – usually makes sense. If a city starts with quick, "big bang" projects, it can build momentum and public support. It can also help pay for future projects with savings from the early ones.

- **Enabling cities to build in stages.** With a plan in place, you can be confident everything will work together in the end because you're adhering to principles and standards that ensure interoperability and collaboration. With such a framework, a city can move forward one step at a time, knowing that individual projects will be compatible with each other, even if they are built at different times.

- **Increasing public support.** A roadmap paints a picture of future improvements in livability, workability and sustainability. It can dramatically increase public understanding and cooperation. It can also rally support and financing from the private sector.

- **Attracting talent and business.** Cities everywhere want to woo talented professionals and job-creating businesses, but both are increasingly choosy when deciding where to establish themselves. They are attracted to cities that have a strong, compelling vision for a better future and a path to get there. Your roadmap, in other words, is also a recruiting tool.

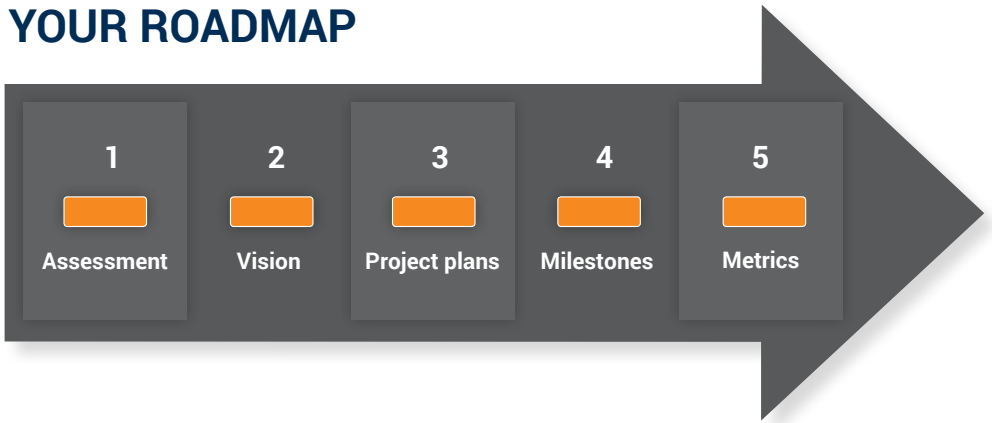


Figure 13.3

The elements of a roadmap

Many authorities recommend that your roadmap include these five elements at a minimum:

1. **An assessment** of where you are
2. **A vision** for where you want to go
3. **Project plans** for the key components
4. **Milestones** to mark progress
5. **Metrics** to measure and prove success

Assessment – a clear picture of where the city is now, measured in terms of the key performance indicators you will use to quantify success. For instance, in pages to follow you'll learn how Vancouver, B.C.'s action plan included baseline numbers to indicate the city's current level of performance.

Vision – a clear picture of the ultimate outcomes, expressed in terms of citizen benefits. The vision should not be expressed solely as technical achievements but also as the lifestyle and workstyle improvements the technology makes possible. It is essential to build that vision with citizen involvement. First, you'll get better and more diverse suggestions. Second, you'll build consensus and commitment. You'll also want to re-imagine what your city's departmental organization should look like.

Project plans – "blueprints" for the most important components of the smart city. Possibilities include master plans for land use and the built environment; for digital infrastructure (communications and computing resources); for data; for transportation; for business and commerce, and for city services. These plans are also helpful for creating visibility around smart city drivers.

Milestones – waypoints at which you measure progress, share lessons learned and discuss course corrections and strengthen commitment. For instance, Vancouver has annual implementation updates. (Click to view an overview of Vancouver's 2011-2012 Implementation Update.) It also holds an annual Vancouver Cities Summit, a discussion platform for business and urban leaders to exchange ideas and best practices. And it issues periodic updates in various media to keep citizens informed and enthused (see Figure 13.4)

Your residents can be a valuable tool in the measurement process. Social media can help you reach out to them to see how technology adoption is progressing, further connecting government and people.

Metrics – key performance indicators that quantify success. Examples include carbon footprint, average commute time, percentage of citizens with broadband, energy efficiency achievements, water efficiency achievements, new businesses formed, patents filed, students graduated, doctors and hospital beds per capita, percentage of city services available online, etc. In some cases, it is possible to choose metrics that also let you calculate your return on investment.

Installing metrics early in your smart city efforts can ensure transparency and improve citizen buy-in. Vancouver's action plan has a list of very specific targets. For instance, it seeks to double the number of green jobs from 2010 to 2020, and double the number of companies who have "greened" their operations. It seeks to reduce greenhouse gas emissions by 33 percent over 2007 levels. It has similar easy-to-measure targets for all 10 of its sub-components.

Milestones to mark progress. *Vancouver has annual implementation updates and monitors what's been accomplished so far and what still needs to be done as 2020 approaches*

Figure 13.4

MOBILIZING 35,000 VANCOUVERITES TO BUILD AN ACTION PLAN

In 2009, Vancouver Mayor Gregor Robertson put together a Greenest City Action Team. Its job was to construct a plan to transform Vancouver into the greenest city on earth. Although only part of the plan references digital technology, all of it represents a sterling example of engendering citizen involvement.

More than 35,000 people participated in the process in one way or another. Many of them monitored progress online via social media (and continue to do so). Others took part in face-to-face workshops and events. More than five dozen city staff, 120 different organizations and 9,500 individuals actively contributed ideas and feedback.

Those contributors had a strong preference to create opportunities immediately as they worked for long-term success – to build a strong local economy and vibrant neighborhoods while creating a city that meets the needs of generations to come.

The resulting Vancouver Greenest City 2020 Action Plan was adopted by the Vancouver City Council in July 2011. The plan addresses three overarching areas of focus: carbon, waste and ecosystems. It is divided into 10 smaller plans, each with a long-term goal for 2050 and a shorter-term target for 2020.

> ***Vancouver's action plan.*** *The No. 1 goal of Vancouver B.C.'s 2020 Action Plan was to secure the city's international reputation as a mecca of green enterprise by doubling the number of green jobs and doubling the number of companies actively engaged in green operations.*
>
> ***Figure 13.5***

VANCOUVER PLAN GOALS

The Vancouver Greenest City 2020 Action Plan includes 10 "sub-plans," each with a long-term goal plus metrics to measure success.

	Goal	Targets
1. Green Economy	Secure Vancouver's international reputation as a mecca of green enterprise	• Double the number of green jobs • Double the number of companies actively engaged in greening operations
2. Climate Leadership	Eliminate Vancouver's dependence on fossil fuels	• Reduce community-based greenhouse gas emissions by 33 percent from 2007 levels
3. Green Buildings	Lead the world in green building design and construction	• Require all buildings constructed from 2020 onward to be carbon neutral in operations • Reduce energy use and greenhouse gas emissions in existing buildings by 20 percent over 2007 levels
4. Green Transportation	Make walking, cycling and public transit preferred transportation options	• Make the majority (over 50 percent) of trips by foot, bicycle and public transit • Reduce the average distance driven per resident by 20 percent from 2007 levels
5. Zero Waste	Create zero waste	• Reduce solid waste going to the landfill or incinerator by 50 percent from 2008 levels

Continued on next page

VANCOUVER PLAN GOALS

	Goal	Targets
6. Access to Nature	Vancouver residents will enjoy incomparable access to green spaces, including the world's most spectacular urban forest	• All Vancouver residents live within a five-minute walk of a park, greenway or other green space by 2020 • Plant 150,000 new trees by 2020
7. Lighter Footprint	Achieve a "one-planet" ecological footprint	• Reduce Vancouver's ecological footprint by 33 percent over 2006 goals
8. Clean Water	Clean Water Vancouver will have the best drinking water of any city in the world	• Meet or beat the strongest of provincial and federal drinking water quality standards and guidelines
9. Clean Air	Breathe the cleanest air of any major city in the world	• Always meet or beat the most stringent air quality guidelines from Metro Vancouver, British Columbia, Canada and the World Health Organization
10. Local Food	Vancouver will become a global leader in urban food systems	• Increase citywide and neighbourhood food assets by a minimum of 50 percent over 2010 levels

Figure 13.6

The process of building a roadmap

There's no "standard" way to create a smart city roadmap. Below we've suggested one approach that combines advice from many experts. It includes six steps:

1. Find a champion
2. Assemble a team
3. Borrow from the larger vision
4. Establish metrics
5. Prioritize your targets
6. Use experts to produce specific plans

Asssemble a team.
Many practitioners suggest that cities start by setting up an interdepartmental task force.

Figure 13.7

Find a champion

The best roadmapping strategy is to involve all important stakeholder groups. Even so, the effort is unlikely to succeed without a champion. Typically this is the mayor or city manager. But some successful efforts have been led by private developers, civic groups, local universities, city council members or other prominent individuals.

The champion's job is to sell the overall vision to city employees and city residents, and to the financial and technical partners the city must recruit. The job requires energy and salesmanship throughout the life of the project. Most experts call for a strong external leader – typically an elected official – teamed with a strong internal advocate – typically someone in a staff position who can lead the day-to-day activities.

Assemble a team

When you assemble your team, you will be balancing two needs. On the one hand, you need expertise from many different areas, which suggests a large team. On the other hand, you need to be fast and efficient, which argues for a small team. Some experts feel the ideal situation is a small group at the core that meets on a regular basis with a much larger group of experts and stakeholders.

Many practitioners suggest that cities start by setting up an interdepartmental task force. Since a smart city is a "system of systems," every decision taken in one area has an impact on others. It is essential to take a cross-functional approach. Some cities bring in a representative from every major department. Others form a core team and consult with other departments as needed. The planning and ICT departments are almost always involved. It's also common for the mayor to lead the task force or to designate a senior staffer.

The task force must have the authority to demand cooperation. Equally important, it should have oversight of departmental projects, at least to the extent of ensuring that

those projects adhere to established standards. Even if departmental infrastructure will not be interconnected immediately, you want the ability to do so when the time is right. And that requires that departments adhere carefully to standards for interoperability, security, privacy, data management, etc.

Many cities will move from an outside task force to an inside smart city department that will, in some ways, resemble today's well-accepted ICT departments. Like ICT, the smart city department will have cross-cutting responsibilities. Unlike ICT, however, it will not have specialization as its goal. Rather, its role will be one of coordination, setting overall standards and ensuring that 1) all departments have a common smart city platform to build upon and 2) all individual projects are coordinated with the larger smart city vision.

Some cities put external stakeholders on the task force. However, the most common method is to use city employees and paid consultants for the working team, then to hold meetings to gather input from important stakeholder groups. Some cities own and operate most services – transportation, electric power, water, telecommunications, etc. In other cases, the private sector provides all or most of those services, with the city government providing boundaries and oversight. Cities that do not control their own infrastructure must consult closely with the electric, gas and water utilities that service their territory.

Skilled smart city suppliers can also be a resource at this stage, especially those experienced in master planning and systems integration. Even if the city does not hire them immediately, they can provide directional guidance and recommendations based on their experience helping many different cities.

Although the Smart Cities Council does not do consulting for pay, it does work with selected Spotlight Cities in the early stages of their planning. The Council advises those cities in their use of the Readiness Guide. And it assembles ad hoc teams of experts for brief "mentoring" sessions to get cities "unstuck."

Borrow from the larger vision

We've emphasized that a smart city roadmap should be in service to larger community goals. Many cities maintain 10- or 20-year plans that are updated regularly. Others have vision documents, typically around goals for sustainability or economic development. And most large private developments have a master plan that has given careful consideration to the region's strengths, needs and cultural preferences.

Many cities also have plans for particular neighborhoods, such as ecodistrict plans or revitalization plans. For instance, the Loop Media Hub Ecodistrict, led by Council advisor David Sandel, is a St. Louis community initiative. It hopes to accelerate economic growth by providing one gigabit (1000 megabits) of Internet access to each building along the city's Loop Trolley right-of-way.

Your smart city roadmap should draw from these plans to establish your goals, priorities and metrics. Smart technology should be the means to an end. So first you need to determine what that end should look like. Every city has a unique mix of strengths, challenges and cultural preferences. Thus, every city will have different goals. Is your economy based on manufacturing? On tourism? On high-tech services? Every city should tailor its roadmap to buttress its strengths and compensate for its challenges.

For instance, cities emphasizing a lower carbon footprint (as with the Vancouver, B.C. example featured earlier) might prioritize projects that impact emissions, such as smart grid, energy efficiency and electric vehicles. Cities aiming to become high-tech hubs might emphasize such things as broadband connections and mass transit.

If your city has no long-term plans, even for individual districts, then you may want to include a visioning exercise as an early step in your roadmapping process.

Starting small:

BUILDING A SMART CITY ONE ECODISTRICT AT A TIME

Portland, Oregon-based EcoDistricts seeks to inspire cities to remake themselves from the neighborhoods up. The nonprofit organization works with city builders and entrepreneurs, policymakers and innovators to create vibrant neighborhoods and smart cities. It disseminates district-scale best practices to create the neighborhoods of the future.

An EcoDistrict is a neighborhood with a broad commitment to accelerate local sustainability. EcoDistricts commit to achieving ambitious sustainability goals and tracking the results. Success is measured around eight performance areas, including: energy, water, equitable development, community identity, access and mobility, habitat and ecosystem function, health and well-being, and materials management.

Although every EcoDistrict is different, many include elements such as district energy, green job creation, livability enhancements, stormwater strategies and comprehensive transportation planning. The EcoDistricts organization has created a tool to guide cities and urban development practitioners from concept through implementation, with an emphasis on process management and community collaboration.

> ***Starting small.*** *The EcoDistrict Framework provides tools to take a neighborhood-by-neighborhood approach to building a smart, sustainable city.*
>
> ***Figure 13.8***

Establish metrics

At this point, you have a team in place and you have broad goals pulled from your city's long-term vision.

A valuable next step is to establish metrics to measure progress towards those goals. A comprehensive smart city roadmap should have 1) measurable goals for livability, workability and sustainability and 2) timely reports of progress toward those objectives.

Some of those metrics will be "inward-looking" as a way for city government to monitor its own performance. But we urge you to include metrics that speak directly to citizens and their quality of life.

Elsewhere in this chapter and in the appendix, you will find examples of city plans and metrics to study for ideas. You may also want to consult published "city indicators." Examples include the Global City Indicators Facility (GCIF), Mercer Quality of Living Survey, the USGBC LEED for Neighborhood Development and the Circles of Sustainability Urban Profile from the UN Global Compact Cities Programme.

Prioritize your targets

With your vision and your metrics in place, you are ready to prioritize the targets you developed in earlier chapters to achieve those goals. We have placed a summary checklist at the end of this chapter. Use it to consolidate the work from the previous chapters and determine which targets to emphasize first.

How do you choose your priorities? These four steps will help:

1. Start with the fundamentals
2. Consider overall goals
3. Bolster your weak spots
4. Seek out quick paybacks

Each of these four steps will screen out some of the possibilities. If you apply these filters in order, you'll end up with a much shorter list of possible first projects.

Start with the fundamentals. Certain targets are so essential that every city should put them in place at the beginning. Or, at the very least, get started on them right away, even if they also do other projects in parallel. Review the five targets below to see if your city is missing any of these basics:

- Citywide multi-service communications
- Adhere to open standards
- Publish privacy rules
- Create a security framework
- Create a citywide data management, transparency and sharing policy

> ***Prioritize your targets.*** *Start with the fundamentals. Certain targets are so essential that every city should put them in place at the beginning.*

Figure 13.9

These five targets have the most profound effect on a city's ability to transform itself. Put another way, these five targets are the ones that will get you in the most trouble if you fail to get them right. Imagine, for example, leaving each individual department to figure out cybersecurity on its own. Some departments may have access to specialized expertise in-house or via consultants. But others are likely to fail at this challenging task, putting the entire city at risk.

Reminder: You don't have to build all of these things yourself, but you must ensure that they are in place. In some cases, the private sector may step up. (Many cities already have city-wide communications in place, for instance.) In other cases, you may be able to borrow ideas from cities that have gone before rather than start from scratch. (You can already find several solid privacy frameworks, for instance.) In other cases, your city may have un- or under-utilized assets that can be put into service. For instance, many cities have unused "dark fiber" – fiber optic cables that were installed but never put into service – that can be used for citywide communications.

Consider overall goals. Once you're comfortable that you have the fundamentals in play, filter your possible projects against your city's overall goals. As explained earlier, look to broader city vision documents and plans that set out long-term goals. Your smart city roadmap should prioritize projects that make progress against those objectives.

If your plan calls for the expansion of tourism, for instance, you'll want to prioritize projects that contribute to that objective. If your long-term plan calls for you to accommodate a large influx of new residents, you should emphasize projects that help you answer that imperative.

Bolster your weak spots. If you still have too many possibilities, you can narrow your choices by looking for projects that shore up your weak spots. The checklists in each chapter (and the summary checklist at the end of this chapter), contain a column to note where you are weak or strong.

Seek out quick paybacks. Finally, if you still have more candidates than you can tackle, look for easy wins. Give preference to projects that can be completed quickly and that have a rapid return on investment. Time and again, we hear from smart city experts that it is essential to demonstrate success early. For your long-term smart city transformation to succeed, you must have some early, short-term wins. These early successes will build enthusiasm and momentum. And, done right, they will create value streams that can help to pay for future projects. For instance, Council member Grid20/20 produces distribution transformer monitors.

> ***Seek out quick paybacks.*** *With the help of distribution transformer monitors, utilities can easily spot energy theft and the solution can often pay for itself in a year or two.*

Figure 13.10

With the help of those monitors, utilities can (among other things) easily spot power that is being lost to theft. Depending on the part of the world, energy theft can suck away 5 to 35 percent of the total power. Thus, a monitoring solution from Grid2020 can often pay for itself in a year or two, freeing up money to apply to other projects.

Seek out quick paybacks:

7 AREAS THAT CAN PRODUCE WINS QUICKLY

Although every city is different, here are seven areas that have proved to be excellent places to look for quick payback. By the way, payback isn't always financial. Sometimes it comes in other forms, such as popularity rankings, business startups or civic enthusiasm.

Smart transportation. This sector is the number one source of smart city projects. Most cities suffer from congestion and most citizens put traffic at the top of the list of things they want solved. According to some studies, congestion reduces a city's gross domestic product by somewhere between 1 and 3 percent. Smart transportation may not result in fare decreases. But it often reduces costs for the operators. And it almost always rewards citizens with lower congestion and shorter travel times.

Energy efficiency. Energy efficiency programs can often get underway without large expenditures. Many gains are possible through simple behavior changes – for instance, learning ways to save water, substituting more efficient light bulbs or learning to postpone non-essential electric use to non-peak times. What's more, many energy services contractors will undertake work for no upfront costs. Instead, they take a portion of the savings.

Smart grids. The payback from a smart grid is not necessarily in lower electric rates. Rather, it may come in the form of reduced outages and greater reliability against storms and sabotage. In areas subject to hurricanes, tornadoes, tsunamis, earthquakes or floods, resilience is highly valued. City governments can gain great approval if they improve reliability and resiliency – and face great wrath if they do not.

> ***Seek out quick paybacks.*** *Remember, paybacks on your smart city projects aren't always financial. There's much value in civic enthusiasm for your smart city efforts.*
>
> ***Figure 13.11***

> ***Seek out quick paybacks.*** *Smart street lighting can be an excellent prospect for a first smart city project.*

Figure 13.12

Smart water networks. Council member Itron estimates that 30 percent of all the water pumped worldwide does not reach its destination. A smart water network can pinpoint leaks and theft, gaining a quick payback in regions where water is scarce and costly.

Smart street lights. A confluence of several factors make smart street lighting an excellent prospect for a first project. First, the latest generation of LED lighting makes possible big savings in energy costs. Second, the same LEDs that save energy also save on "truck rolls." They last much longer, so maintenance crews don't have to spend as much time replacing lamps. Third, by networking the street lights – adding communications to each one – you make possible numerous smart applications, including remote diagnostics and control. Fourth, once you have a "canopy network" in place for street lights (and paid for by the savings in energy and maintenance), you can use that network for other smart city applications. After all, street lights already have power, already exist throughout the city and already sit up high – the perfect places to play host to a citywide network.

Public safety. Smart policing can have a dramatic impact on crime rates and public confidence. By feeding current and past crime statistics into analytical programs, cities can predict where crime is most likely to occur. And by equipping officers with cameras, laptops, tablets or smartphones, they can reduce the time spent on bureaucratic paperwork and increase the time on patrol.

Digital government services. You can often get a quick win by converting a government service from "manual" operation to a more convenient online or smartphone version. Done well, such projects can save money for the city while simultaneously improving citizen satisfaction (no more standing in line). There are dozens if not hundreds of possibilities, including licenses, permits, registration for social services, purchase of fare cards, reporting potholes and many, many more.

Setting up simple e-government apps can be a matter of months or even weeks. For instance, Council advisor Living Labs Global has founded a website called Citymart.com where you can browse for smart city apps from more than 1,000 suppliers around the world. And Council member AT&T has bundled eight of the most popular city applications into a package called Community Central. Since the apps are hosted in the cloud, a city doesn't need to buy any computers or hire any technical staff to get started.

Smart payments: Payback from smarter payments can be quick – and significant. Cash and other physical means of payments are generating huge costs for city administrations, as well as being very risky and needing secured transfers. By digitalizing all disbursements and collections, a city can generate significant savings and increase its operational efficiency. For example, by switching city service benefits from direct deposits and check cashing services to a prepaid card, the city of Toronto generated huge savings for both social assistance recipients and the city. Public estimates claim that more than $250 a year can be saved for a single client receiving $600 a month, and the city itself expects net savings of at least $2.5 million annually by eliminating the cost of issuing checks. This program was rolled out in less than a year.

Seek out quick paybacks:

DUBUQUE, IOWA: INVESTING IN SUSTAINABILITY

Roy Buol will tell you that the theme of making Dubuque a more sustainable city was central to his successful run for mayor in 2005. He'll tell you how much the issue resonated with the thousands of voters he spoke with in the course of knocking on thousands of doors. But one thing he won't do is take top credit for Dubuque becoming the model of a sustainable midsize city that it is today.

To Buol, that credit goes to the 60,000 citizens of Dubuque who worked to establish a unified vision of what sustainability means to them as a community. "My role was really to focus and channel a set of beliefs and priorities that was already there," Buol explains.

One key question was where to start. After the first few months of planning, several ideas made it to the table, reflecting the wish lists of a variety of groups. The filtering process took the form of a two-day workshop that dove deeply into issues of payback, practicality and timing. Moderated jointly by Council member IBM and key city officials, and involving no fewer than 83 people with diverse perspectives, the sessions produced both a clear consensus on where to focus and a roadmap for action.

The decision to lead off with a water conservation initiative was in many ways an outgrowth of Dubuque's existing efforts to revitalize its Mississippi waterfront areas. But another key factor was the pragmatic desire to take advantage of a water meter replacement program that was already in the works, which would effectively lower the risk and cost of implementing it.

> ***Seek out quick paybacks.***
> *As its first sustainability project, Dubuque chose water conservation, an outgrowth of existing initiatives which lowered risk and cost of implementation.*

Figure 13.13

Use experts to produce the specific plan(s).
At this stage, you have a prioritized list of targets plus ideas for your first projects. You may even have a cross-departmental implementation calendar that looks several years ahead.

If you are not already consulting with experts, now is the time to bring them on board. Their job will be to produce specific, detailed project plans and engineering specifications. (If you are building a district or city from scratch, then the experts' job will be to produce a master plan.)

> ***Use experts.*** *Finding the right experts is an important task. They must have a holistic, big-picture outlook to help your city find cross-departmental synergies.*

Figure 13.14

Finding the right experts is an important task. They must have a holistic, big-picture outlook to help your city find cross-departmental synergies. But they must also have access to specialized knowledge to produce detailed technical specifications. Ideally, they will also have experience in smart city projects.

"Outsourcing" all or part of your project implementation can have important benefits. First, few city employees will have the up-to-the-minute technical skills to ensure that the city is getting state-of-the-art solutions. Second, few city employees have the time to take on such a complicated extra job. Smart city projects demand focused effort. Most city employees – and most city leaders – are focused on too many initiatives to truly drive the smart city charge, even if they have the technology skills. Outsourcing allows for a passionate focus on the project. And outsourcing can survive and bridge a change in government if elections or appointments occur in the middle of the project.

Where do you find such experts? Many cities have had success working with regional universities. Many cities bring in consulting firms to administer the overall process, trusting those consultants to bring in other specialists as needed. And many cities have found success working directly with experienced smart city suppliers like the Council members listed in this Guide's appendix.

The suppliers in the appendix have demonstrated exceptional smart city capabilities. They have collectively worked on thousands of projects that relate to smart cities. They know what works in real life, what problems are likely to occur, and which technologies are truly ready for prime time. It is no exaggeration to say that they represent the planet's very best smart city suppliers.

And they've also demonstrated a vitally important characteristic – the willingness and ability to collaborate with others. No single company can create the totality of a smart city. It takes a small army of specialists to build out the "system of complex systems" that is a smart city. Membership in the Smart Cities Council signals a firm's commitment to collaborating with other companies to produce the best possible solutions.

USING AN EXPERT TO IMPROVE CITIZEN INVOLVEMENT

When Council member National Grid set out to create a smart grid pilot in the city of Worcester, Massachusetts, USA, it put community involvement at the core. "The centerpiece of our new effort was a community summit," explains Cheri Warren, Vice President of Asset Management. Along with the city government, National Grid co-hosted a "Green to Growth" summit in September 2011. The two-day forum was attended by more than 300 residential and commercial customers, government officials and other stakeholders.

Few people will appreciate modernization if it's imposed from the top down. But many people can get enthused about a better energy world for themselves and their children. The summit meeting included a "dream phase," where residents could decide how they wanted their energy future to look. Thirteen different initiatives came from the meeting. National Grid is leading some of them. Others are being led by the community.

The Community Summit was a two-day event led by Dr. David Cooperrider of Case Western Reserve, who has co-developed a methodology called Appreciative Inquiry. It is a way to lead groups through a collective inquiry into the best of what is now and to imagine the best of what could be. From there, the desired future state is collectively designed. The system attempts to create a consensus vision that is so compelling it does not require the use of incentives or coercion.

"We didn't stop at a one-time event," says Warren. National Grid co-leads a community council that meets every other month. The council includes two representatives from the city, two from National Grid and several volunteers. It will further develop energy opportunity areas identified during the summit. For instance, National Grid helped build out a "Sustainability Hub," a showcase and hands-on education center in partnership with the city and nearby Clark University.

> ***Use experts.*** *National Grid used an expert consulting firm to involve the local community in designing and supporting a smart grid pilot project in Worcester, Massachusetts, USA. It also helped fund a Sustainability Hub to educate the public about energy efficiency.*

Figure 13.15

Success strategies for a roadmap

Much of this Guide gives advice with a technical flavor. However, when it comes to building a compelling and effective roadmap, the most important advice pulls from common sense. Cities should:

- Think big... but start small
- Work together... but move fast
- Emphasize synergies and interdependencies
- Borrow from the best
- Harvest good ideas

Think big... Earlier we said that a smart city roadmap should be subservient to a city's long-term vision. Don't hold back when setting those long-term goals. Be bold. Aim high. With the help of digital technology and willing citizens, virtually any city can achieve a greater level of health, happiness and prosperity. Yes, it will take longer for some cities. But the beauty of the digital revolution is that it offers hope to all, regardless of location. Indeed, in some cases digital technology allows cities in emerging economies to leapfrog cities from the developed world. Since they have much smaller investments in legacy infrastructure, they can jump straight to the better technologies now available.

> ***Start small.*** *With your grand plan in place, start small at first. Pick a project that has a small upfront investment, a quick turnaround and a rapid payback.*
>
> ***Figure 13.16***

... but start small. With your grand plan in place, start small at first. Pick a project that has a small upfront investment, a quick turnaround and a rapid payback. Ideally, this first target will be a consensus priority – something that is near the top of the list for all of the key stakeholder groups. Invest in one or a few select projects with the biggest and fastest payback. On the financial side, this allows you to apply the savings from the first project(s) to finance the next one(s). On the public relations front, it allows you to get an early win that builds support and momentum.

Starting small can also mean taking a neighborhood-by-neighborhood approach. Many cities start their smart city journey by designating one area for a pilot project. Districts – neighborhoods, if you prefer – are small enough but big enough too. They are small enough to be manageable and nimble. But they are big enough to have a critical mass of constituents and to gain some economies of scale. And they are small enough to innovate quickly but big enough to have a meaningful impact.

If the neighborhood approach is not right for your city, you might look for other self-contained environments such as industrial parks, campuses, leisure complexes, transport hubs, etc.

Work together... Time and again, we hear that collaboration is key to successful smart city projects. "When it comes to achieving the high-tech, sustainable, and smart cities of the future, there is one word that sums up the pathway to success: partnership," explained Terry Kirby in The Guardian in May 2013. Kirby and other observers say those partnerships should include (at a minimum) local governments, local utilities, local universities, local business groups, local developers and property owners and relevant advocacy groups (such as those that promote sustainability).

Smart city pioneers agree that collaboration is key – and that it can be surprisingly hard to achieve given the "stove-piped" structure of many city governments and the sometimes adversarial relationship between the public and private sectors. First, city governments need to get better at collaborating internally after decades of working in departments with strict boundaries. Second, cities need to get better at collaborating with business and with the public.

> ***Move fast.*** *Identify "hot spots" or priorities to enable a quick start on the journey to becoming smarter.*

Figure 13.17

Gartner analyst Andrea Di Maio argued in 2012 that "technology is mostly irrelevant unless policymakers, city managers, heads of department and city CIOs get the fundamentals right. What really matters is how different sectors cooperate and how they can exchange meaningful information. Of course there is technology involved, but that's not enough to make cities smart.

Cooperation requires solid governance and a roadmap that is respectful of 1) the different – and potential diverging – business objectives and timeframes of different stakeholders and 2) the inevitable resource constraints."

... but move fast. Those who hesitate may not be lost, but they will be passed by. As part of your planning, identify "hot spots" or priorities to enable a quick start on the journey to becoming smarter. For one thing, cities are in constant competition with each other to attract business, talent and creative types. Cities need to begin their smart city journey soon, or they will forever be playing catch-up to their rivals.

In addition, starting fast with an easy win can help with the political realities. Many elected officials operate on a relatively short horizon. Yes, they may have long-term goals for their cities. But they must operate within the constraints of frequent elections. They must show short-term progress along the way if they hope to be re-elected.

Emphasize synergies and interdependencies. Done well, your roadmap will consider the totality of the city, not just one or two important departments. In the beginning and at every progress review you should be looking for inter-departmental synergies.

If, for example, you target water alone, you will fail to capture the interdependencies with other departments such as energy. For instance, pumping water for irrigation and human consumption can represent 20 percent of a city's overall energy budget. Often a city can slash its energy bill just by shifting pumping to off-peak hours when there is less demand on the power grid. Likewise, the same communications system that carries messages for smart water meters can often handle smart electric meters as well, doing away with the expense of a second network. These kinds of synergies and savings don't show up when systems are studied in isolation.

In previous chapters, we've highlighted the interdependencies between different responsibilities. For instance, the built environment relies heavily on services from energy, telecommunications and water systems. Likewise, public safety relies heavily on services from telecommunications, energy and transportation

The roadmapping phase is when you put the theories of synergy and interdependency into practice. All the more reason to work together – to construct a task force that gets input from all the departments.

Borrow from the best. Study those who've gone before. It's smart to learn from your mistakes. It's even smarter to learn from the mistakes of others. And it's smartest of all to learn from the successes of others. Hundreds of cities have embarked on smart city initiatives big and small, so there's no need to invent your smart city plan from scratch. Study their roadmaps and plans (most are public documents).

Harvest good ideas wherever you find them. You'll find links to several smart city plans and related tools in the appendix of this Guide. The Smart Cities Council website can also help. You'll find success stories in the examples and case studies section. And you'll find advice on building plans in the visioning and roadmapping tools section.

> ***Harvest good ideas.***
> *The old port city of Santander, Spain has garnered international attention for the thousands of sensors ithat is making it smarter.*
>
> ***Figure 13.18***

Now you're ready to get started. It will be hard work, but it will also be rewarding. The roadmap you create will be the jumping off point for a better city for current residents and the generations that follow.

ADDITIONAL RESOURCES

Building a roadmap

The 5 principles of Shanghai's smart city roadmap

With approximately 24 million residents, Shanghai is the largest city by population in the People's Republic of China. In 2011, the City of Shanghai set forth a three-year action plan to construct a full-fledged smart city roadmap. Operating under the city's motto "Better City, Better Life," the plan was grounded on five "implementation principles." First on the list was to put the fundamentals in place, including an ICT platform for building smart applications and a unified planning function.

Working together, but moving fast

Smart City Vienna incorporates stakeholder input from the start

In its ranking of the top 10 smart cities on the planet, Fast Company magazine noted that Vienna, Austria was the only city that ranked in the top 10 in every judging category: How did that happen? From the beginning of its smart city journey, Vienna adopted an integrated stakeholder process that brought together constituents along with experts from relevant fields. In all, more than 650 experts were involved in preparation of the city's roadmaps.

Leading the broadband boom

How Korea leapfrogged the United States in broadband

The Internet flowered in America in the 1990s, when South Korea was in great distress due to the Asian financial crisis. But then South Korea decided to build the infrastructure to become a "knowledge superpower." First it deregulated the telecom sector to foster competition. Next it began to market broadband as a way for students to enhance their prospects in school By 2012, South Korea's high-speed Internet penetration rate topped 100 percent – the highest in the world.

Emphasizing synergies and interdependencies

Improving government interoperability: A capability framework for government managers

This comprehensive white paper by the Center for Technology in Government, a Council advisor, provides guidance for government managers as they begin to move beyond the vision of a more effective government to the reality. It defines government interoperability as the mix of policy, management and technology capabilities needed by a network of organizations to deliver coordinated government programs and services.

CREATING YOUR ROADMAP

Priority 1-high 2-medium 3-low	Enabler	Universal Targets How smart cities deploy and use ICT to enhance livability, workability and sustainability	Implementation Progress None Partial Over 50% Complete
☐	**Instrumentation**	Implement optimal instrumentation • Supplement: for all transportation modes (Transportation) • Supplement: across the watershed (Water and Wastewater) Ensure universal high-speed broadband access (Telecommunications) Ensure a citywide wireless network (Telecommunications)	
☐	**Connectivity**	Connect devices with citywide, multi-service communications	
☐	**Interoperability**	Adhere to open standards Use open integration architectures and loosely coupled interfaces Prioritize use of legacy investments • Supplement: including physically stored data (Public Safety) Enable distributed generation with interconnection standards (Energy) Enable multi-channel access to an integrated customer transportation account (Transportation)	
☐	**Security & Privacy**	Publish privacy rules Create a security framework Implement cybersecurity De-identify patient and student data for storage in the cloud (Health and Human Services)	

Continued on next page

CREATING YOUR ROADMAP

Priority 1-high 2-medium 3-low	Enabler	Universal Targets How smart cities deploy and use ICT to enhance livability, workability and sustainability	Implementation Progress None Partial Over 50% Complete
	Data Management	Create a citywide data management, transparency and sharing policy • Supplement: including energy usage data (Energy) • Supplement: including water usage data (Water and Wastewater) Architect a single health history for citizens (Health and Human Services)	
	Computing Resources	Consider a cloud computing framework Use an open innovation platform Have access to a central GIS Have access to comprehensive device management	
	Analytics	Achieve full situational awareness • Supplement: across the watershed, and informed by weather data (Water and Wastewater) Achieve operational optimization • Supplement: for sustainability, efficiency, and cleanliness and safety (Water and Wastewater) Achieve asset optimization Pursue predictive analytics • Supplement: integrate all transport modes for multi-modal transportation optimization (Transportation) Automate fault and outage management (Energy) Automate fault and leak management (Water and Wastewater) Segment and personalize programs for customers (Energy) Enable dynamic, demand-based pricing (Transportation)	

Figure 13.19

Appendix

1. About the Smart Cities Council

There is no other organization like the Smart Cities Council. We act as a market accelerator and advisor to cities – advocating for the transformation of urban areas into more livable, workable and sustainable communities. The Council is a coalition of leading technology companies with deep expertise in areas such as energy, water, communications and transportation. We have come together to provide a collaborative, vendor-neutral framework to guide cities through their smart city planning and implementation. We envision a world where technology and intelligent design are harnessed to create smart, sustainable and prosperous cities. We work to create cities that exemplify our three core values: livability, workability and sustainability. Visit www.smartcitiescouncil.com to learn more.

2. The Future of the Readiness Guide

This Readiness Guide is the first collaborative and comprehensive framework for a smart city, against which cities can assess their readiness to innovate – identifying a path, taking next steps and measuring progress. It was prepared with input from best-in-class companies across many industries. In addition, more than 50 of the world's foremost independent experts on smart city development from academia, research and advocacy have reviewed and contributed to the Guide. This version 1.0 was released at the Smart City Expo World Congress in Barcelona, Spain on Nov. 19, 2013. We will continue to revise and update it and welcome your comments and suggestions. Please direct them to Council Research Director Chris Williams: Chris.Williams@smartcitiescouncil.com

3. City master plans

As noted in the Ideas to Action chapter of this Guide, cities don't have to reinvent the wheel when planning a smart city roadmap. To provide ideas and inspiration, we've gathered a selection of visioning/roadmap/master plan documents from cities around the world. If you have others you'd like to recommend, please direct them to Editorial Director Liz Enbysk: liz.enbysk@smartcitiescouncil.com

Belfast City Masterplan

Birmingham's Smart City Vision

Chicago Technology Plan

Digital Masterplan for Dublin

Imagine Austin

Jobs and Growth Plan for London

New York City Digital Leadership 2013 Roadmap

Philadelphia 2035 Citywide Vision

Portland Plan

Stockholm Vision 2020

4. Council Partners

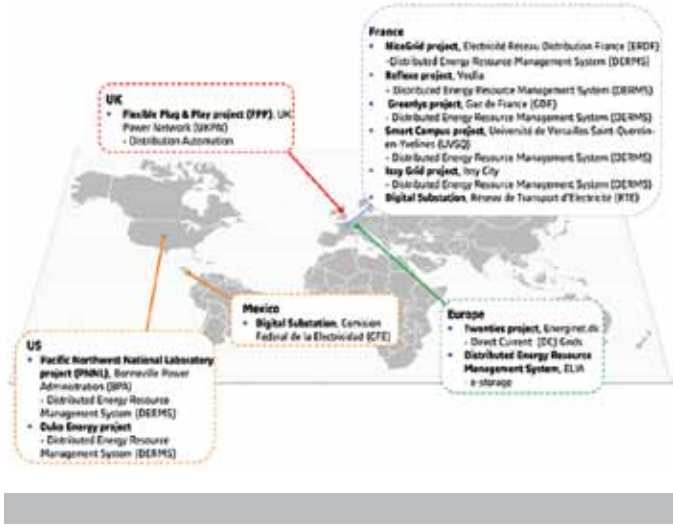
On the pages that follow, you will meet our Partners and Advisors. We invite you to join with us too. Learn more by contacting Council Executive Director James Whittaker: James.Whittaker@SmartCitiesCouncil.com

Smart Cities Council

INTRODUCING SMART CITIES COUNCIL LEAD PARTNERS

Council Lead Partners are for-profit companies that are global leaders in their sectors. Learn more about them on the pages that follow.

> *Alstom developed a number of demonstration projects in leading smart grid countries, in partnership with governments, utilities, industries, academic and research institutions.*



As a leading producer of smart technologies and services, Alstom Grid is pleased to lend its expertise to the Smart Cities Council's efforts to support and educate city leaders, planners and citizens.

To meet today's increasing global energy demands and challenges, networks must evolve and become smarter. Alstom Grid enables an efficient transmission and distribution of electricity and supports the development of Smart Grids and Supergrids with engineered solutions for applications in utility and industry settings; updating existing grids, integrating and customizing solutions such as alternating current and direct current substations, from medium up to ultra-high voltages. Alstom Grid is a key player in developing and implementing solutions to manage electric grids in the new era of increasing renewable energies and distributed energy resources, by enabling real-time, two-way management of electricity and information.

At the heart of the Smart Grid revolution, its solutions provide immediate benefits in many eco-city projects, thus enabling end-consumers to benefit from better energy consumption. Alstom Grid's knowhow is displayed in over 30 large scale demonstration projects in the US and Europe, with partners from both the public and private sectors.

The North Carolina Smart Grid Project in the USA led by the US Department of Energy (DoE) is designed to integrate distributed energy resources into the electrical grid efficiently in order to help the DoE reach its smart grid targets for 2030, including a 40% improvement in system efficiency. The NiceGrid smart district project developed with the French Distribution System Operator ERDF, located in the city of Nice (French Riviera), aims at developing several microgrids with integrated renewable energy sources and electricity storage with a scalable and cloud-based IT platform.

Clean grid

Learn more >

Global grid

Learn more >

Smart grid

Learn more >

Electrical network systems

Learn more >

Video overview

See video >

> *By the end of 2012, AT&T had installed 11 MW of solar and fuel cell capacity at its facilities.*

AT&T shares the Smart Cities Council's vision of a world where digital technology and intelligent design are harnessed to create smart, sustainable cities with high-quality living and high-quality jobs.

AT&T Inc. (NYSE:T) is a premier communications holding company and one of the most honored companies in the world. Its subsidiaries and affiliates – AT&T operating companies – are the providers of AT&T services in the United States and internationally. With a powerful array of network resources that includes the nation's largest 4G network, AT&T is a leading provider of wireless, Wi-Fi, high speed Internet, voice and cloud-based services. A leader in mobile Internet, AT&T also offers the best wireless coverage worldwide of any U.S. carrier, offering the most wireless phones that work in the most countries. It also offers advanced TV services under the AT&T U-verse® and AT&T |DIRECTV brands. The company's suite of IP-based business communications services is one of the most advanced in the world.

Innovation is the driver of the future: As government continues to find new ways to unite and serve constituents, technology has the power to help. Across the country, dedicated AT&T professionals are working with state and local governments to identify and implement innovative solutions to transform the business of government.

Additional information about AT&T Inc. and the products and services provided by AT&T subsidiaries and affiliates is available at http://www.att.com/aboutus or follow our news on @ATT, on Facebook at http://www.facebook.com/att and YouTube at http://www.youtube.com/att.

The explosive growth in government data requires the ability to capture, store and transform data into meaningful information.

Learn more >

Security solutions from AT&T are designed to protect critical agency and citizen data so you can focus on serving the community.

Learn more >

With the explosion of mobile communications, data growth is unlimited and government is seeking new ways to unlock its potential.

Learn more >

Whether the data is in your pocket, on your desktop or in the network, state and local governments can count on AT&T to provide security.

Learn more >

AT&T solutions for public safety enable first responders to access and share mission critical information when they need it, where they need it.

Learn more >

Bechtel is pleased to support the Smart Cities Council's aspirations to foster the creation of smarter cities around the world by sharing our experience delivering major infrastructure projects and knowledge of planning, financing and sustainable solutions.

As a company, we work hard to build a more sustainable world. In our work with cities and governments we enhance local communities and improve the quality of life for people around the world. Time and again our work has demonstrated that the only limits on human achievement are those that we place on ourselves.

Bechtel is a global leader in engineering, procurement, construction and project management. Bechtel's diverse portfolio encompasses energy, transportation, communications, mining, oil and gas and government services.

We have been privileged to contribute towards some of the most significant urban infrastructure projects around the world, including the Channel Tunnel, Hong Kong International Airport, the Athens Metro system and work on more than 20 new cities and communities. In order to deliver projects of such magnitude successfully, we combine smart planning, technical know-how and an integrated approach to make visions become a reality. We look forward to sharing the benefits of this experience and our knowledge of planning, financing and sustainable solutions, to support the Council's aspirations to foster the creation of smarter cities around the world.

Since its founding in 1898, Bechtel has worked on more than 22,000 projects in 140 countries on all seven continents. Today, our 53,000 employees team with customers, partners and suppliers on diverse projects in nearly 50 countries. We stand apart for our ability to get the job done right - no matter how big, how complex or how remote. www.bechtel.com

Bechtel is working with the President of Gabon to build a sustainable, mixed-use housing and neighborhood development in Angondje, Libreville.

Learn more about Bechtel's infrastructure work in Gabon here.

Learn more >

Jim Dutton, Bechtel's Programme Director in Gabon, explains to Project magazine how Bechtel is contributing to Gabon's sustainable development.

Read more >

As world populations shift to urban areas, community leaders are pressed for answers to related problems. These include overcrowding, pollution, budget and resource constraints, inadequate infrastructures and the need for continuing growth. Cisco Smart+Connected Communities solutions use intelligent networking capabilities to bring together people, services, community assets and information to help community leaders address these world challenges. By connecting the unconnected, we can do amazing things to address these real world challenges and create a more sustainable environment.

Cisco Smart+Connected Communities -- help transform physical communities to connected communities and achieve economic, social and environmental sustainability.

Transforming communities >

Retro-fitting existing cities with smart solutions is the urban challenge of the 21st century.

Learn more >

> *City transforms economic sustainability with public cloud.*

The Electricite de France Group, one of the world's leading electric utilities, has a mission "to bring sustainable energy solutions home to everyone." With sustainability at the core of its strategy, the group is creating ways to cut CO2 emissions by developing alternatives to fossil fuels; by building safer power grids; by fostering innovations with tangible benefits to customers; and by reducing environmental impact, especially on biodiversity.

EDF Group believe that the application of innovation to industrial expertise will transform how our cities use energy, optimising our collective resources and massively reducing carbon emissions. Today, EDF R&D teams across the world are exploring the technologies of the future while also developing solutions for today, including energy efficiency in buildings, electric transport, smart grids and the integration of renewables into the energy system.

EDF website

Learn more >

The energy mix for a greener future

Learn more >

Access to energy remains a global issue

Learn more >

Marine current energy: a resource for the future

Learn more >

> *Together we are building a Free-CO_2 future.*

GE Digital Energy

GE's Digital Energy business is a global leader in protection and control, communications, power sensing and power quality solutions. Its products and services increase the reliability of electrical power networks and critical equipment for utility, industrial and large commercial customers. From protecting and optimizing assets such as generators, transmission lines and motors, to ensuring secure wireless data transmission and providing uninterruptible power, GE's Digital Energy business delivers industry-leading technologies to solve the unique challenges of each customer. For more information, visit http://www.gedigitalenergy.com.

Empowering the Industrial Internet with software and analytics solutions to provide utilities with big data management and predictive intelligence.

Learn more >

Providing HV transmission solutions for a safe, reliable and secure electrical grid.

Learn more >

GE raises the bar on electrical system performance and reliability.

Learn more >

> *We enable utilities with solutions to monitor and control the generation, transmission, distribution and use of power.*

As a leading producer of smart technologies and services, IBM is pleased to lend its expertise to the Smart Cities Council's efforts to support and educate city leaders, planners and citizens.

IBM is helping cities around the world use the vast amount of information already available to deliver more efficient citizen services. IBM's experience with cities continuously fuels more effective solutions and best practices to help city leaders transform their communities.

IBM Smarter Cities Press Kit

Press Kit >

IBM Smarter Cities Web Page

Web Page >

White Paper: Smarter, More Competitive Cities

Cities >

People for Smarter Cities

Smarter Cities >

IBM Smarter Cities You Tube Channel

YouTube >

> *IBM worked with Rio de Janeiro to design a command center that integrates over 20 city departments to improve emergency response management and collaboration across the city. Predictive analytics capabilities use information to decide how to best react to current events and how to best plan for what is likely to happen in the future in order to minimize impact on citizens.*

Tianjin, China Eco-City: Itron's technology will enable conservation and consumer engagement efforts.

Read article >

"By enabling cities to better manage energy and water resources, Itron believes that, with collaboration and innovation, we can help cities not only adapt to address challenges, but also thrive. By drawing on today's best minds and technology, the Smart Cities Council and its members are committed to achieving just that." –Russ Vanos, Itron's senior vice president of strategy and business development.

Itron is a global technology company. We build solutions that help utilities measure, manage and analyze energy and water. Our broad product portfolio includes electricity, gas, water and thermal energy measurement, sensing and control technology; communications systems; software; and professional services. With thousands of employees doing business in more than 130 countries, Itron empowers the world's utilities, cities and citizens to responsibly and efficiently manage energy and water resources.

As a founding member and lead partner in the Smart Cities Council, Itron is advancing smart cities initiatives through collaboration, innovation and leadership. We see energy and water—and their convergence, the energy-water nexus—as the building blocks for smarter cities. Our continued livelihood and sustainability will depend on creative solutions and a new brand of resourcefulness.

Itron's Stephen Johnson discusses Itron Embedded Sensing, a measurement, monitoring and control platform for intelligent edge devices.

Itron Embedded Sensing >

Itron's leak detection solution helps Providence Water recover nearly 1 percent of unaccounted for water through proactive detection and mitigation.

Read more >

Itron's water AMI solution helps Houston utility achieve ambitious operational and customer service goals.

Read more >

MasterCard shares the Smart Cities Council's vision of a world where digital technologies and intelligent design are harnessed to create smart, sustainable cities with high-quality living and high-quality jobs.

MasterCard is a global payments and technology company. We operate the world's fastest payments processing network, connecting consumers, financial institutions, merchants, governments, cities and businesses in more than 210 countries and territories.

Our products and solutions are advancing the way consumer and business cardholders around the world shop, dine, travel, and manage their money, enabling transactions that drive global commerce and improve peoples' lives.

Passionate about innovation, MasterCard is constantly seeking to develop and test new payment channels and digital solutions that are safe, simple and smart.

Cities are becoming smarter, and whether it is to simplify internal processes, facilitate micro payments (transit, commerce...), optimize collection of funds or improve disbursement methods, MasterCard is developing inventive ways to support Cities digital strategy, drive local business growth, fuel commercial development, increase citizen's satisfaction and reduce costs.

Special and Unique Offers with MasterCard Priceless Cities. www.priceless.com

London bus passengers speed up their journey times with contactless card payments.

London bus cards >

The global journey from cash to cashless: boosting economic growth and advancing financial inclusion.

Learn more >

Digital sharing and trust project: understanding the five online personas.

Learn more >

Microsoft

Learn more about how Microsoft and our partners are helping cities innovate with a people-first approach at http://microsoft.com/citynext

Founded in 1975, Microsoft is the worldwide leader in software, services and solutions that help people and businesses realize their full potential. Microsoft CityNext is an extension of that vision with a people-first approach to innovation that empowers government, businesses and citizens to shape the future of their city. People-first means harnessing all the ideas, energy and expertise of a city's people as they create a healthier, safer, more sustainable place to live.

With a broad devices and services platform, a vast global network of partners, and a history of successful education and social programs, Microsoft helps cities find the right answers for their local challenges and opportunities. Together with our partners, we are committed to helping cities

- **Transform operations and infrastructure** by improving city functions with innovative partner solutions, leveraging the power of cloud computing to reduce costs and increase efficiencies, empowering employees with enterprise grade devices and apps, and enabling innovation on your terms with a modern solutions and big data platform.
- **Engage citizens and businesses** by delivering personalized services and apps with a people-centric approach, enabling real-time dialogue via social media and spurring city app development and economic growth with open data initiatives.
- **Accelerate innovation and opportunity** through programs that empower youth with 21st century learning and personal development opportunities, expand digital inclusion with access and skills training, and nurture new businesses and innovators with resources and support to help cities compete in the global marketplace.

Through a people-first approach and strategic partnerships, cities can enable sustainable cycles of innovation, opportunity, and progress for years to come.

Find out how Microsoft and our partners are enabling cities worldwide to harness the new era of innovation.

Learn more >

Microsoft CityNext helps dynamic city leaders turn their smart city vision into reality.

Watch here >

Learn how Microsoft cloud services and devices play a role In Barcelona's innovative initiatives.

Read more >

Read why Frankfurt am Main, Germany is consolidating its highly decentralized IT infrastructure.

Read more >

Auckland, New Zealand, is using Microsoft technologies to provide new transportation services.

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National Grid is a British multinational utility that delivers electricity and gas to Britain and the Northeastern United States. As one of the largest investor-owned energy companies in the world, National Grid is at the heart of the need to create sustainable energy solutions for the future and lay a foundation for economic prosperity in the 21st century. To that end, National Grid is working to address energy needs while meeting the challenges posed by climate change.

New England's first-of-its-kind Sustainability Hub opened its doors in October, 2013, in Worcester, Mass. and is now providing hands-on education about energy efficiency and emerging energy technologies for National Grid's customers and the community at large. The 2,200 square foot interactive space was donated by Clark University and is an integral part of National Grid's Smart Energy Solutions Program, the largest and most comprehensive smart grid program in Massachusetts.

Learn more >

National Grid's vision is to deploy smart grid technology in order to optimize the flow of green energy resources, enhance the performance of the electric distribution grid, and provide customers with the ability to make informed decisions about how they use energy. A smart grid will be the fundamental service platform for future years. It will help towards reducing energy consumption and greenhouse gas emissions while enhancing the reliability of National Grid's infrastructure.

Learn more >

> *The Sustainability Hub houses interactive exhibits and demonstrations to help people maximize their energy savings.*

> *For local, state and federal government personnel, good situational awareness can help save lives and better protect assets.*

Qualcomm Incorporated is the world leader in 3G, 4G and next-generation wireless technologies. Qualcomm Incorporated includes Qualcomm's licensing business, QTL, and the vast majority of its patent portfolio. Qualcomm Technologies, Inc., a wholly-owned subsidiary of Qualcomm Incorporated, operates, along with its subsidiaries, substantially all of Qualcomm's engineering, research and development functions, and substantially all of its products and services businesses, including its semiconductor business, QCT. For more than 25 years, Qualcomm ideas and inventions have driven the evolution of digital communications, linking people everywhere more closely to information, entertainment and each other. Qualcomm innovation and technology can be used by cities worldwide to provide smart, efficient and sustainable services, including:

Cellular Grid Connectivity- ubiquitous consumer coverage, high bandwidth and real-time communications of 3G and LTE cellular networks that enable critical smart grid functionality such as advanced smart metering, demand response, distribution automation, and outage management.

Home Area Connectivity- unsurpassed whole home coverage, performance and reliability in an energy efficient manner.

Connected Vehicle- anywhere/anytime emergency assistance services, remote monitoring and diagnostics, advanced driver assistance features, GPS and GLONASS-enabled position-location features and services.

Wireless Electric Vehicle Charging- a simple, no fuss way to charge your electric vehicle. No cables, no wires, just park and charge.

Mobile and Wireless Health- broadband technologies enabling mHealth devices and services for chronic disease management, remote patient monitoring, diagnostic care, as well as products associated with general health, wellness, fitness, and aging.

Mobile Learning- mobile broadband technologies enabling personalized experiences within collaborative communities, transforming the work of teachers/students in K-20 schooling.

Qualcomm Government Technologies leverages Qualcomm's wireless expertise, innovative technologies and vast industry reach to provide capabilities and services that enable government customers – federal, state, and local.

Learn more >

Real-time situational awareness.

Learn more >

Next-generation wireless.

Learn more >

Secure wireless communications.

Learn more >

S&C is proud to support the Smart Cities Council as it seeks to accelerate the transition to smart, sustainable cities.

S&C, with global headquarters in Chicago, USA, is applying its heritage of innovation to address challenges facing the world's power grids. S&C's innovative solutions for power delivery are helping cities transition to the cleaner, more reliable supply of electricity required in the 21st century. S&C's solutions reduce the length and frequency of power outages, improve energy efficiency, support smart microgrids, and make it practical to use intermittent renewable energy sources like wind and solar power on a larger scale. S&C has introduced ground-breaking technology to make power grids self-healing, allow use of grid-scale energy storage, and advance microgrid systems. Additional information is available at sandc.com.

From Old Grid to Smart Grid: The Economic Impact on Electricity Customers

Watch video >

Chattanooga Shows Smart Grid Can Deliver Results

Case Study >

Microgrids: An Old Idea with New Potential

Read more >

The Role of Energy Storage in Smart Microgrids

Read more >

Perfect Power at Illinois Institute of Technology

Case study >

Chattanooga, USA deployed S&C's self-healing smart grid solution to improve power reliability. The system is exceeding outage reduction goals of 40%.

Smart Cities Council

INTRODUCING SMART CITIES COUNCIL ASSOCIATE PARTNERS

Council Associate Partners are for-profit companies that are leaders in their sectors. Learn more about them on the pages that follow.

ABB strongly supports the Smart Cities Council's goals of livability, workability and sustainability"

"Cities today are home to over 50 percent of the world's population and account for 80 percent of global GDP. By 2050, an additional 2.9 billion people will be living in cities, and urban dwellers will represent 70 percent of the world's population. About 90 percent of this growth will be in developing economies as people are drawn to urban areas by the perceived economic advantages. These cities will need new and intelligent infrastructure to meet the needs of their citizens and businesses.

Other cities that are not facing dramatic population increases are setting goals to ensure their long-term prosperity. With businesses and workforce becoming increasingly mobile, they are shaping their futures around competitiveness, liveability and sustainability.

An effective way to support these city goals is by using technology to more intelligently monitor, optimize and control key systems and infrastructure. In other words, to operate as a 'smart city'.

Many intelligent power and automation solutions already exist to enable cities to automate their key public and industrial services in the areas of:

- City Communication Platforms
- Electricity Grids
- Water Networks
- Transport
- Buildings
- District Heating and Cooling

ABB's heritage in power and automation is one of continued innovation and delivery on behalf of our customers, spanning over 125 years. Our products and solutions are at the heart of a city's critical infrastructure, relied upon for everything from the supply of power, water and heat, to the automation of factories and the buildings we live and work in."

ABB Smart Cities portal

Smart Cities >

ABB Smart Grids portal:

Smart Grids >

As a leading producer of smart technologies and services, Alphinat is pleased to contribute to the Smart Cities Council Readiness Guide and other materials to help accelerate the move to smart, sustainable cities.

Alphinat is a software editor of SmartGuide® the leading "one stop" Web, Mobile and Cloud Solution Development Platform that enable cities to easily create, deploy and manage intelligent personalized web applications. With our partners we are looking to give client cities constituents a simpler user experience that can, guide them to an optimal experience in a mobile or traditional browser-based environment. SmartGuide provides organizations and other software editors with the agility to quickly deliver efficient online services to their stakeholders unleashing the full value of existing IT assets. An Alphinat partner is delivering intelligent e-services for municipalities in the Netherlands in SaaS and on-premises modes incorporating SmartGuide® into their suite giving municipal clients the ability to quickly deploy intelligent online services. Citizens no longer need to fill in data already known to the government. Furthermore, these online services are accessible on Smartphone or tablets. SmartGuide allows municipalities to deliver e-services with personalized, real time data exchange. With these intelligent e-services, municipalities greatly enhance the quality of their online service delivery and increase citizen satisfaction. The e-services offered automatically determine whether a citizen is entitled to a particular service such as a tax refund or a parking permit. These complex real-time validations delivered by the digital service bureau result in tremendous time savings for citizens and the community. Alphinat technology can benefit city of all sizes by helping them modernize, automate and render cost-effective a many business processes at a fraction of the cost associated with conventional customized solutions. Alphinat is headquartered in Montreal, Quebec, with offices in Paris, New York and Zurich. For more information, visit http://www.alphinat.com or http://www.alphinat.com/en/files/Alphinat_DGME_Case_Study.pdf.

GRID20/20, Inc. wholeheartedly endorses and supports the Smart Cities Council efforts to enhance our world's metropolitan areas through more efficient, productive, enjoyable, and sustainable living experiences.

GRID20/20, Inc. provides electric utilities with essential Distribution Transformer Monitoring. Using a patented hardware device known as the OptaNODETM DTM GP, we capture a robust set of data points such as Energy, Current, and Voltage from transformer assets. Each OptaNODETM DTM GP device carries onboard communications module options including GSM, and RF Mesh for a virtual plug and play experience, and RF LAN for autonomous collaboration with a predominant AMI provider. The GRID20/20 turnkey solution includes highly accurate patented hardware sensing, a DNP3 headend repository for SCADA, MDM, or AMI collection engine integrations, plus OptaNODETM INSIGHT advanced analytics.

The OptaNODETM DTM GP device is the easiest to install in the world. GRID20/20 provides a wide range of value propositions addressing Asset Loading, Power Theft Identification, Outage Notification/Restoration Enhancement, Conservation Voltage Reduction, Peak Contribution for Targeted Demand Response, Bi-directional energy recognition from distributed generation sources, and Preventive Maintenance awareness. GRID20/20 drives critical, timely management data from within the heart of the distribution grid to utility operators. The ROI benefits are supported by direct and immediate cost savings, and enhanced electric customer service experiences.

GRID20/20 website >

Integrated distribution transformer monitoring for advanced grid intelligence.

Learn more >

As a leading provider of smart technologies and services, Invensys is pleased to lend its expertise to the Smart Cities Council's efforts to support and educate city leaders, planners and citizens.

Invensys is a leading global provider of automation and information technology, systems, software, and services to the infrastructure and manufacturing industries. Through our Wonderware® software product line and partner ecosystem, we provide unique, modern industrial software solutions and systems that help improve critical infrastructure operations for cities of any size. These solutions help cities and municipalities provide essential, life-sustaining services like clean drinking water, sanitary wastewater treatment, reliable electricity, safe and efficient transportation, and many other services.

With Wonderware software, cities are able to utilize critical data to make better, faster decisions, and they can design response mechanisms that promote efficiencies based on economic and environmental considerations. They can securely manage their entire infrastructure systems from ONE integrated platform, viewing real-time operational information of practically any kind from anywhere at any time and provide it to anyone. Invensys Wonderware software's flexible, open, scalable software architecture integrates and connects with virtually any legacy system, allowing cities to leverage existing investments and build on in-place infrastructure. At Invensys, we are committed to helping cities transform their operations – to be smarter, more sustainable and more innovative now and into the future.

Invensys Site

Learn more >

Smart and Sustainable – Spanish Ecocity Valdespartera

Learn more >

Wonderware Software Solutions for Smart Cities

Learn more >

Carson City Public Works Leverages Smart City Technology in the U.S.

Learn more >

MaxWest Environmental Systems Inc. is a leading renewable energy company that offers local governments and private wastewater treatment companies a safe, cost effective and environmentally friendly alternative for sustainable biosolids disposal. To achieve this, the MaxWest Gasification System captures wastewater biosolid's energy, reducing its volume by over 95% and potentially benefiting from future greenhouse gas and carbon credits. It is the first full-scale commercialized gasification technology that converts biosolids into green, recyclable thermal energy, provides a long-term stabilized biosolids cost, reduces the production of greenhouse gases and improves the facility's carbon footprint.

Municipalities face unique challenges of serving federal, civilian and dedicated environmental groups that require operation within tightly controlled budget constraints, meeting increasing environmental regulations and maintaining a positive relationship with members of the communities which they serve. A biogasification system allows them to save costs while meeting emission requirements and enhancing sustainability.

Learn more >

Cities facing regulatory and environmental issues relating to biosolids management and disposal will want to know how Sanford, Florida worked with MaxWest Environmental Systems to create a biosolids gasification system expected to result in long-term cost savings that could reach $10 million.

Learn more >

As a leading producer of innovative technologies and services, Opower is pleased to lend its expertise to the Smart Cities Council's efforts to support and educate city leaders, planners and citizens.

Working with 85 utility partners and serving more than 18 million consumers across seven countries, Opower is the world's leading provider of customer engagement solutions for the utility industry. By providing the tools, information and incentives consumers need to make smarter decisions about their energy use, Opower's engagement platform and solution suite, Opower 4, enables utilities to involve their customers in programs that support energy efficiency goals, smart grid and new rate structures, brand loyalty and lowering the cost of service. Proven to drive behavioral change at scale, Opower has helped its utility partners achieve more than 2.7 TWhs in energy savings, and drives significant increases in customer program participation and overall customer satisfaction. Founded in 2007 and privately held, Opower is headquartered in Arlington, Virginia, with offices in San Francisco, London and Singapore.

Opower website >

5 Universal Truths about Energy Consumers.

Learn more >

Behavioral demand response.

Learn more >

As the world's leading car sharing network, Zipcar is pleased to lend its expertise in smart transportation to the Smart Cities Council's efforts to support and educate city leaders, planners and citizens about the need for innovative and efficient technologies and services.

Founded in 2000, Zipcar operates the world's leading car sharing network with operations in urban areas and college campuses throughout the United States, Canada, the United Kingdom, Spain and Austria. Zipcar provides the freedom of "wheels when you want them" to its members by giving them a convenient, cost-effective and enjoyable alternative to car ownership. Since inception, Zipcar has been invested in bringing smart, simple and convenient transportation solutions to cities and campus and continues to be at the forefront of an evolution in urban transportation. Zipcar's self-service vehicles are available on-demand in conveniently-located reserved parking spots in neighborhoods where members live and work. Members can reserve cars, choosing from 30 different makes and models, by the hour or by the day at rates that include gas, insurance and other costs associated with car ownership. Zipcar is a subsidiary of Avis Budget Group, Inc. (Nasdaq: CAR), a leading global provider of vehicle rental services. More information is available at www.zipcar.com.

2013 Millennials & Technology Survey results:

See results >

SunGard Public Sector is a leading provider of software and services for local governments, public safety and justice agencies and nonprofits. More than 150 million citizens in North America live in municipalities that rely on our products and services. For more than 30 years, SunGard Public Sector has leveraged ground-breaking technology and our innate understanding of the needs of the public sector toward the development of public administration and public safety software. SunGard Public Sector's products enable our customers to experience the future happening today. Visit us online at www.sungardps.com.

SunGard Public Sector's software products not only enhance the way municipalities, public safety and justice agencies, and nonprofits conduct business—they redefine the way citizens and employees interact with government.

Leesburg, Florida has been a model for community-centered government for over 150 years. Just hours from the heart of Orlando, the community that made a name for itself in the citrus industry is now a full-service city responsible for providing utilities not only for itself, but for parts of the county as well. To manage its workload while maintaining efficiency, Leesburg has chosen SunGard Public Sector's Click2Gov Customer Information System. Click2Gov offers up-to-date, online views of customer utility accounts. Citizens may now easily view their account information and make their monthly payments by choosing from several convenient payment methods, including over-thephone, bank drafts, or online.

Read more >

The City of Elk Grove is located just south of the state's capital, Sacramento. Because of its small size, city officials knew they did not want to employ a large IT staff to operate its information systems. Elk Grove needed one simple system that could be accessed by all the departments. The solution was SunGard HTE's Naviline software, powered by IBM's System i hardware.

Read more >

SmartCitiesCouncil

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