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# Building and Managing an Intelligent City

How new strategies, technologies, open platforms and effective governance can help create cities that are sustainable and attractive to ongoing development

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# Foreword

In a world of shifting economic power, dramatically changing demographic patterns and long-term resource pressures, cities are emerging as critical points of action and transformation in the global map.

With more and more of the world population living in cities, their potential to impact the quality of life of populations, shape economic activity and stimulate sustainable growth is becoming ever more clear. In parallel the potential for challenges arising from over-crowding, resource exploitation and economic polarization is also rising. As cities increasingly compete for citizens, enterprises and investment in an interdependent multi-polar world, the bar is also being raised on the intrinsic capabilities, facilities and capacities to enable long-term, sustained development.

This document describes Accenture's point of view on how "Intelligent Cities" can be created to respond to these opportunities and challenges. Our perspectives are garnered from our experience working with projects and programs in this space around the world and watching as city leaders grapple with positioning their locations to compete. They are doing this in the midst of a wave of technological change, with pervasive Internet, mobility and cloud technologies converging to transform the ways that citizens want to work and live. As a result, the concept of citizen-centricity is increasingly important as the connections between citizens and the providers of services become more direct—and the need for responsiveness, transparency and agility rises.

The demands of a resource-constrained planet—and the expectations of people with regard to the sustainability of the environment in which they live—are driving change and the requirement for new levels of efficiency and innovation. Emerging-market cities are growing at a tremendous pace and many are looking to leapfrog to new models; while in the developed world the requirements for integration, connectedness and adaptability need to be retrofitted on legacy infrastructures.

We believe the combination of technology intelligently applied to clear strategic intents by city leaders can transform and accelerate progress toward the vision of sustainable urbanization. The solutions need to be pragmatic and modular, and build on proven frameworks and architectures. The technologies are maturing fast, as is the readiness of citizens to take advantage of this progress. The blurring of home and work lives and the devices and tools that increasingly straddle these environments create huge opportunities. Green city programs are proliferating and urban planners and strategists are

grappling with how to create scalable implementations of ideas that have been relatively small pilots to date.

Accenture sees an opportunity to take an end-to-end approach and, by combining clear strategy, integration, open platforms and modular solutions in a collaborative environment of partnerships, make a real difference. Many cities can begin to see the vision of intelligence and sustainability that they aspire to; our intent is to create a clear roadmap as to how to accelerate movement toward these goals. Not through technology for technology's sake but through wise application of business, technology and people in workable solutions.

**Mark Foster**
Former Group Chief Executive,
Accenture Management Consulting

# Building and Managing an Intelligent City

A city capable of becoming both environmentally sustainable and attractive to citizens and businesses requires a new kind of intelligent infrastructure—an innovative, open platform based on smart technologies that can help forward-looking cities more predictably integrate a complex suite of services cost-effectively, at pace and at scale.

## Executive overview

### The influence and responsibilities of the modern city

A century ago, only about one in seven of you reading this report would have been living in a large urban area. Today, half of you are, and that percentage is growing steadily every year. As the world's population increasingly migrates to major urban centers, the influence of cities on the planet—their technologies, businesses, forms of government, resource consumption, the quality of life they enable and much more—rises to greater and greater levels.

Large concentrations of people can have a positive influence on humanity: personal and professional opportunities, stimulation of local and national economies, high productivity, and an environment for creativity of many sorts. At the same time, because of their power and influence, these large concentrations of people also pose risks to the planet—overcrowding, excessive carbon emissions and waste, and high rates of consumption of non-renewable resources. Thus, cities—city governments as well as the businesses that drive much of the growth of a city and its citizens—bear great responsibility for the effective stewardship of people and the environment.

This need to create a responsible, sustainable living environment exists side by side with another important goal: the need to create an attractive economic and social environment in which citizens, companies and government live, work and interact. Because of the mobility of the world's population, both within and across nations, cities are actually competing for citizens and enterprises, much as a business competes for customers. What becomes increasingly important, then, is the overall attractiveness of a particular city and the experience it provides to citizens and businesses: its economic opportunities, cultural diversity, safety, healthiness, ecological effectiveness, efficiency of city services and other important characteristics.

Call this situation for cities one of establishing "competitive responsibility". Becoming attractive to business and citizens to maintain economic viability, while guiding ongoing initiatives according to the principles of sustainable development. These dual goals are at the heart of what we call an "Intelligent City."

### Becoming an "Intelligent City"

For a city, what does "intelligence" mean? Every city is unique, of course, with its specific characteristics in terms of geography, demographics, economic context, culture, political system and legacy infrastructure.

Yet each city has common capabilities and delivers some set of common services, as well:

- Office and residential buildings
- Natural resource management
- Transportation
- Health and safety
- Waste management
- Education and culture
- Public administration and services

One important characteristic that distinguishes an Intelligent City is the manner in which it delivers services using advanced technologies: an integration of a number of innovations including machine-to-machine communication enabled by telematics, sensors and RFID technologies; smart grid technologies to enable better energy production and delivery; intelligent software and services; and high-speed communications technologies that serve as a core network for all related city, citizen and business services.

However, as cities have attempted to apply these technologies to improve the effectiveness and efficiency of their services, many have taken a fragmented and limited approach when it comes to infrastructure and technologies. This means they are getting only a percentage of the potential value of their technology-based services, and are also at risk of being unable to grow and integrate those services cost-effectively as technologies evolve.

Critical to the success of an Intelligent City is combining a coherent and specific vision along with the right kind of technology platform to enable the optimal integration, delivery and management of city services over time. We call this capability an "intelligent infrastructure"—an open, standardized and scalable platform that provides the interface between service supply and citizen demand, and that integrates the multiple partners that make up the complex set of solutions and services. Because the platform is modular, intelligent services can start from a manageable size and then scale as necessary. As technologies and solutions change, new components of the overall infrastructure can be replaced with minimal impact on quality and delivery.

This intelligent infrastructure delivers a host of important benefits, including:

- Higher-quality and more consistent services to citizens and businesses.
- Lower total cost of ownership through reduced need for customization, better vendor management and less redundancy.
- Improved resiliency and ability to adapt to current and future risks including aging infrastructures, growing populations and climate change.
- Access to open innovation and continuous learning.

## Taking intelligent action

Many cities have already launched programs to address their economic, environmental, social and governance challenges and to enhance their competitiveness and attractiveness. However, in spite of a number of strong examples around the world, overall implementation progress has been slow and carbon emissions from cities continue to increase.

Too often, these programs—though well-coordinated—involve only a few departments within a city. Less apparent is whether cities are putting in place a flexible, integrated and open infrastructure that will enable them to scale their intelligent capabilities to reach intended outcomes (e.g., reductions in carbon emissions) and cost-effectively manage future initiatives. Taking a long-term view is essential, since city infrastructures represent a long-lasting set of physical assets. The rate of change for a city's buildings is only 1 percent to 2 percent per year; decisions made today may last generations, so careful and integrated planning is essential.

At the same time, as the environmental impact of cities grows, executives and planners need to act now if cities and nations are to work together effectively to reduce the risks of resource depletion, environmental degradation and congestion that can accompany unmanaged urban growth. Coordinated actions across all city departments and services—supported by an open intelligent infrastructure and integrated management—will be essential to creating a city that is able to compete effectively for people, resources, businesses and investments.

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# Introduction: Managing the challenges of urbanization

The dominance of the "city" is a fairly recent development in human history. Human populations until quite recently lived primarily in rural environments. In 1800, only 3 percent of the world's population lived in urban areas; a century later, that number had grown only to 14 percent. Inexorably, population distribution since then has shifted toward cities. In 2008, the world passed a milestone in that, for the first time, its population became evenly split between rural and urban areas, and urban concentration is now relentlessly on the rise.[1]

The urbanization of the world's population appears to be an unstoppable phenomenon. According to United Nations forecasts, the proportion of the human population residing in cities is expected to grow to nearly 60 percent by 2030 and to almost 70 percent by 2050. Already, just in Asia, 40 million people are added to city populations each year.[2]

This concentration of humanity could be a source of cultural, political and economic strength; cities act as talent magnets and incubators of innovation and are generally the chief engines of economic growth. The top 25 global cities already account for more than half of the world's wealth. In developing nations, cities account for between 65 percent and 80 percent of national gross domestic product (GDP). Sao Paulo, the largest city in Brazil, and Bangkok, the capital of Thailand, each account for about 10 percent of their respective country's population, but more than 40 percent of its GDP. Tokyo's GDP per capita is more than three times that of the rest of Japan. In China, population migrations are expected to bring more than 350 million more people to cities in the coming years.[3]

## Creating a sustainable city

At the same time, sprawling urbanization comes with significant risks. Chief among these are pressures that rapidly rising populations have on aging infrastructures: gas and electric utilities, water supplies, waste management and transportation infrastructure. Cities generate almost 70 percent of the world's $CO_2$ emissions and are also the prime sources of other air and water pollutants. Because of their large populations, cities consume significant percentages of the earth's non-renewable resources and also produce large amounts of waste. Although many cities offer better conditions in terms of clean water and sanitation than can be found elsewhere in a country, in fact between 25 percent and 50 percent of the population in developing-nation cities live in overcrowded slums that put people's health at risk. Around the world, more than a billion people live in cities where pollution exceeds acceptable levels and where fresh drinking water is inaccessible.[4]

Energy security is also important. As expanding populations and lifestyle changes result in increased demand for energy (for example, the number of cars sold in China rose 46 percent in 2009[5]), no city can take its resource supply for granted. The health of large populations will depend on sustainability initiatives to reduce greenhouse gas emissions, deliver safe water supplies and dispose of waste effectively.

## Creating an attractive and competitive city

Although managing the potential problems of urban growth is critical to all cities, equally important is managing the overall experience of city life to create an environment to which people and businesses are attracted.


Figure 1: Multiple characteristics go into making a city attractive to citizens and businesses

Because of the mobility of populations and the ability of businesses to work from almost any location, the world is now an open playing field. Cities will increasingly compete for citizens and businesses not just within their nations but across the world as they seek to become and remain globally attractive. This competition takes at least four forms:

- Competition for business: Creating an appealing environment for businesses and entrepreneurs that help to generate economic wealth.
- Competition for public and private expenditures: Competing for funding—the investments that create jobs and stimulate growth.
- Competition for residents: Attracting a diversity of citizens, including the well-educated, entrepreneurial and affluent residents who can stimulate innovation and new sources of growth.
- Competition for visitors: Competing for visitors, both tourists and business travelers.

In other words, we have entered an era of "competitive responsibility" in the way cities should be planned and managed. Accenture believes that the cities that will thrive in this era are what we call "Intelligent Cities"—those capable of achieving and maintaining two important goals simultaneously: (1) reducing the negative impact of people and businesses on the environment, and running government and services in a sustainable fashion; and (2) creating an attractive economic and social environment for growth in which citizens, companies and government live, work and interact. The two goals are closely interconnected, since it is in part the ability of a city to be environmentally safe that creates a large portion of the city's attractiveness.

# Enablers of the Intelligent City

The technological foundation of an Intelligent City is an intelligent infrastructure: the ability to embed intelligence in city operations, making the drive toward sustainability and attractiveness more standardized and industrialized.

## Technology-based infrastructure

The technological foundation of an Intelligent City is an intelligent infrastructure— the ability to embed intelligence in city operations, making the drive toward sustainability—and attractive services and living environments—more standardized and industrialized. Smart technologies, which include innovations such as machine-to-machine communications, sensors, intelligent software and analytics, enable a range of critical capabilities such as improved efficiency of electricity, water and gas usage.

The intelligent infrastructure is both analog and digital. That is, in addition to the physical infrastructure—roads, buildings, rail, power and utility grids—an information and communications technology infrastructure serves as the basis for most of the monitoring and optimization capabilities of an Intelligent City, and for the interaction between citizens and service providers.

These technologies provide essential communications, education and entertainment to citizens—a kind of window to the world—but equally important is the foundation of the various intelligent features whereby technology takes the place of human intervention in key areas of monitoring and management. Communication technologies integrated with sensors ultimately enable a kind of "sense and respond" capability of a city, and maximize the synergies of the various parts of a city's life. One can see this kind of capability already in cities where linked networks of cameras and sensors throughout an urban area can track weather conditions, traffic flow and other things such as criminal activities.

Sensors can also enable cities to reduce traffic congestion (and generate additional revenues) through congestion pricing. For example, in Stockholm and London, zones have been created where an additional fee is collected from vehicles entering a congested city center. This toll is charged automatically using electronic toll collection or automatic number plate recognition, since stopping the users at conventional toll booths would cause long queues and delays. Singapore has gone one step further and launched a program for dynamic road pricing to adjust incentives in real time.[6]

Another innovative example of intelligent, sense-and-respond technology is the use of audio sensors attached to rooftops and telephone poles that can detect when a gun is fired and pinpoint the location, enabling police to respond without the need for citizen intervention. Chicago, along with 30 other US cities, currently uses such audio solutions.[7]

The US city of Wilmington, North Carolina has launched a pilot whereby cameras and sensors will help the city analyze and respond to real-time data about traffic congestion, fuel consumption, water quality and sewage capacity.[8]

## Strategy

Intelligence drives the growth and planning of intelligent cities at a strategic level. An Intelligent City does not evolve "naturally" but only with careful planning. City planners must take a 360-degree view of all relevant social, economic, cultural and resource-related components of the city. Development in any one area is closely coordinated with each of the others, with special attention to potential unintended consequences. For example, the congestion toll discussed earlier might be effective at reducing the number of cars entering a city, but might also put an unfair burden on people at lower income levels.

## Management and governance

Intelligence also needs to be embedded into the management and governance of cities. Intelligent cities manage the disparate elements of city government and services more effectively—in a more integrated fashion, overcoming the silos and lack of communication that often interfere with the value delivered by city services. They put in place an integrated governance structure covering multiple city departments such as energy, water, waste, building, transportation and culture to drive the sustainability agenda in a coordinated way.

Within the governance aspect of the common Intelligent City platform are several other important supporting components that act as enablers or catalysts of an Intelligent City:

**Regulatory and policy frameworks:** The diverse and growing challenges that modern cities are facing require transformational change—strategies and approaches different from those

that cities have typically leveraged. New policy approaches are critical in that many of the specific technologies needed to address cities' environmental and social challenges already exist, yet implementation is slowed because policies have not kept up with the potential of leading-edge technology-based solutions. As noted earlier, the sensor technology that can enable congestion-related tolls on vehicles is available today; but what is a city's policy toward this capability? Might it discriminate against lower-income citizens? What are the consequences to city life (and to a politician's electability) of such technologies? City governments must have in place the right mechanisms to support innovation and experimentation, not simply react to crises, especially as different parties need to come together to collaborate toward common goals.

**Financial incentives:** Because an Intelligent City is concerned not only with theory but also with actual behavior change among leaders and citizens, incentive frameworks are especially critical. Creating proper incentives, including taxes and subsidies, involves defining new concepts that are economically viable and that effectively align the goals of city leaders and private partners.

The design of new financial models should be an integral part of the Intelligent City common platform. A good example of more effective incentive models is the feed-in tariff, used as a policy mechanism in more than 60 countries around the world to encourage the adoption of renewable energy. A feed-in tariff, which can be supported at different levels—city, region, nation—guarantees the owner or developer of a renewable project access to the power grid and a long-term contract for the electricity produced. For example, in Denmark, a successful feed-in tariff policy has led to more than 20 percent of the nation's electricity coming from wind power.[9]

**Partner ecosystem management:** The intelligence that is the goal of a 21st-century city requires new forms of partnerships among the private and public sectors, overcoming the different mindsets and agendas that have often prevented effective collaboration. Cities must play a leadership role in ushering in this new era of collaboration by encouraging things such as task forces where industrial and academic leaders can share innovative ideas, and working groups where citizens can share best practices with city representatives or companies.

Cities are increasingly aware of the power and influence they can have if they band together. For example, in preparation for the 16th edition of Conference of the Parties of the United Nations Framework Convention on Climate Change (COP 16) in Cancun in 2010, a large group of megacities—now called the C40—united to claim a seat at the climate negotiations table based on their common belief that they are key to the solution of the world's carbon emissions challenges.[10]

# Intelligent city archetypes

Each city is unique from a geographic, demographic and economic standpoint. Consequently, cities are not equal when it comes to their impact on the environment, positive or negative. That implies, then, that cities will need to assess what their current impacts are before they can move effectively into the Intelligent Cities era. Based on our research and experience however, we can group them in different categories or archetypes of cities based on their current level of environmental impact, history with sustainability initiatives and efforts to promote attractiveness. Identifying a city's current status can help suggest a more realistic path toward the ultimate goal of becoming an Intelligent City.

"Pioneers" have already embarked on the journey to decrease their energy consumption by pursuing alternative energy sources and reducing their overall carbon footprint. They are actively considering technology-based solutions such as smart grids to drive decentralized energy production, a higher share of renewables with better demand management, either new or retrofitted smart buildings plans, and pilots or deployments of dynamic mobility solutions.

"Legacy Cities" are those that are also working to reduce their emissions levels—which are generally in the low to medium range—but have not yet begun comprehensive, large-scale programs to enable them to embrace the same ambition as Pioneers.

"Cities at Risk" generate relatively lower levels of pollution, but face significant "congestion" challenges to their near-term growth plans because of inadequately managed, rapid economic development. These cities also have an expanding population that is putting additional pressure on the environment through fast, uncontrollable growth of private-vehicle fleets, unmanaged building construction and rapidly rising energy consumption.

"Fast Adopters" are cities that are growing rapidly—such as urban areas in China—which aim to leapfrog towards the Intelligent City model to manage hypergrowth without falling into the congestion trap.

"Large Emitters" are the megacities with the most disadvantaged starting position, based on their legacy energy and transport systems. Such cities need to engage in a series of initiatives to decarbonize their energy mix as the size of the problem requires extensive supply transformation.

# Intelligent City pioneers

Around the world, our research and experience highlight many pioneering cities (for city archetypes, see sidebar) that are engaged in innovative initiatives to improve their competitiveness and attractiveness to citizens. For example, many city leaders are setting ambitious environmental and mobility targets. Regarding $CO_2$ emissions, a number of cities have committed to specific reduction target goals, though the magnitude of their ambition varies greatly. Among the cities Accenture research has benchmarked, Amsterdam is one important example of a city that is significantly committed to reducing its carbon footprint. The city has set a $CO_2$ emissions reduction target of 40 percent of its 1990 level by 2025.[11] (For more, see sidebar, "Making Amsterdam Smarter.") Moreover, many cities committed prior to COP16 to communicate their new emissions targets, and several Chinese cities have embarked on aggressive emissions reduction plans without necessarily publicizing their intended targets. In Japan, Yokohama aims to aims to reduce its GHGs emissions per person to 30 percent of its 2004 level by 2025.[12]

When it comes to the transportation domain, which is at the heart of the congestion problem in all large cities and not only an emissions contributor, cities are setting specific targets for improved performance. Singapore, which is already a global leader in public transportation usage, has set a target by which, by 2020, residents will make 70 percent of all morning peak-hour trips on public transportation, with at least 85 percent of public transportation commuters completing their journey within 60 minutes.[13] Shanghai wants to raise the proportion of trips taken by residents on public transportation to 50 percent in the central city, with most residents making the trip within one hour.[14] And Seoul aims by 2020 to increase the use of public transportation to 70 percent, the use of bicycles to 10 percent and the share of green vehicles used by residents to 20 percent.[15]

# Making Amsterdam smarter: Living in an Intelligent City

Consider one example of how a city plans and manages itself intelligently across the various service domains of an Intelligent City. Amsterdam is in the midst of an ambitious program to become the first Intelligent City in Europe. The goal of the project is to develop and implement sustainable and cost-effective programs that will help Amsterdam reduce its carbon footprint while exceeding the carbon reduction targets put forward by the European Union's 2020 emissions and energy reduction targets.

The program actually has three primary objectives in terms of environmental impact: A 40 percent reduction in $CO_2$ emissions by 2025 (using its 1990 baseline, twice the European objective); reliance on 20 percent renewable energy by 2015; and achieving total $CO_2$ neutrality by 2015.

Accomplishing these objectives involves bringing together various technologies and approaches that include smart meters, smart grid, electric vehicles, and intelligent building design to promote energy efficiency in the residential, commercial, public and transportation economic sectors.

Looking at the citizen outcomes to be produced from the initiative, four are primary:

**Sustainable living:** Reducing carbon emissions generated by citizens through awareness programs, supporting behavior changes, and encouraging energy efficiency through technologies such as smart meters.

**Sustainable working:** Reducing carbon emissions generated by businesses by increasing building efficiency and by adopting "smart building" technologies that can reduce the carbon intensity of business processes.

**Sustainable mobility:** Reducing carbon emissions from transportation by increasing the percentage of vehicles with a lower carbon footprint (e.g., electric vehicles), and by changing transportation patterns and behaviors.

**Sustainable public spaces:** Reducing emissions associated with public spaces by, for example, installing more energy-efficient lighting.

Amsterdam has carefully considered the phases of work to maximize impact and to leverage the lessons in one phase or pilot in later efforts to scale the program. City planners acknowledged the importance of bringing citizens and city employees along in the process—helping to develop the understanding, partnerships, citizen engagement and capabilities to take successful projects forward at scale.

The city began with a two-year program to be implemented in three phases. City executives used a rigorous selection process to identify the right set of projects to deploy during these phases. Projects were evaluated on the basis of feasibility, costs and carbon reduction potential.

The first of the city's smart grid measures was launched in 2009. Smart meter installations were included within the first phase of work, along with an innovation called "Climate Street." This area, within the popular Utrechtsestraat shopping and dining area in Amsterdam, features sustainable waste collection, numerous energy generating tram stops, and highly efficient streetlights. City managers are able to monitor energy consumption on Climate Street through the use of smart meters and to share their findings with business owners.

Keys to the success of this Intelligent City initiative in Amsterdam include:

Integrating the multiple components of the Intelligent City service domains across city departments including energy, water, well-being, transport and buildings. Enabling technology capabilities across city departments is also critical; this integration includes communications and data, sensing and control, and customer-facing hardware and applications. These technology capabilities are a critical dimension of making a city "smart"—enabling it to maximize carbon reduction and supporting better coordination with other parts of city government overseeing employment, investments and tourism.

A smart grid infrastructure—fueled by a 100 million euro investment by electricity provider Allander—that will provide the core technology foundation.

A private and public sector consortium to develop and deliver low carbon incubator pilots as part of a three-year, 1.1 billion euro program that will begin by piloting key Intelligent City concepts, but then will scale the program across the city.


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# Challenges to becoming an Intelligent City

However, while these and many other leading examples of civic innovation and planning exist around the world, most cities face numerous challenges as they match traditional operating and management models against the unique needs of 21st-century urban environments.

First and foremost, the realities of city government and the way city departments are structured mean that even the best initiatives may deliver suboptimal returns because these are conceived and implemented in a siloed or piecemeal manner. The greater challenge is really in getting disparate parts of a city government to act in harmony toward a common goal. Effective single examples of initiatives often arise, but because of the lack of coordination, these never reach the scale that would show the potential for widespread, positive impact. This fragmented situation is partly the result of organization structures and mindsets, which can discourage collaboration through reward systems based on the performance of individual departments, rather than on how well those departments work together for the greater good. Moreover, the limited technology capabilities and infrastructure in most cities add to this organizational disadvantage.

Second, initiatives tied to sustainability issues often face difficulties in maintaining focus across administrations. Rather than being "owned" by a city generally, some such initiatives become tied to leaders within a particular administration—meaning that progress can be slowed or reversed if an administration changes before results are delivered, as priorities shift under economic and political realities. One example of this kind of political challenge is in the stops and starts of high-speed train programs in the United States, which have sometimes been proposed in one administration, then derailed by competing priorities in subsequent administrations.

Third, in spite of civic leaders' best intentions, constituencies have competing interests that can derail the best of programs, and the basic infrastructure for delivering essentials like sustainable energy resources may hamper efforts. For example, in geographic areas heavily dependent on the use of coal to generate electricity, cities and businesses find themselves extremely hampered in making significant reductions in their carbon footprints because commercially viable alternatives are not yet available at scale.

Fourth, the businesses on which cities depend for economic growth need to retool their own capabilities to operate in a more sustainable world, and also to learn how to operate effectively in a private-public partnership mode. Recent research conducted by Accenture in conjunction with the United Nations found that most companies struggle to embed sustainability principles into their supply chains, to attract talent with the skills in sustainability management, and to convince the financial community that their efforts in support of a sustainable world should be recognized in shareholder value.[16]

Finally, involving citizens and enlisting them as supporters can be a complicated and even vexing matter. Many of the environmental, social and governance issues of an Intelligent City require more than simply "assent of the governed"; they require changed behaviors such as new consumption patterns. For example, experimentation with smart meters in both North America and Europe has highlighted the risks of rejection of such innovations because of concerns about privacy and anxiety about "Big Brother" government oversight. As yet, no city has quite figured out the right combination of communications, information, incentives and policy changes that need to be in place for people to not just understand what is happening, but to embrace things like sustainability objectives in a way that makes them want to behave differently.

# Creating an open platform for effective integration and scalability of Intelligent City capabilities

One of the most important contributing factors to the fragmented nature of many current approaches to becoming an Intelligent City is a city's legacy technology environment, which is usually the result of proprietary, closed infrastructures and technology systems. Information systems and physical infrastructures often come into being on an ad hoc basis—based on the needs of the moment. Over time, these systems take on lives of their own; those within one city department become costly to maintain and integrate with other related departments. The negative impact of this fragmentation can be felt in excess costs, diminished services and an infrastructure that is not agile enough to adapt to the needs of the future.

Accenture believes, therefore, that one of the most important enablers for an Intelligent City is an open, interoperable and scalable platform that provides intelligent infrastructure functionality as a service and allows for optimal resource management. (See Figure 2.) This open, intelligent infrastructure has several critically important characteristics for the future of cities around the world:

First, it is based on a philosophy of open innovation, partnering and cooperative models across the public and private sectors. It therefore leverages open technologies and architectures, which means that interfaces can readily be created and maintained across all the service domains of a city. The platform allows the aggregation of all services needed in the city—construction and buildings, natural resource management, transportation, health and safety, waste management, education and culture, and public administration and services—in one "smart" system.

The platform enhances operational efficiency by enabling fully automated service interoperability via a central hub. For example, the platform would enable electric vehicles (or e-ticketing systems) to be integrated with a smart grid via dynamic pricing. The integrated, common platform means that areas that tap into common capabilities—for example, traffic management must synthesize readily with urban logistics and mass transit—can interact effectively, avoiding redundancy and waste.

The platform also enhances innovation by enabling service and product combinations, as well as smooth and efficient data exchange. Flexible and cost-effective interfaces mean that multiple contributions from innovation sources around the world can be leveraged as applications on the platform. The city can be managed more

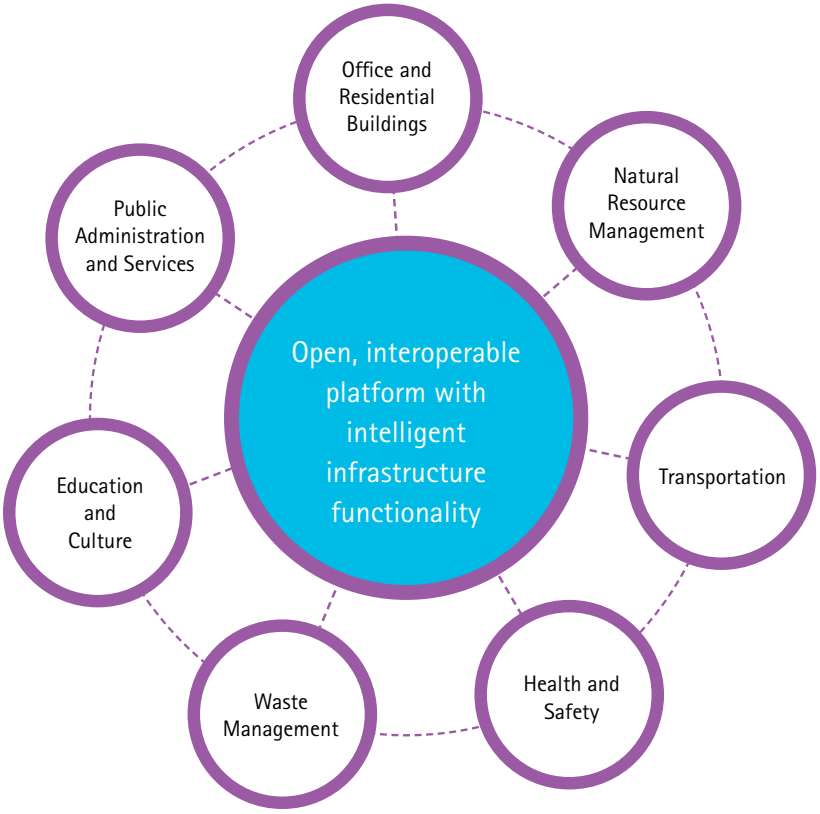


Figure 2: An open platform can integrate and make interoperable the critical components of an Intelligent City

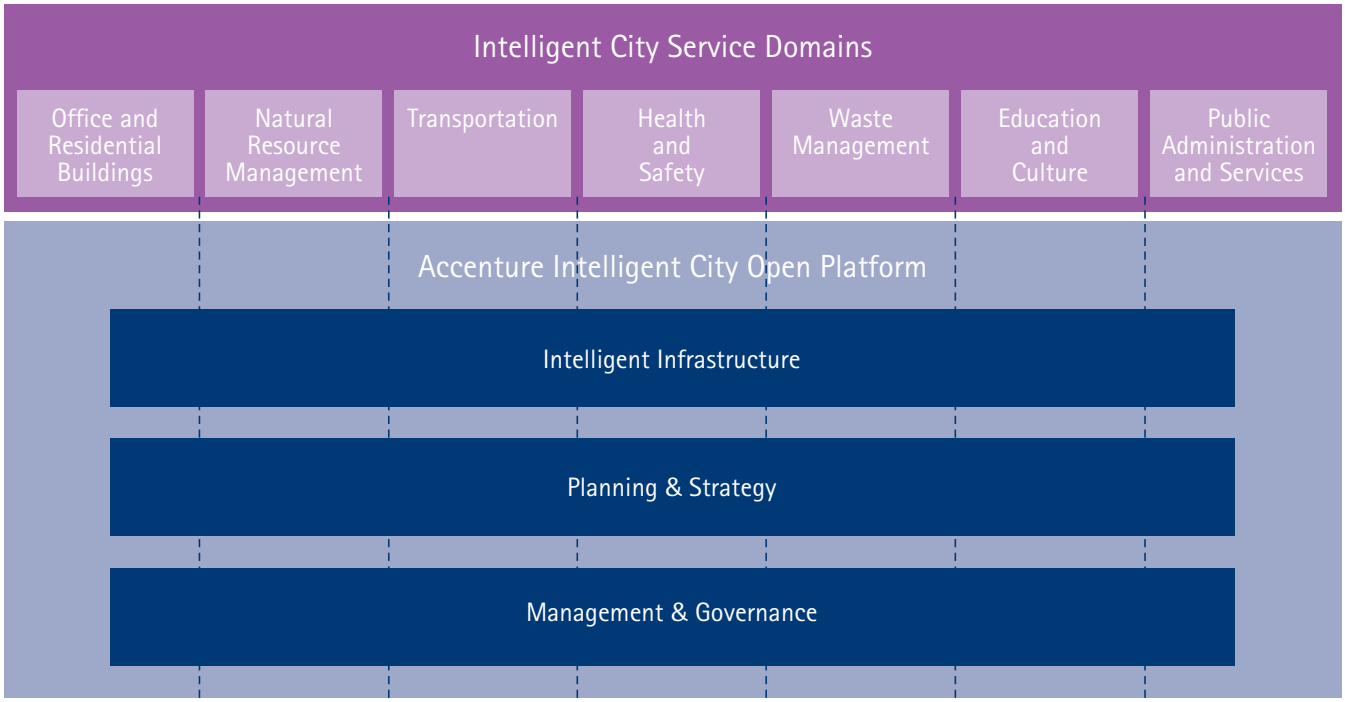


Figure 3: An open platform integrates the technologies, strategies and governance mechanisms across all Intelligent City service domains

effectively because different domains and stakeholders can "speak" the same language. Different solution partners can be brought in, either to compete or collaborate, to provide new city services faster, and then to manage them more efficiently.

Second, because of the use of open standards, the platform is modular and, therefore, more readily scalable. Intelligent services can start from a manageable size—a sub-selection of priority services for each city—and scale from there. And, as technologies and solutions change, new components of the overall infrastructure can be replaced and integrated with minimal impact on the overall structure. For example, renewable technologies for energy provision can be added as demand rises.

Third, the platform enables city services to be delivered in a leaner fashion. The platform offers infrastructure capabilities delivered as a service, ready and adaptable for a city's unique needs, by integrating all relevant services in a single, Internet-enabled utility. This reduces the total cost of ownership for city services—reducing the initial investment, but also lowering the costs of maintenance and operations through usage-based charging.

Added up, the most important overall benefit of this open, intelligent infrastructure is that it is replicable across different city environments. The platform itself embeds within it all the lessons and experience from other implementations; each one includes the wisdom of previous ones in a context of continuous improvement. So solutions can be designed and implemented faster, with whatever customization is needed. And they can also be managed and operated more efficiently, at less cost, than solutions built on proprietary architectures.

## Pioneering examples of open-platform approaches to managing Intelligent Cities

Because the idea of an open platform for intelligent infrastructures is a cutting-edge idea, no city has as yet implemented a broad range of functionalities on an open platform. Nevertheless, looking at a selection of innovative programs from early adopters is instructive. For example, in Europe, a number of private- and public-sector organizations are collaborating on an initiative called Cooperative Vehicle Infrastructure Systems (CVIS). The goal of the project is to develop technologies that enable vehicles to communicate with roadside infrastructure and other vehicles, and to share data about traffic status and the surrounding road environment. This network-wide information, when processed and delivered to drivers, will lead to a reduction in traffic accidents, fewer congestion delays and reduced fuel consumption and pollutant emissions.[17]

CVIS uses a single, open architecture and reference platform that integrates with both vehicle and roadside systems. The communication solution is open and medium agnostic—it provides both direct and networked connectivity using the most appropriate medium available in a given situation. Because of the open approach, CVIS allows different services and applications to be added more readily and to work together collaboratively.[18]

In the Netherlands, technology, civic and research organizations have been collaborating on an extension of CVIS called Strategic Platform for Intelligent Traffic Systems (SPITS). The project is intended to result in a ready-for-market, open platform on which additional applications can be installed as necessary—much as the iPhone accommodates additional applications.[19]

# Intelligent services

An open, intelligent infrastructure makes possible the delivery of city services in a way that keeps in mind an Intelligent City's two primary goals: sustainable development and operations on the one hand and, on the other, maintaining the competitiveness of the city and its attractiveness to citizens and businesses. These dimensions of sustainability and competitiveness require intelligence in the way a city is planned and managed, including a strong and consistent vision, effective coordination and flawless execution.

The following sections describe the seven key Intelligent City service domains (see Figure 3) and discuss how pioneering cities are balancing sustainability and attractiveness in the delivery of the services. Intelligence must be applied across all of the relevant service domains of a city:

## Office and residential buildings

Physical living and working spaces are one of the most obvious material components of a city, with a variety of impacts on the environment and on living conditions. An Intelligent City will increasingly be focused on using sustainable building technologies to create a living and working environment that utilizes fewer resources and generates less waste; cities will also need to adapt or retrofit existing structures to be more energy and water efficient. These technologies then need to be integrated with other service domains.

To reduce the negative environmental impacts of construction and building management, some cities are using building retrofits and certifications that can reduce the usage of energy and water; they are also using smart metering and smart building technologies to help optimize consumption.

Significant energy can be saved by retrofitting existing buildings and homes or by better utilizing information already residing within existing building management systems. Several cities are leading the way in this regard by targeting both municipal buildings and commercial buildings. For example, the unique public-private partnership called EnVision includes the U.S. city of Charlotte, North Carolina, as well as energy companies and high-tech firms such as Cisco. This partnership will help Charlotte reduce energy usage by 20 percent in its 60 largest commercial buildings.[20]

Paris aims to retrofit 20 percent of its municipal buildings, and projects a 12 percent reduction in greenhouse gas emissions by 2020.[21] London launched the Buildings Energy Efficiency Program to retrofit public sector buildings, targeting reductions of 440,000 tons of $CO_2$ per year by 2025.[22]

Residential buildings can also be retrofitted to reduce their negative environmental impact. Chicago, for example, aims to retrofit 400,000 residential homes or units by 2020. Between 2004 and 2008, Chicago saved $6 million on energy costs because of office space retrofitting. In 2008 and 2009, the use of more efficient appliances and energy-saving fluorescent light bulbs has saved Chicago residents more than $12 million on their energy bills.[23]

Another aspect of smart buildings involves optimizing energy and water consumption for the people and businesses occupying the buildings. Pilots in cities such as Amsterdam, Sydney and Chicago are testing advanced smart meters that enable end-users to display real-time data on energy usage and prices. Smart meters and displays show real-time data about when the most energy or water is being used and its cost, helping consumers to identify actions they can take to save resources and money.

Smart meters can also benefit utilities by helping them locate outages more precisely, communicate directly with their customers and use the data to customize their pricing programs. Leading cities and utilities continue to investigate the right combinations of technology, information and price signals that will lead to sustained behavioral change on the part of consumers, and therefore improved conservation of energy and water.

Building codes, standards, and certifications are other important aspects of creating smarter buildings. Many cities are mandating higher efficiency codes and standards for new construction and renovations. For example, Seoul aims to make it mandatory to acquire green building certificates by 2030 for all new buildings. Singapore aims to have 80 percent of its existing buildings achieve a Green Mark Certification rating by 2030.[24] London is mandating energy performance certificate ratings for all workplaces by 2020.[25] Additionally, many leading cities have reduced fees and streamlined the review and approval processes associated with green buildings to further incent innovation in construction.

## Natural resource management

This service domain refers to integrating various kinds of sustainable technologies within the city to reduce the environmental footprint, increase the efficiency in resource supply and demand, and in general to create a healthier living and working environment for citizens. The scope of this domain covers energy, water, food, air and water quality, and the preservation of natural habitats and biodiversity.

In terms of the basic supply of natural resources, many cities are working to reduce the carbon intensity of the energy supplied to their citizens and to improve the reliability and efficiency of their supply and delivery networks.

Centralized electricity generation relying primarily on fossil fuels loses approximately 60 percent to 70 percent of its primary energy in production, transmission, and distribution. By increasing the capacity for more decentralized generation, cities can significantly reduce energy losses. Cities like Sydney, London and Chicago have committed to increasing distributed energy systems, which can significantly improve the efficiency of power delivered.[26]

For example, the City of Sydney plans to implement a network of distributed generators to become independent of coal-fired, centralized energy generation by 2030.[27] The City of London plans to deliver 25 percent of its electricity through decentralized generation by 2025.[28] And the Chicago Energy Plan establishes the goal of meeting 22 percent of new electricity demand from distributed generation.[29]

Another important development is combined heat and power, which is a form of decentralized energy technology generating heat and power on site. It can achieve efficiencies much higher than electricity supplied from conventional power plants and heat supplied by gas boilers. One advanced form—combined cooling, heat and power or "trigeneration"—is expected to result in only 15 percent energy loss, compared with an average 66 percent energy loss for a typical coal-based electricity generating plant.[30] Several examples indicate the potential of combined heat and power to improve the attractiveness of cities. Helsinki's combined heat and power system already generates more than enough electricity to meet the local needs, and 92 percent of the city's district heating.[31] And the City of Sydney has committed to producing 70 percent of its electricity supply from trigeneration by 2030.[32]

In terms of water resources, the primary concerns of a city are related to availability and quality. By using alternative sources such as storm water and better water treatment, cities can address this challenge. For example, Singapore's Marina Barrage converted a seawater bay into a new downtown freshwater reservoir providing a water supply, flood control and new recreation opportunities. Singapore also is a leader in recycling treated wastewater. Its NEWater brand of recycled water now meets up to 30 percent of Singapore's water needs.[33]

In cities where an infrastructure to deliver safe-to-drink water is already in place, the primary focus has switched to reducing leakages and removing inefficiencies. Tokyo, for example, has one of the most efficient water systems in the world; its capabilities have successfully decreased its leakage rate from 20 percent in 1956 to 3.6 percent in 2006. The city's "info-structure" is a key enabler, helping executives manage all data relating to water supply through a computerized system that monitors information on leakages, from detection to repair.[34]

Smart grids are another important enabler of Intelligent Cities. By interconnecting electricity networks and merging them with information and communications technologies, smart grids can provide cities with a modernized system that provides electricity more reliably, safely, and affordably. Smart grids can result in more optimal power delivery, two-way communication across the grid, lower energy costs, more reliable power, and reduced carbon emissions.

Smart grids can also enable the more rapid take-up of electric vehicles with smart charging capabilities—dynamic charging based on system demand and energy prices—and vehicle-to-grid power flows. Although some early pilots have met resistance from regulatory bodies over concerns related to customer benefits, cities and their utilities will likely continue to look for ways to modernize the energy infrastructure while enabling more efficient energy usage.

More reliance on renewable energy is also an important part of the mix. Renewables represented 19 percent of global energy consumption in 2008 (including renewables used for heating and transportation), but only 3 percent of total global power generation (dominated by wind-based production).[35] Several cities are leading the way in this area, including Sao Paulo, where 56 percent of the state's energy consumption comes from renewables,[36] and the city of Växjö in Sweden which generates 51 percent of its energy from non-fossil fuel sources, including solar, geothermal and biomass.[37]

To encourage alternative, renewable fuel production and consumption, cities can incentivize households or business owners to promote the development of renewables. As mentioned earlier, feed-in tariffs are a proven and powerful policy mechanism for promoting renewable energy.

## Transportation

This service domain refers to how citizens move physically *within* the city, or use transportation to reach other areas in the nation and world *from* the city. It also refers to the movement of materials and freight. Intelligent transportation initiatives involve the application of new strategies and technologies to help offset the emissions generated by transport systems (especially older ones), and to support the development of a more intelligent infrastructure that uses energy more efficiently. Specific areas of concentration in this domain include traffic management, on-demand transportation, clean vehicles and urban logistics.

We have already mentioned a number of innovations in the area of traffic management that leverage an open-systems approach. Another example of innovation in the area of making transportation smarter comes from Singapore, which has joined with the Massachusetts Institute of Technology to create the Singapore-MIT Alliance for Research and Technology (SMART). The goal of this group is to develop in Singapore and its surrounding areas a new approach to the design and management of urban mobility systems leveraging new communications, computing and telematics technologies. The program has three emphases:

- A smart, networked infrastructure using technologies such as mobile mesh networking and onboard automation.
- Modeling capabilities that shows the potential impact on energy use, land use and the environment more broadly. Modeling can enable a city to predict performance and optimize operations.
- Performance assessment capabilities help evaluate alternative mobility systems and then put in place the organizational and regulatory supports for the new system.

An important innovation making it all work is what the program calls "SimMobility," a platform enabling the simulation of human and commercial activities, transportation, energy use and impact on the environment. The modeling engine is then linked to networked computing and control technologies, enabling real-time information and insights to improve management and decision making.

The approach also uses behavioral modeling of human activities having an impact on mobility systems and usage. To test the impact of different technologies and policies, the model simulates individual behaviors to reveal usage patterns which are then matched to resource consumption, demonstrating the impact of those behaviors over the entire population. The modeling technique serves as a decision support tool for city leaders and urban planners.[38]

## Health and safety

The focus of health and safety is on ensuring long-term prosperity to a city's inhabitants while safeguarding the natural environment, providing clean air, water and other conditions critical to the ongoing health of the population. Specific activities cover a broad range of concerns including the health care system, food and drug supervision, disaster response, fire and police, and security monitoring. This service domain also includes activities related to adaptation and increasing a city's resilience to the impacts of climate change.

An intelligent healthcare system is built on scalable storage systems and an open communications platform. With this type of IT foundation, patient records are electronically stored and shared wherever they are needed. This data not only is used for disease diagnosis but also facilitates future research. The communication platform enables faster-response emergency services. Videoconferencing technologies facilitate remote medical center services to patients' homes, for those who are unable to travel to hospitals.

Innovative information and communications technologies are transforming the ability of cities to provide remote health care to citizens, especially the elderly and other homebound residents. In Taiwan, for example, a Telehealth Pilot Project was launched to explore the benefits of providing telecare services, particularly to members of Taiwan's increasingly aging population. The Telehealth Pilot Project relies on the digital transmission of medical data collected from patients in community health centers, private homes and nursing homes. One of the benefits of the telecare program is that it makes health resources available close to patients' homes, which is particularly important to less mobile patients such as the elderly. Since the project has been launched, senior citizens no longer need to journey to big hospitals far away from their homes.[39]

Another example comes from Copenhagen, Denmark, where health officials have begun a home-monitoring pilot that could affect 800,000 people with chronic obstructive pulmonary disease, allowing hospitals to discharge

patients who would be more comfortable at home. Another program, currently in testing at Odense University Hospital, provides a videoconferencing translation service that helps foreign patients who don't speak Danish communicate with hospital staff.[40]

In Tokyo, city planners have established the goal of creating the world's first urban model for a super-aging society. One key initiative of the city in this respect is to implement human resource development that focuses on practical training for doctors, so that in 10 years, doctors with excellent clinical competence and a patient-oriented mindset will be active in area hospitals.

Turning to the safety component of this category of services, the benefits of the open platform for Intelligent Cities discussed earlier can be seen in one important initiative in the safety arena coming out of Canada. A group of eight Canadian companies has formed a technology and marketing alliance—the Secure City Technology Alliance (SCTA)—aimed at delivering integrated video, messaging and sensor networks to urban and regional emergency operations centers with an emphasis on wireless. The alliance brings together a variety of companies in areas such as IP-based video cameras and management systems, mesh wireless systems, and large-scale telecommunications and enterprise data networking hardware and software.

Alliance members seek to present a pre-integrated solution to end-user agencies and tier-one integrators that are building intelligence service centers—sometimes called "fusion centers." Such centralized response centers, which can bring together a large number of agencies at federal state and local levels, are increasingly being seen as a cornerstone for coordinating cross-agency communications and response in the event of a natural disaster, industrial accident or terrorist attack.[41]

Similar developments are occurring in the United States. The U.S. Department of Homeland Security has created 72 fusion centers across the country. Their role is to coordinate, analyze and disseminate information up, down and across federal, state and local lines, serving as connecting points that can help uncover potential threats.[42]

## Waste management

Cities increasingly need to apply innovations so they can more effectively manage and control the waste and pollution generated by individuals, businesses and other city services. The waste management service domain covers diverse activities including waste collection and disposal, recycling and conversion of waste into alternative energy sources.

Large cities must deal with millions of tons of solid waste each year. Reducing that level of environmental impact has typically followed the "Reduce, Reuse, Recycle" approach to waste management. Reduction of waste generation can be accomplished by reducing waste sources, such as packaging or plastic bags. Reuse can also make a significant impact. For example, analysis in Chicago found that 59 percent of the waste generated by the city was related to construction and demolition debris.[43] To counter that impact, the city entered into an intergovernmental agreement with the Environmental Protection Agency of the State of Illinois to reuse soil and rubble rather than disposing it in a landfill. This move reduced emissions related to its transport, and avoided the need to procure virgin materials, a process that often produces negative environmental effects.

Recycling and recovering materials or energy from waste is another option that is attractive in part because it can bring both environmental and financial benefits to cities. Cities also must deal with hazardous waste more effectively to limit impact on the environment and limit the occurrence of diseases stemming from inadequate waste treatment.

Finally, improving municipal waste collection logistics, in particular waste transportation, can save money and lessen carbon emissions. By rethinking waste logistics and transport, cities can reduce $CO_2$ emissions and make municipal waste disposal easier. Increasing proximity and frequency of collection can help cities avoid the negative effects of illegal dumping, a problem that plagues cities in both the developed and developing worlds.

Collecting waste, however, involves transportation technologies, which then increase $CO_2$ emissions. Advanced cities are rethinking logistics and transport to get cleaner and less labor-intensive waste collection and disposal. In Amsterdam, waste collection is becoming greener thanks to electric waste removal trucks and environmentally friendly vessels on the canals of the inner city. In Paris and Singapore, some pilot programs are using an underground network of pipes to convey solid wastes pneumatically to central bins—a development that can reduce the environmental impact of traditional waste collection.

In terms of recycling, many cities are already deploying important initiatives to increase their recycling rate. In Brazil, Curitiba has one of the highest recycling rates in the world (70 percent) because of several innovative programs.[44] One is a garbage exchange program to

minimize the amount of waste and litter on the streets in poorer neighborhoods. People are given bags of food or transportation tokens in exchange for bags of trash.

Amsterdam recycles 43 percent of all municipal waste, double the European average; most of the remainder is used to supply electricity to 75 percent of Amsterdam households.[45] One percent of the city's waste ends up in a landfill. Citizens in Seoul can recycle for free but must pay for the disposal of other trash using pre-paid bags. The program was implemented in 1995 and has resulted in a doubling of the recycling rate.[46]

Another example comes from the City of London, which has developed the RecycleBank scheme to give households more incentives to recycle by offering cash, rebates or vouchers to households based on how much additional waste citizens recycle each month.[47] Chicago also has ambitious goals to recycle 90 percent of its municipal waste by 2020, aided in part by educating residents about recycling, and also by restructuring methods of garbage pickup and transport.[48]

Intelligent Cities are also investigating ways to convert waste into energy. For example, projects to capture methane generated by landfills have been implemented in several areas across the globe. In Paris, 60 percent of municipal solid waste should be converted to energy through incineration plants by 2012.[49]

Other kinds of advanced technologies have been implemented in other areas of the world to create energy from waste. Amsterdam's waste-to-energy incineration plant achieves high levels of energy efficiency that enable it to power more than 75 percent of city households. The plant can even profitably extract gold and other metals from the resultant ash.[50]

The city of Sydney, Australia, is working towards a target to divert 66 percent of residential waste going to landfill by 2014. To achieve that goal, the city is working to improve waste collection using simple measures such as introducing new recycling bins and expanding the garden waste collection. To reduce waste sent to landfill even more, the city is sending some garbage to an Advanced Waste Treatment facility. One aspect of the facility is focused on converting much of a household's garbage into a gas for generating energy without relying on incineration.[51]

## Education and culture

This aspect of an Intelligent City refers to the public education system (and integration of private systems and universities into city life), especially as enabled by new technologies. Also included are a city's cultural and recreational amenities such as music, theater, sports and other leisure activities, and tourism.

An equally important aspect of education in the context of an Intelligent City, however, is the need to engage citizens through education in how behavior change can improve a city's overall sustainability and environmental health. Citizen engagement must be a key component of any Intelligent City program, since such engagement is at the heart of success for the Intelligent City business model. Helping citizens understand and then take consistent action through changed behaviors is a long process. Citizens should be closely involved while the strategy and vision of the city is defined.

Several cities are leading the way in how they educate and engage their citizens in sustainability goals. For example, Melbourne, Australia established frameworks and models by which the federal, state and local government cooperatively work with the local community to address sustainability challenges. This work was nominated for the 2010 Lee Kuan Yew World City Prize—a biennial international award to recognize individuals and organizations that have made outstanding contributions to the creation of vibrant, livable and sustainable urban communities around the world.[52]

In Copenhagen, Denmark, an "Eco-City" project established new forms of cooperation between grass-roots organizations and government, increased involvement of the local community and led to changes in social behaviors.[53] In Portland, Oregon a "CivicApps" contest has promoted collaboration between citizens and government to develop IT applications that address city issues.[54]

The private sector also can play an important role here. For example, BC Hydro's Power Smart program provides innovative education and outreach initiatives across British Columbia and has led to increased awareness and significant participation in various energy efficiency programs.[55]

In Philadelphia, the city collaborated with Dow Chemical in a "Coolest Block" competition. Dow contributed all the roofing and insulation materials to retrofit approximately 60 homes, resulting in a 20 percent reduction in energy usage for the blocks (neighborhoods) participating.[56]

## Public administration and services

This service domain of an Intelligent City includes the mechanism for governance, administration and the provision of services. Particular concerns here involve such things as information technologies that improve citizen communications and that provide the analytics

capabilities that can more readily match citizen needs with the most effective responses and resources.

For example, Innovative Cities for Next Generation (ICING) is a European project coordinated by the Dublin Institute of Technology examining a multi-modal, multi-access concept of e-Government. The model is intended to be sensitive to both the citizen and the environment through the use of mobile devices, universal access gateways, social software and environmental sensors. Intelligent infrastructure will enable a Public Administration Services layer and a Communities layer of management. Communities will interact with the infrastructure to access services created by city administrations, and will also create their own information-based services.

The research is focusing on the areas of embedded intelligence, tighter integration of operator platforms and city infrastructure to enable city services, empowerment of citizens to evolve systems of interaction with the city via social software, input from citizens and sensors for management systems and decision modeling, and a combination of city systems and multi-device communications to provide enhanced services. The technology platform will gather indicators from the city, process the information, propose actions to be taken with human intervention and supervision and connect the city with its constituency. Services and information will be delivered on a range of devices, providing greater reach and accessibility to local government and communities.[57]

# Conclusion: Practical considerations in creating an Intelligent City

The distinctive aspects of an Intelli-gent City are the dual characteristics of being (1) sustainable and (2) attractive. That is, the environmental dimension of Intelligent Cities is more than just a moral obligation. Sustainability is important for its positive social consequences, but also because it is a key factor in creating a livable environment—one conducive to the health and prosperity of a city and its citizens and businesses.

Every city is different and, there-fore, there is no one "correct" way to go about developing the suite of capabilities necessary to become an Intelligent City. One common way to begin, however, is to assess the city's starting point, based on its unique geographic, economic and politi-cal situation. From there, a city can assess scenarios of the costs, impacts and tradeoffs of various programs and begin to plan the technology, strategy, process, training, governance and management aspects of a development program.

We believe the following are especially important factors to be considered while plotting a course toward becoming an Intelligent City.

## Encourage and develop new forms of leadership and governance structures

City and business leaders should be vigorous in embracing and championing the Intelligent City concept, highlighting challenges and successes in their communications with citizens and customers. City leaders need the confidence and support of business partners; in turn, businesses need the support of city leaders.

## Align and engage all relevant stakeholders

To successfully implement the Intelligent City vision, city leaders should work to align the interests and goals of each sector of the community.

### City departments

The service domains of an Intelligent City cut across many city depart-ments. To maximize efficiencies and accelerate implementation, traditional silos of city departments need to be broken down so that the overall program can be managed across departments. The city department responsible for implementing and managing the Intelligent City vision should report directly to the city's leader. The department should serve as a coordinator and mediator and should have the final authority of the city leader to settle potential disputes

regarding priorities and responsibilities.

### Private-sector partners

Successfully implementing the Intelligent City vision depends on jointly engaging the public and private sectors and on gaining buy-in from corporate executives. As employers of city residents, supporters of city cultural institutions and sources of innovation, the private sector will play an integral role in achieving a city's goals.

### Citizens

Citizen engagement is another key component of any Intelligent City program. Technologies can support the behavioral changes needed, but not the emotional component. As discussed earlier, initiatives aimed at educating citizens to increase their acceptance and encourage different behaviors should be considered.

## Assemble the capabilities to drive an open, intelligent infrastructure

Through conversations with technology vendors and integrators, city Chief Information Officers should begin exploring the technologies and concepts at the heart of open, intelligent infrastructures. Conferences and targeted conversations with cities and companies involved in implementing aspects of an Intelligent City can help to lay a foundation of knowledge and experience that makes it easier to advance specific Intelligent City initiatives.

Cities should then consider a pilot project with a limited scope and controlled risks in a specific service domain such as transportation or energy management. Again, one of the benefits of the open platform is that solutions scale more readily, so experience in a limited domain can actually accelerate the benefits achievable as cities move down the road toward more complex implementations.

## Extend managers' capabilities in program management and delivery

An Intelligent City program should tap into highly competent program managers because the complexity of the overall initiative requires the management of numerous disparate elements, as well as the ability to keep city workers and citizens engaged in the initiative. The process of establishing goals and time lines, and tracking and reporting performance metrics, actively involves city stakeholders, aligns their interests, and provides a mechanism to quantify success.

## Create financial models that are up to the challenges and opportunities ahead

Standard models for financing infrastructure investments are usually inadequate to the challenges of creating an Intelligent City, so new models and approaches are necessary. For example, savings-based models—using savings from maturing technologies such as smart meters—can fund other technology research and development along other parts of the intelligent infrastructure.

In most cases, public-private partnerships will need to be pursued to fund the required infrastructure investments and revitalize a city. For example, since 1990, more than 1,400 public-private partnerships, representing nearly $US347 billion (€260 billion) in capital, have been established across the European Union in support of the goals of Intelligent Cities.[58]

Cities can be the catalyst for bringing together the public and private sectors based on new business and operating models, as well as better partnership models. Such an approach requires moving away from isolated initiatives executed by individual players in the city to a coordinated effort among all public- and private-sector players. Strong coordination can align interests and balance risk-sharing among all parties.

Given the influence of cities on the health of the planet, the Intelligent City agenda has importance for all citizens, regardless of where they live. If cities are to take focused, cost-effective actions to embed intelligence in all their services, they should work to put in place the right kind of foundation—an open, intelligent architecture capable of delivering smart services now, and then scaling as the city's needs grow.

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