Smart Cities

Guide to Smart Cities

The Opportunity for Mobile Operators

February 2013 Version 1.0

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Executive summary

City administrations across the world are looking to harness information and communications technologies (ICT), including mobile connectivity, to help address the many challenges of urbanisation, such as traffic congestion, waste disposal and rising energy usage. ICT can be used to deliver smart city initiatives that improve citizens' quality of life, make public services more efficient, generate new sources of revenue and fuel economic growth.

This paper is designed to be a practical guide to the smart city opportunity for mobile operators. It draws on a series of interviews with municipalities, mobile operators and systems integrators, together with GSMA analysis. Here are the main findings:

What is a smart city?
A smart city makes extensive use of information and communications technologies, including mobile networks, to improve the quality of life of its citizens in a sustainable way. A smart city combines and shares disparate data sets captured by intelligently-connected infrastructure, people and vehicles, to generate new insights and provide ubiquitous services that enable citizens to access information about city services, move around easily, improve the efficiency of city operations and enhance security, fuel economic activity and increase resilience to natural disasters.

The global mobile addressable market in smart cities, transport, utilities and intelligent buildings will amount to USD$67.1bn in 2020, up from USD$22.8bn in 2012, according to Machina Research. By 2020, security in intelligent buildings, (which includes connected security alarm systems, fire alarms, CCTVs, intercoms and building access control) will account for 52% of the total addressable market for mobile operators, according to Machina Research's forecasts for the smart cities, intelligent buildings and utilities sectors. Smart meters will be the second largest addressable revenue category, with 22% of the total by 2020, followed by environment and public safety sector applications with 14% in 2020. Note that Machina Research's revenue forecasts don't include the potentially significant revenues that mobile operators could earn from the data generated by smart city services.

Mobile operators are already involved in smart city projects. Out of the 150 smart cities the GSMA tracks globally, more than 100 cities have deployed services (beyond smartphone apps) that make use of mobile networks. The GSMA has identified 232 mobile products and services that cover a wide variety of smart city sectors. The majority of these fall into four main categories:

Transport related (99 projects worldwide), such as ticketing applications, intelligent transport systems and traffic information systems.

Environment/energy related (95 projects), such as smart metering, building efficiency and electric vehicle charging.

Municipal infrastructure (49 projects), such as waste and water management and street lighting.

Economic stimulus and open data (14 projects), such as the development of mobile app clusters.

Mobile operators can play a role in four key elements of smart city services:

- **Connectivity/managed connectivity** – connecting city infrastructure and individuals' handsets to central servers and databases;
- **Data aggregation/analysis** – combining data from multiple sources to produce new insights;
- **Service delivery** – delivering real-time information to people and machines that will enable them to adapt and respond to events in the city;
- **Customer interface** - providing customer support operations, such as call centers and web portals, as well as delivering messages to subscribers.

However, the smart city market is still at a nascent stage, and few operators are taking full advantage of the opportunity. The purpose of this report is to provide insights into how the potential of the mobile smart city market can be realised, in practical terms. It identifies a number of key barriers (business, operational, technical and privacy-related) to the deployment of mobile smart city services and makes a number of key recommendations to overcome the barriers:

- Consider the longer-term strategic business case, including the opportunities around big data and cloud-based services;
- Develop market intelligence and build internal skills to address smart cities;
- Engage with city administrations – encouraging municipalities to take a holistic view and adopt joined-up thinking;
- Robust evaluation of the impact of mobile-enabled smart city projects across multiple KPIs;
- Adopt standards-based solutions that can be scaled both within cities and across cities;
- Segment cities according to their approach to planning (centralized/de-centralised) and the availability of resources (government budget versus private industry).

The first steps are for mobile operators to identify the priorities of each city, work out the value of ICT to municipalities and, finally, develop marketing messages that will demonstrate the value to cities that do not always think in terms of net present value and return on investment. "Greenfield" smart city opportunities and large centralised municipal tenders are few and far between. Most projects will be implemented in 'brownfield" cities and the majority of these cities - even those with balanced municipal budgets - will seek private funding to complement their existing resources. The development of public-private partnerships, in which the participants share the risks and the benefits, are high on the agenda of many smart cities.

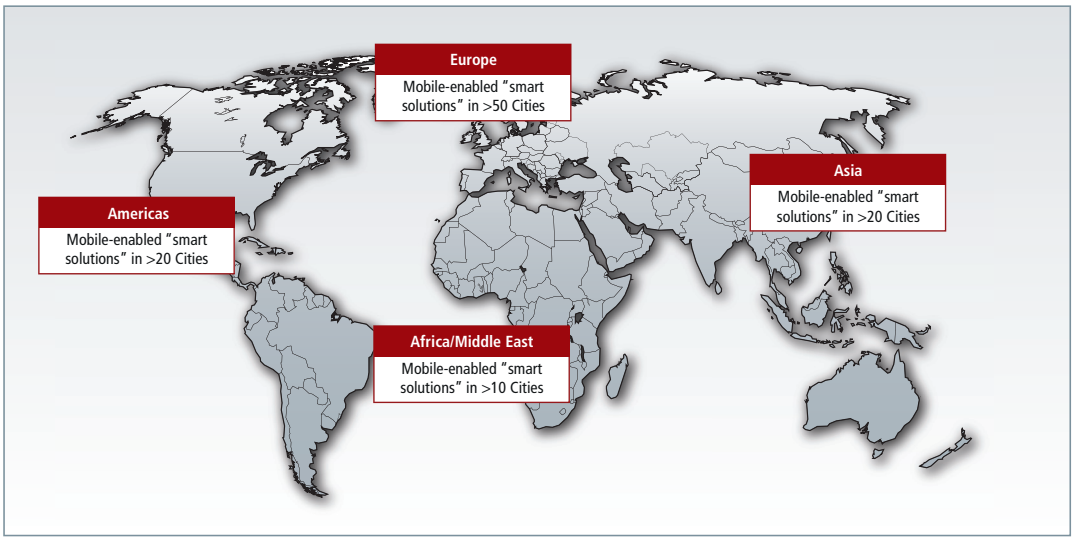
In this paper, the GSMA provides some suggestions for approaching cities, according to a loose classification based on how cities govern their assets (concentrated/centralised or decentralised), as well as their access to funding (public and/or private).

In summary, now is the time for telcos to engage in the emerging smart cities market: The world is urbanising fast and municipalities realise that they need to make far better use of ICT to enable millions of people to live together successfully in small geographic areas. Although the political, financial and organisational complexities of city administrations will limit the short-term revenue opportunities for mobile operators, smart cities represent a strategically important market in the medium-to-long term. If they engage with city administrations now, mobile operators will have an opportunity to become an essential part of the city's social infrastructure, creating a platform for future revenue-generating services that harness big data and cloud computing.

Introduction

To improve the quality of life of their citizens cities worldwide are looking to harness information and communications technologies (ICT) to help address traffic congestion, waste disposal, rising energy costs, over-crowded public transport and many other challenges. As leading providers of ICT and related services, mobile operators, the GSMA's core membership, are well placed to help city administrations become more efficient and effective.

Smart cities are still in their infancy, but it is already clear that they will make extensive use of mobile networks and services. Out of the 150 smart cities the GSMA tracks globally, more than 100 cities have deployed services (beyond smartphone apps) that make use of mobile networks. Half of these cities are located in Europe.



Source: GSMA Connected Living Tracker

Crucially, mobile networks can capture data in real-time from connected devices and machines, such as vehicles and handsets, that are moving around the city. In some cases, cities are looking to deploy public services for their citizens via mobile portals and applications, as a way to differentiate themselves from other cities. At the same time, there is a growing interest among mobile operators in intelligently connecting many more devices, machines and vehicles to create a so-called Internet of Things that could be used to underpin a smart city.

However, many mobile operators are unclear how to pursue the smart city opportunity, partly because the concept is still evolving and partly because they have yet to develop business models that could make large-scale smart city services sustainable. Moreover, very few cities have a holistic approach to harnessing ICT, making it difficult for mobile operators to identify appropriate decision-makers for smart city projects. "A lot of the stakeholders do not understand the new converging areas with IT and smart cities and the synergies that can be created and miss the opportunity," said Prof. Jung-hoon Lee, Associate Professor in Graduate School of Information, Yonsei University, South Korea, in an interview for this report.

To date, systems integrators and vendors, such as IBM, Cisco and Accenture, have tended to spearhead smart city implementations. Some of these companies are developing comprehensive smart city platforms that can combine data from a large number of sources and generate new insights that can be used to create new services and enhance existing ones. By contrast, many mobile operators continue to play a passive role, simply offering standalone M2M solutions aimed at specific vertical sectors. As a result, mobile operators run the risk of being relegated to a commodity supplier of connectivity to companies offering higher-value services, such as data aggregation, data analytics and new service creation.

Objectives of this report

This guide aims to provide both the strategic rationale and the practical advice that will enable mobile operators to capitalise on the growing interest among municipalities worldwide in the concept of a smart city. It sets out the technological and business factors that mobile operators need to consider as they develop smart city propositions and enter into discussions with municipalities.

Specifically, the report aims to:

- Define the smart city opportunity for mobile service providers;
- Identity the potential role of mobile operators within the smart city ecosystem;
- Pinpoint the key barriers to the deployment of mobile smart city services;
- Identify different categories of smart city projects and services, and the best approach in each case;
- Explore potential sources of funding for smart city projects, and emerging business models;
- Explore how to engage citizens in smart city projects;
- Consider how to evaluate smart city projects;
- Explore how to scale up smart cities initiatives;
- Make recommendations on next steps.

To gain insights into the workings of smart cities, we interviewed officials from several municipalities, such as San Francisco, London, Liverpool and Barcelona, technology companies and systems integrators, such as Cisco and Accenture, telcos, such as Vodafone, Deutsche Telekom and KT-Cisco joint venture Centios. We have also drawn on the GSMA's extensive analysis into mobile-based smart city services for the Connected Living Smart City Tracker[1] and smart cities case studies.[2]

The primary target audience for this report is mobile operator directors, strategy and business development teams. Vendors, technology companies and systems integrators working with mobile operators should also find it valuable.

1 http://www.gsma.com/connectedliving/tracker

2 http://www.gsma.com/connectedliving/resources/?project=Smart_Cities

What makes a smart city?

The term "smart city" means different things to different people and is used in many different contexts. For the purposes of this report, we have defined a smart city in this way:

A smart city makes extensive use of information and communications technologies, including mobile networks, to improve the quality of life of its citizens in a sustainable way. A smart city combines and shares disparate data sets captured by intelligently-connected infrastructure, people and vehicles, to generate new insights and provide ubiquitous services that enable citizens to access information about city services and move around easily, improve the efficiency of city operations, enhance security, fuel economic activity and increase resilience to natural disasters.

Smart city applications

The graphic below gives an overview of the types of smart city projects and services that have been deployed in selected cities in Europe, North America and Asia. The services in these cities fall broadly into the following categories:

- **Transport,** including public transport, intelligent transport systems and parking;
- **Environment/Energy,** including energy-efficient buildings;
- **Municipal projects,** including waste management, modernisation of water systems, smart lighting systems, public safety and city resilience programmes;
- **Economic stimulus and open data** projects.

	Amsterdam	Barcelona	Copenhagen	Helsinki	Charlotte	San Francisco	Singapore	Seoul
Transport	DIVV has made available all its data on traffic and transportation	Smart parking; the orthogonal network of public transport	Integrated public transport Transport - Cycling	Smart Urban Spaces (NFC for foot traffic) Helsinki ITS Traffic Info Platform		Smart Parking	Smart predictive tools Smart Cards Smart congestion charging	Smart Transportation Pricing Pay-as-you drive
Environment and Energy	National Smart Metering Installation Climate Street	Zero energy blocks and energy; efficiency in buildings	Sewage modernisation system Renewables: wind power; municipal heating network		Envision Charlotte, Smart Energy Now Smart Air Now		Jurong Lake District	National Smart Grid System
Municipal Network		Pay per Lighting City resilience - rain water and waste managemnt; city situation room	Waste management		Envision Charlotte, Smart Water Now Waste management	Smart Water Metering	Deep Tunnel Sewerage System Punggol Eco Town	Seoul Star City for Rainwater harvesting
Economic Stimulus and Open Data	AIM Amsterdam Living Lab			Apps4Finland CitySDK and Helisnki Region Infoshare Code4Europe		Living Zone Open Data - SFdata	SENSEable City Lab Feedback loop between people moving in the city and digital data	O.P.E.N System for data

Mobile for Smart Cities: The Opportunity

This section uses both analysis and examples to help identify how city administrations might make use of the capabilities of mobile operators. It considers how smart cities are using mobile networks today and then sizes the potential market between now and 2020. It then goes on to identify the potential role of mobile operators in the development and operation of smart cities, before concluding by considering the potential barriers to the deployment of mobile-enabled smart city services.

How city administrations are looking to use mobile technologies

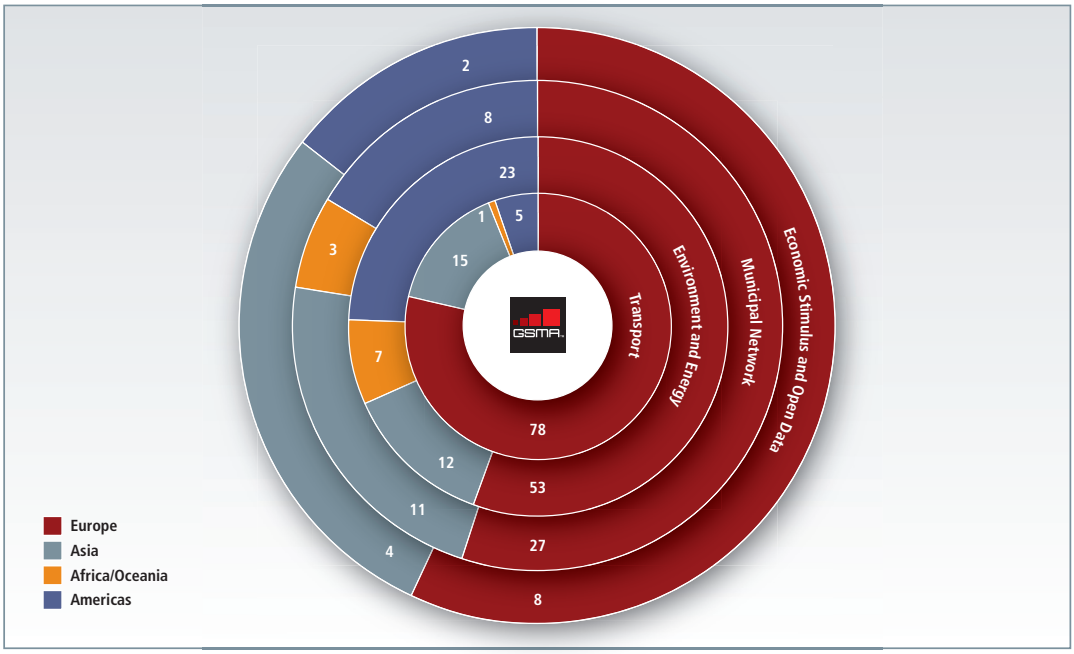
City administrations are responsible for providing essential services that are not provided by the private sector and, in some cases, regulating essential services provided by the private sector. Most cities also deploy supplementary services, such as car parking facilities, which raise revenues and help pay for essential services. City officials generally want to be re-elected or re-appointed and, therefore, focus on making life better for their citizens – they are primarily interested in mobile technologies' ability to address the frustrations of daily life and fuel economic growth, thereby increasing the incomes of citizens and potentially their tax intake.

Existing mobile smart city services

To help pinpoint the best smart city opportunities for mobile operators, we have analysed the products and services captured by the GSMA's Connected Living tracker, a public database of trial and commercial projects with the involvement of mobile operators. There are 232 mobile smart city projects in this tracker. Here is a breakdown by category (see graphic):

- Transport accounts for nearly 100 projects globally. These include ticketing applications (50), intelligent transport systems (29), traffic information systems (20).
- Environment/energy accounts for 95 projects globally, including smart metering projects (74), electric vehicles and charging infrastructure (14) and renewables projects (7).
- Municipal infrastructure services account for 49 projects globally, including water and waste management.
- Economic stimulus and open data includes 14 projects globally. These include initiatives to develop IT mobile application development clusters.

Core Smart City Services



Source: GSMA Connected Living Tracker http://www.gsma.com/connectedliving/tracker

Below we outline examples of smart city services that have been deployed or are being deployed.

Transport

As the population of cities continues to grow, one of the major challenges facing municipalities is encourage the use of public transport by providing sufficient number of buses, trains and trams, easing congestion by reducing the number of private vehicles on the road, and reducing the time it takes citizens to get to and from their place of work. Lengthy commutes reduce quality of life and economic productivity, while increasing greenhouse gas emissions. Information about other modes of mobility is also of interest to the municipalities: the Greater London Authority, for example, would like to be able to access real-time information on pedestrians and cyclists to help it better understand the movement of people around the city.

Here are examples of trials and commercial projects using mobile connectivity and services to improve transport:

- Started in 2011, Istanbul in Motion was one of the first trial projects to be initiated by the smart city partnership between Vodafone Global Enterprise and IBM. The project aims to better match the provision of public transport with the habits and lifestyles of the people in Istanbul. Vodafone and IBM are collecting information on the start and end points of citizens' journeys to help the Istanbul Municipality optimise public transport routes.
- NCS, the IT arm of SingTel, is helping Singapore's Land Transport Authority to provide citizens with easy access to public transport and traffic information. NCS is operating and maintaining three web portals and electronic service platforms that disseminate timely traffic and transport information to motorists and commuters.
- San Francisco's Municipal Transport Authority is trialling an initiative, called SFpark, designed to reduce traffic by helping drivers find parking spaces. SFpark collects real-time information (using wireless parking sensors) about where parking is available and then distributes that information via a smartphone app to drivers. It also periodically adjusts meter and garage pricing up and down in line with demand, encouraging drivers to park in underused areas and garages, reducing demand in overused areas. In a pilot phase, the new parking management system is being tested at 7,000 of San Francisco's 28,800 metered spaces and 12,250 spaces in 15 of 20 city-owned parking garages.

Environment and energy

Cities want to use energy more efficiently both to reduce their costs and to improve the environment both directly through lower pollution and indirectly through lower greenhouse gas emissions. Cities, particularly in Europe where the European Commission has set the 20-20-20 green agenda[3], are increasingly taking a lead in the fight against climate change, setting aggressive targets to lower greenhouse gas emissions and sharing knowledge with each other. For example, the C40 initiative[4] is supporting efforts by 58 cities around the world to reduce greenhouse gas emissions through direct assistance, peer-to-peer exchanges and research.

3 http://ec.europa.eu/clima/policies/package/index_en.htm

4 http://www.c40cities.org

Here are examples of how cities are using ICT to reduce energy use:

- The city of Charlotte in North Carolina, in the USA, is planning to achieve a reduction of up to 20% over 5 years, in energy usage by using mobile networks and other ICT systems to roll-out connected smart meters and energy consumption displays in the lobby of each building in business parks and educate employees on how to use energy more efficiently. Run by the Envision Charlotte public-private partnership, the project also aims to educate its citizens about energy efficiency, improve the image of Charlotte, and reduce the peak demand for energy.
- Amsterdam's Climate Street initiative has transformed a busy retail street into a sustainable shopping area by improving energy management and logistics and the efficiency of public services, such as waste collection. The city has connected electricity meters to help match energy supply and demand. It has also connected rubbish bins, so that waste is only collected when the bins are full. Business owners can view energy management information on their mobile handsets. As a result, Amsterdam has reduced the annual CO2 emissions of the shopping area from 3,400 tons in 2010 to 1,276 tons in 2012. Amsterdam is also using mobile services to engage with the community, as part of its broader strategy to combine smart city "bones" (infrastructure) with "flesh" (community) to reduce CO2 and cut energy consumption.
- Korean telcos KT and SKT are using Jeju Island in South Korea as a test bed for an automated metering infrastructure, connected by both mobile and fixed networks, for electricity, water and gas suppliers. The infrastructure automatically detects leaks, and provides accurate meter readings, improving reliability, reducing waste and costs. This is complemented by a building energy management system which enables citizens and businesses to monitor and control the energy usage of their buildings remotely via mobile networks. Moreover, the municipality has introduced an electric vehicle service enabling straightforward car rental and sharing, supported by automated authentication and billing for electricity charging.

Municipal projects

City administrations are looking to use information and communications technology to increase the efficiency and effectiveness of key municipal services, such as waste and water management and street lighting. They are also looking to use ICT to improve the effectiveness and efficiency of emergency services, such as the police or fire service. Moreover, the city's resilience to severe weather events can be improved by the data captured by a smart city platform.

- In Cubas de la Sagra, Madrid, Spain, municipal waste collectors have trialed a NFC device (located in a truck) to scan a code inside rubbish bins. The NFC device then used a mobile network to tell the waste management service how full the bins are, their location and the pickup date and time. This information enabled the municipality to improve the planning and logistics of its waste management service, reducing the time the trucks spend on the street, congestion and the cost of the service.
- Madrid has also introduced a new communications system for the fire brigade, the police, paramedics and its traffic management service. The system integrates information provided by each of these services to provide a holistic view of an incident, which can then be accessed by emergency services in real time using secure mobile and wireless networks. The unified view of incident data has enabled faster and better decision making, reducing average emergency response times by 25%.

Open data and economic stimulus

By creating a high quality of life and robust city infrastructure, smart cities can attract new employers and stimulate the development of new economic clusters. Some countries in the Middle East have built an advanced ICT infrastructure into new cities specifically to attract companies and investors. Several forward-looking cities, such as Busan in South Korea and Helsinki in Finland are beginning to use smart city projects to capture data and make it available to private companies to provide innovative new services, driving economic growth and making the city's businesses more competitive with rivals elsewhere.

Here are some examples of smart city initiatives that are seeking to drive innovation and, ultimately, economic growth:

- Deutsche Telekom has created a test-bed for smart city services in Friedrichshafen in southern Germany. The telco has completed more than 40 pilot projects in Friedrichshafen, with a view to commercialising the most promising services in multiple cities, potentially opening up new revenue opportunities for DT and driving growth in the wider economy. It has implemented several services commercially on full scale. These include a GPS mayday call system for rescue coordination, telemedicine systems for health monitoring, smart electricity metering, multimedia stations with communication facilities and home network sensors.
- In Helsinki in Finland, Forum Virium Helsinki, a private non-profit organisation owned by the City of Helsinki, has been tasked with the development of new urban services in collaboration with the private sector, the municipality, other public sector organisations and Helsinki residents. As well as improving life in Helsinki, Forum Virium is aiming to help local companies grow and develop innovative services they can sell to other cities through support and incubator programmes aimed at small and medium enterprises. Helsinki's smart city strategy is supported by the creation of a mobile application cluster and a focus on open data. To create better services and new businesses, the Forum Virium has set up the Helsinki Region Infoshare project to distribute open public–sector data to all interested parties, including municipalities, universities, and research companies.
- In partnership with Cisco and KT, the city of Busan, South Korea, has set up the App Development Centre to co-create smart city services with start-ups. The centre is supported by a cloud-based mobile application development platform (a platform-as-a-service or PaaS). In its first year, it established 13 companies, which developed 70 apps, earning annual external project revenue of $2.2 million and online sales revenue of $42,000. The goal is to employ 3,500 app developers and 300 sole traders by 2014.

Sizing the future mobile opportunity

To help gauge the mobile smart city opportunity, we have used market forecasts from Machina Research. Although Machina Research's datasets don't match the smart city service categories we identified in the previous section, they provide an indication of the scale of the opportunity. Machina Research's datasets are structured in this way:

- **Smart cities and public transport,** including digital billboards, environment and public safety, public transport and traffic management
- **Utilities,** which covers smart metering and electric vehicle (EV) charging
- **Intelligent buildings,** which include building automation, microgeneration (renewables) and security.

Note, some of the smart city services tracked by Machina Research will be deployed in both the private and public sectors. In some cities, municipalities may not lead utilities or intelligent buildings projects, for example. In the U.S. and the U.K., and in some European countries, the utilities sector has been privatised and the investment decisions are outside the control of municipalities. Similarly, apart from public buildings, it is generally private sector companies that make decisions about investing in building automation and security.

Yet, municipalities own large numbers of buildings and do get involved in setting policies for building energy efficiency performance in the private sector (examples include Barcelona, Charlotte, Amsterdam). The Greater London Authority, for example, can impose carbon emissions limits on new buildings.

The table below presents the current situation, as measured by the number of projects in the GSMA Tracker, and Machina Research's forecasts for connections and revenues in 2012 and 2020.

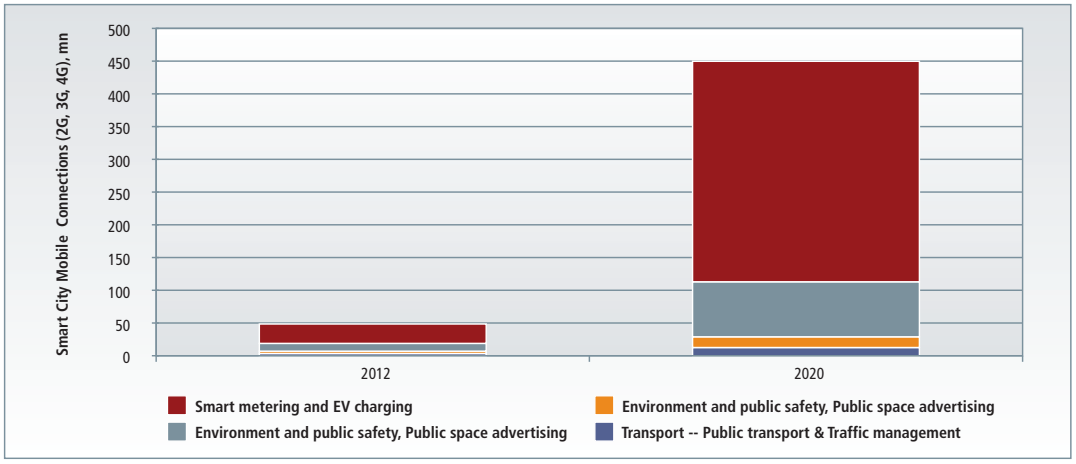
Projects tracked by the GSMA Connected Living programme	**Services covered in category definition** (Machina Research)	**Addressable market connections and revenue forecast** (Machina Research)
Transport: 99 projects globally	Smart cities and public transport: public transport and traffic management	WWAN 2G, 3G, 4G connections: 3.5 mn (2012) –> 13 mn (2020) Addressable mobile revenue: $1.1 bn (2012) –> $4.6 bn (2020)
Energy: 95 projects globally	Intelligent buildings – building automation Utilities – smart meters Utilities – EV charging	WWAN 2G, 3G, 4G smart metering/EV connections: 30 mn (2012) –> 337 mn (2020) Addressable mobile revenue: $3.2 bn (2012) –> $14.5 bn (2020)
Municipal infrastructure: nearly 50 projects globally	Smart cities – public space advertising, environment and public safety	WWAN 2G, 3G, 4G connections: 3.5 mn (2012) –>16 mn (2020) Addressable mobile revenue: $5.7 bn (2012) –> $9.9 bn (2020)
Open data and economic stimulus: 14 projects globally	Provision of city data Support for mobile app developers	Forecasts not available – the open data business model is still evolving
Intelligent buildings – security (currently not included in the GSMA tracker)	Connected security cameras and alarm systems protecting buildings	WWAN 2G, 3G, 4G connections: 4.9 mn (2012) –> 54 mn (2020) Addressable mobile revenue: $10.5 bn (2012) –> $34.7 bn (2020)

Machina Research forecasts that the total number of mobile wide area network connections in smart cities (the public and private opportunity in transport, energy, building security and municipal projects combined) will increase from 48.4 million in 2012 to more than 450 million in 2020 globally.

Smart meters will account for a growing share of the total – up from 61% in 2012 (30 million connections) to 75% in 2020 (337 million connections), according to Machina Research (see graphic). Intelligent buildings will account for nearly one fifth of all smart city mobile connections (84 million) in 2020, while public safety, public transport, traffic management and public space advertising will account for a further 29 million connections in 2020.

In-vehicle toll and traffic information devices, as well as the growing number of road sensors measuring traffic volumes and speed, can use short-range communication technologies, such as Dedicated Short Range Communications (DSRC), to communicate with roadside gantries and other roadside furniture. Machina Research expects that as many as 98% of these devices and sensors will communicate using short range technologies by 2020, limiting the number of mobile connections. Mobile networks, however, will generally be used as aggregation points, carrying the data captured by these device and sensors back to central computer services: On average, Machina Research forecasts that one wide area network connection will aggregate as many as 47 short-range traffic management connections in 2020.

Smart City Mobile Connections (2G, 3G, 4G), mn, 2012, 2020



Source: Machina Research, January 2013

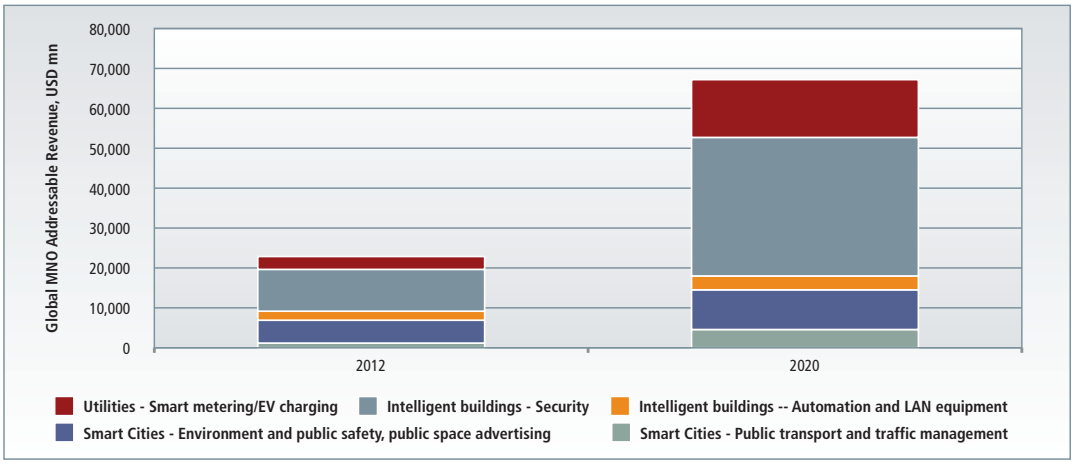
However, there isn't a direct correlation between the numbers of smart city connections and the revenue opportunities for mobile operators. At the end of 2012, security in intelligent buildings, which includes connected security alarm systems, fire alarms, CCTVs, intercoms and building access control, accounted for 46% of the total combined addressable smart city market revenue for mobile operators, according to Machina Research. The research firm forecasts that figure will grow to 52% of the total in 2020. This is driven in part by the use of connected security cameras to transmit video images, making extensive use of the network. But another factor will be the increasing use of mobile networks to back up fixed-line connections that might fail in the event of a power cut or as a result of damage by criminals.[5]

Smart meters will be the second largest addressable revenue category in the combined smart city, utilities and intelligent buildings forecast, with 22% of the total by 2020, followed by environment and public safety sector applications with 14% in 2020. Although many intelligent buildings and smart meter deployments will be driven by private sector companies, such as real-estate and utilities, municipalities and governments will play an important role through setting environmental and sustainability standards for city buildings, and implementing policies that require commitments for the installation of smart meters. Moreover, local governments own large numbers of properties and are typically major landlords providing social housing to disadvantaged citizens.

5 http://www.machinaresearch.com/intbuilds2020.html

Overall, the global mobile addressable market in smart cities, transport, utilities and intelligent buildings will add up to USD$67.1bn in 2020, up from USD$22.8bn in 2012, according to Machina Research (see graphic).

Global MNO Addressable Market Revenue, USD mn, 2012, 2020



Source: Machina Research, January 2013

However, it is important to note that most industry revenue forecasts, including those from Machina Research quoted in this report, do not include the potential sources of revenue that operators may be able to generate from the data captured by smart city solutions. We discuss this opportunity further in the next chapter.

How should mobile operators pursue these opportunities?

Strategic considerations

To determine their potential role in the smart city value chain, mobile operators need to evaluate their existing assets and strategic priorities. If a mobile operator is part of a large telecoms group, with its own systems integration capabilities, it can play a potentially much larger role than a smaller mobile operator that lacks significant IT expertise.

The role of mobile operators in a smart city may also vary depending on the age of the city. Greenfield cities, or new developments, are mostly located in China, Asia-Pacific and the Middle East. In Europe and North America, most cities are now well established (or "brownfield") and there are relatively few greenfield developments.

Extensive fibre networks are now typically included in new "greenfield" towns and cities, enabling the widespread deployment of high-speed wireless networks that can be used to support many smart city services. KT and Cisco, for example, are making extensive use of fibre to provide smart city services in new cities in South Korea.

However, even in these purpose-built smart cities, some services, particularly those involving vehicles, are still likely to require the ubiquity and seamless connectivity provided by mobile networks. In fact, some municipalities are looking to use mobile smart city services to help distinguish their city and attract new businesses and citizens. "If they use mobile networks, they have to pay service fees, which is a concern for city administrations," said Jin-Hyeok Yang, Smart City Consultant at Centios, a Cisco–KT joint venture, in an interview for this report. "But they still want mobile services to differentiate."

3 Final type approval legislation is expected to confirm the requirement for embedded systems (draft legislation envisaged for early 2013).

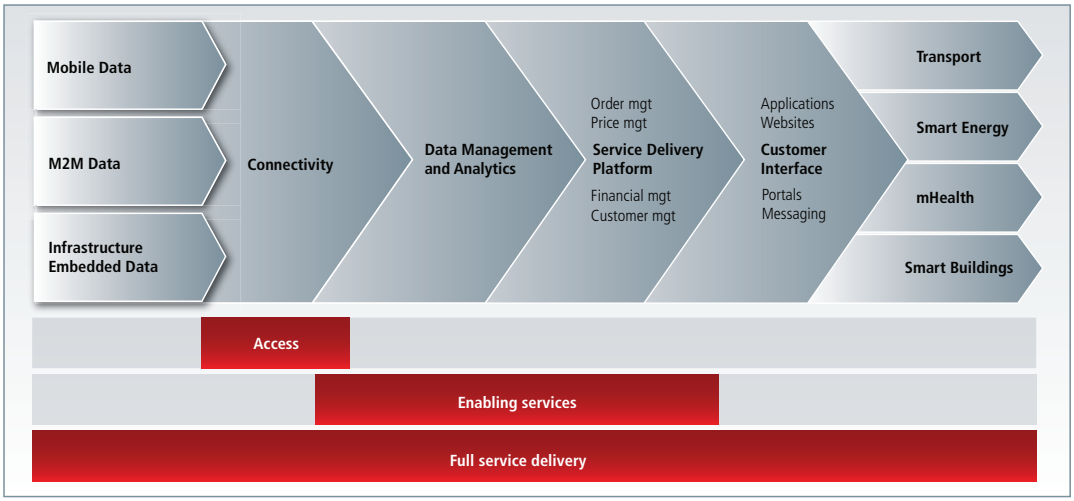
If a telco plans to participate in greenfield projects, then it may need expertise in construction and property development. In South Korea, KT, for example, hired people from the real-estate industry to help it deploy ICT infrastructure during the construction phase of a new city. "As a telco, KT didn't have the necessary experience," Jin-Hyeok Yang noted. "We had to get used to the construction business."

In brownfield cities, fibre can be expensive to deploy extensively – laying fibre-optic cables requires roads to be dug up, causing disruption. In these cases, a municipality may find it more cost-effective and easier to make use of the existing mobile networks to retrofit smart city services on top of the existing city infrastructure.

In both greenfield and brownfield cities, mobile operators could play a role in four key elements of smart city services (see diagram):

- **Connectivity/managed connectivity** – connecting elements of city infrastructure and individuals' handsets to central servers and databases;
- **Data aggregation/analysis** – combining data from multiple sources to produce new insights;
- **Service delivery** – delivering real-time information to people and machines that will enable them to adapt and respond to events in the city;
- **Customer interface** – supporting smart city services with customer support operations, such as call centers and web portals, as well as promoting them through messages to their existing subscribers.

Mobile for Smart Cities - Beyond Devices



Source: Accenture, Cisco, GSMA, Smart Mobile Cities report, 2011

Connectivity

To create a smart city, a municipality needs real time information about its fixed assets (e.g. buildings), movable assets (public transport) and its citizens (where people are and what services they are accessing). Smart city projects will typically make use of several different telecoms networks and technologies, including wide area mobile technologies, such as GSM, HSPA and LTE, fixed networks, using ADSL and fibre, and short-range wireless technologies, such as Wi-Fi.

Depending on the application, they may also require a proximity technology, such as NFC, to help authenticate individual citizens and city employees. For example, a smart city project might enable a citizen to tap their NFC handset (with their identity data securely stored on the SIM card) against an NFC reader to rent an electric vehicle for a few hours.

Cities will want these technologies to work together seamlessly. Ideally, smart city services themselves should be interoperable, using open APIs, to enable the data they capture to be easily aggregated and analysed using a single integrated smart city platform.

In the context of smart city projects, mobile networks have several key strengths:

- First and foremost, mobile networks provide existing widespread coverage.
- A mobile connection is typically easy to install and configure. A mobile device is equipped with a SIM card at the point of manufacture, enabling it to automatically connect to a mobile network.
- Mobile connections tend to be more secure than alternatives because they operate in licensed spectrum and mobile IP addresses are more difficult to spoof than fixed line IP addresses.
- Mobile networks can support a large number of devices.
- Mobile networks can support managed connectivity for signaling, alarms, alerts.

These strengths mean mobile networks are well suited to providing the connectivity needed for many different types of smart city infrastructure, from connected buses, trains and fleets of vehicles, to smart meters for water and electricity, and building automation gateways, among others. In addition to connected machines (included in the Machina Research forecasts in the previous section), existing mobile handsets can also be used as sensors to support several key smart city services, such as:

- **Energy efficiency** – Telcos can use information captured by mobile networks from handset devices to determine the physical occupancy of buildings, helping the relevant company or public sector organisation to identify when and where heating/lighting can be turned off.
- **Transport and logistics** – Mobile networks can track the movements of people, vehicles and goods across a city in real-time, enabling the municipality to identity potential congestion early and take remedial action, such as changing the frequency of traffic lights, alerting drivers or dynamically changing road tolls.
- **Sentiment monitoring** – Municipalities can use a mobile messaging service to ask citizens to identify the biggest frustrations they face each day. The municipality can use the resulting data to prioritise investment.

The mobile handset SIMs used to support the above services will be excluded from the connections forecasts quoted above, but they will potentially be generating new service revenues for mobile operators.

Mobile networks are also well placed to collect information from, and remotely control, fixed assets, such as street lights or environmental sensors.

Data analysis and aggregation

Whereas individuals, local government, public agencies and businesses within cities already make extensive use of mobile services and mobile networks, the data captured by these mobile services and networks typically remains in silos and isn't used to its full potential. On behalf of their customers, some mobile operators do analyse the data captured by machine-to-machine applications, such as connected vehicles or sensors, but that data is rarely combined with data from other sources.

As many mobile operators work with companies and agencies across the economy, they could act as "the glue" that brings the data from disparate stakeholders together, yielding new insights and synergies. To do this, a mobile operator may need to work with the systems integration arm of their group or strengthen their own project management skills and employ experts in systems integration.

If real-time data from multiple sources could be aggregated and analysed in an integrated platform, a municipality could use the output to make well-informed, city-level decisions (this is the vision typically put forward by Accenture, Cisco, IBM and other prominent smart city advocates). The end result would be more efficient and effective city services, such as public transport, waste collection, and security.

The analysis of real-time data could also help city agencies to better manage unexpected events. In densely-populated urban areas, individual incidents can have a major impact on thousands of people and their use of city infrastructure and services. For example, an accident at a major road junction might delay a large number of commuters heading home to a particular suburb. City authorities could use real-time traffic data to warn utility companies of heavy traffic congestion, signalling that peak demand for energy and water in a specific suburb will be postponed, as commuters arrive home later.

Moreover, the aggregation of data from multiple sources at a city level could be used to generate new services. For example, data on traffic congestion could be combined with data from car parks to provide individual citizens with real-time advice on where to park and how to continue their journey.

In other words, telcos need to go beyond simply offering ICT solutions to improve the efficiency of individual vertical sectors, such as smart metering in the utility sector or asset management in the logistics sector, to providing integrated solutions that enhance the way the city as a whole functions. In concrete terms, a centralised smart city platform will be made up of the databases, computer servers and software required to aggregate, mash-up and analyse data from multiple sources. This computing power will also need high-bandwidth connections and significant redundancy to mitigate against any equipment failures. This nerve centre may need to be backed-up by a second facility that can be called into action if the primary one fails. In many cases, municipalities will require this potentially-sensitive data to be held locally and by a regulated entity with a significant physical presence in the city.

Telcos or their partners may also need to develop the necessary server and client software for specific smart city services, such as real-time transport updates or mobile payments. Furthermore, city officials and other stakeholders may want to be able to access the data generated by smart city services via a straightforward web or app-based interface.

In South Korea, for example, telco KT provides city administrations with a managed platform, complete with large screens showing dashboards displaying key metrics. Deutsche Telekom is developing horizontal M2M enablers that can be used across different vertical sectors and will allow data from multiple sources to be combined easily.

Service delivery

Offering near-ubiquitous coverage and, therefore, immediacy, mobile networks are well-suited to the delivery of smart city services, such as real-time traffic or transport information, to businesses, individuals and machines. For example, a mobile network can be used to switch on street lights in the case of fog or overcast conditions or to inform bus drivers of an incident that is blocking their route. In the case of services aimed at consumers, the ubiquity of mobile handsets means they are often better suited than PCs to the provision of services aimed at all citizens, including those without computer skills or at the bottom of the economic pyramid.

Mobile networks and devices also enable individuals to interact with smart city services wherever they are. "Mobile services can be used to match supply and demand in real-time," noted Jen Hawes-Hewitt, a Global Intelligent Cities Strategist at Accenture, in an interview for this report. She gave the example of how part-time and casual workers, such as parents and pensioners, could use their mobile handsets to indicate to a recruitment agency their availability for work in specified windows of time. The agency might reply with a message offering them a specific job nearby for a specific time slot. Over time, individual workers would build up a track record for punctuality, reliability and trustworthiness, enabling them to qualify for more demanding (and better paid work).

Authentication, security and billing

Mobile operators can authenticate devices and machines using a SIM application on a UICC (Universal Integrated Circuit Card). This capability could, for example, be used to authenticate citizens voting electronically in elections or to ensure that only authorised city officials can view sensitive data, such as the location of police officers. Once a device or machine has been authenticated, the use of encryption algorithms, and the complexity of the air interface protects traffic over the network, making cryptographic attacks near-impossible to achieve in real time and, otherwise, extremely difficult to execute.

A mobile operator's billing systems can also be used to charge individuals or companies for smart city services on a recurring or pay-as-you-go basis. By using the operator's billing systems to generate charges and to understand the connectivity used by individual devices, third parties can pass on charges (if the business model for the smart city service is designed around that model) or be assured that the charges being levied by the mobile operator to a third party are accurate.

Equally, operator billing systems can be used to manage other forms of contract. Wholesale agreements with companies or enterprises can be facilitated to provide a single bill for a large number of individual devices, even when those devices may not be tied to an individual person. This makes the operator capable of providing bills to customers with large numbers of traditional machine-to-machine devices as a consolidated bill. Operators can support any form of charging model, from a flat rate monthly service charge to a highly granular bill, with detail of each individual occasion of device-network interaction. No change in network technology is required to enable this, only an understanding of the contract and suitable software changes to reflect the billing model on the customer bill itself.

Customer care and customer support

Telcos could use their existing retail stores and call centres to promote and support smart city services. Retail staff, for example, could demonstrate smart city services and provide customer care, potentially in return for a fee from the ultimate beneficiary. Although operators have traditionally provided remote customer care via call centres, they have increasingly been moving this service online as a cheaper, more efficient option. Operators are also accustomed to supporting corporate accounts, involving large numbers of devices, such as a sensor network.

Barriers to the adoption of mobile smart cities services

Notwithstanding the potential benefits of smart city services and the considerable capabilities of mobile networks and mobile operators, there are many potential barriers to the roll out of mobile smart city services. These fall into the following categories: business models, operational challenges, security and privacy considerations and technical issues.

Business models

- **Funding** – A scarcity of public funding means that most cities won't be able to fund smart city projects up front, limiting the potential financial returns available to service providers. Mobile operators may need to adopt longer-term and more strategic business models than they are accustomed to. They may need to adopt a shared risk/shared responsibility approach.
- **Pre-conceptions and a lack of understanding of the smart city opportunity** – Many mobile operators are either unaware of the smart city opportunity and are ill-equipped to pursue it or are unwilling to engage with financially-constrained municipalities.
- **Cost of connectivity** – Municipalities can be reluctant to pay a mobile operator monthly fees to transmit data, SMS and MMS messages. This is one of the factors driving the deployment of municipality-owned fibre/Wi-Fi networks in some new-build cities.
- **Procurement policies** – Municipalities don't typically want to be locked into one supplier of connectivity or computing power. They also tend to run lengthy and resource-intensive procurement processes, which may be influenced by political considerations. In general, municipalities tend to take more time over procurement and are less decisive than private sector companies, resulting in a challenging business environment.
- **Customisation** – While smart city service providers want to achieve economies of scale by selling the same solutions to multiple cities, municipalities often demand customised services that address local factors and political considerations.

Operational challenges

- **Protracted implementation** – In some smart city projects, particularly those involving greenfield developments, the construction phase may take several years, running the risk that the chosen information and communication technologies will be outdated by the time the smart city services are up and running.
- **Need to demonstrate benefits** – The immaturity of the smart city market means that many municipalities are not aware of the potential benefits of smart city services. Mobile operators will typically need to show city officials and other stakeholders what is possible and the feasibility of their solutions.
- **High level of risk** – Some smart city services are mission-critical, in which case there is a high level of risk associated with failure to deliver them. That may mean cities seek to contract with multiple service providers and vendors to build in redundancy and resilience. In practice, this approach could limit the role and potential revenues of any single mobile operator.
- **Difficulty of ensuring necessary quality of service** – Although many smart city services can be delivered using 2G networks, some demanding services, such as connected security cameras, will need more bandwidth. In some cases, the bandwidth available to a security camera may be limited by the presence of other devices also trying to connect to the same base-station. Mobile operators need to highlight to cities that with new 4G-LTE networks, they have more scope to provide individual devices with a specific quality of service (QoS), supported by service level agreements (SLAs). Moreover, mobile standards body 3GPP's Release 7 supports policy and charging control, centred around the QoS Class Identifier (QCI), a parameter which gives network operators full control over the QoS provided for specific services for each of their subscriber groups.
- **Organisational complexity** – Smart city services tend to require the involvement of multiple stakeholders from different economic sectors, potentially requiring complicated and time-consuming partnerships. To manage this complexity, mobile operators may need to work with specialist systems integrators, such as Accenture or IBM.
- **Lack of continuity** – City governments tend to change periodically, so there is a lack of continuity. Newly-elected city leaders may have a different set of priorities to their predecessors meaning smart city projects may be abandoned or altered dramatically.

Security and privacy concerns

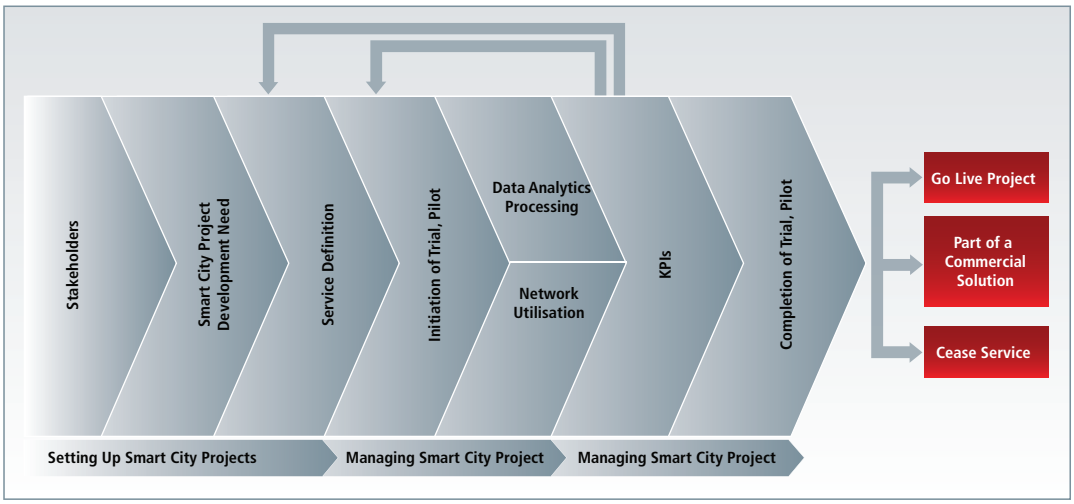
- **Privacy concerns** – The need to safeguard individual citizens' privacy adds another layer of obligations to smart city service providers. In some cases, it may be unclear legally who owns specific data and what can be done with particular datasets.
- **Security concerns** – In many cases, smart city services will require previously closed IT systems to be connected to the Internet. These systems were not designed for this purpose and, regardless of the type of connectivity deployed, there will be a small risk that the smart city infrastructure is hacked and/or disabled by malware. Although cities require very tough SLAs, which impose heavy fines on service providers that fail to keep their infrastructure secure and continuously available, mobile operators need to communicate to the smart city ecosystem that their networks are secure and are accustomed to working with such SLAs.

Technical issues

- **Technical complexity –** Smart city services may involve many different information and communications technologies, including an array of connectivity options, beyond mobile networks. Some mobile operators may not have enough local data centres and computer servers or fixed-line infrastructure and may need to partner with other players to meet a city's requirements.
- **Lack of standards –** The immaturity of smart city services means that there are relatively few technical standards. There is a risk that smart city solutions deployed today may need to be replaced to make them interoperable with future systems. The lack of standards can also make it difficult to combine data from multiple sources.

Guide to Setting up Mobile Smart City Services and Projects

As smart cities are still a relatively new concept, most projects are first implemented as a trial or a project that tests the initial proposition and then refines it before the launch of an actual commercial service. The graphic below maps out the key implementation steps and the feedback loops for a typical smart city pilot project.



Source: GSMA

Beyond this high-level generic framework, the nature of smart city projects, the sources of funding, the approach taken and the role of mobile operators varies considerably from one city to another. Some city administrations are highly-centralised, while in others, individual departments have a high level of autonomy. The available resources also depend heavily on the size and the GDP per capita of the city and the administration's ability to tap public funds for ICT-related projects.

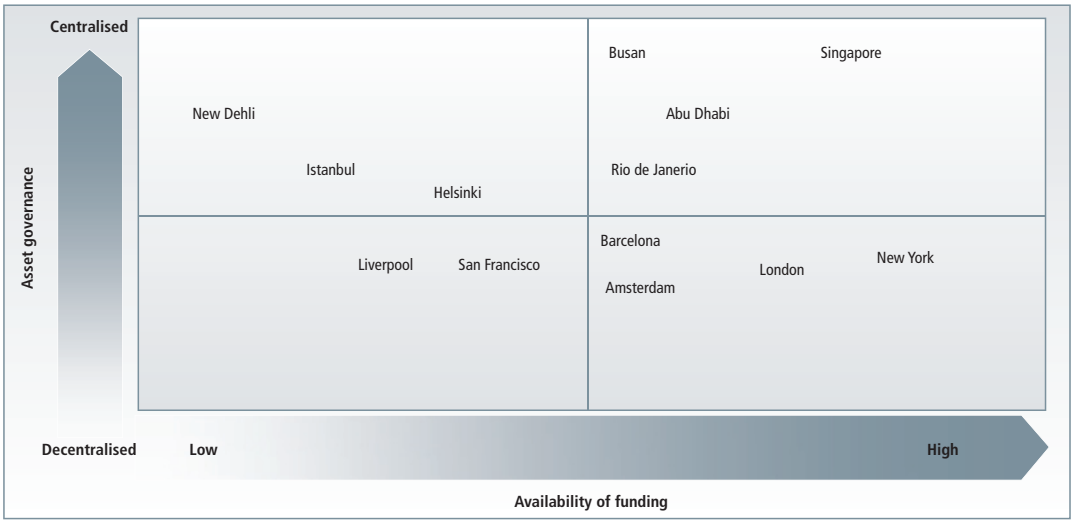
To provide some guidance on how the different characteristics of cities can impact smart city projects, this section classifies cities that might deploy smart city services into four categories (see diagram). The classification of actual cities is indicative, rather than precise. Note, that these classifications will change as cities evolve, expand and adopt different policies.

- Cities that govern assets centrally and have potential access to significant funds (public and/or private).
- Cities with decentralised asset management and potential access to significant funds (public and/or private).
- Cities that govern assets centrally and have limited access to funds (public and/or private).
- Cities with decentralised asset management and limited access to funds (public and/or private).

In each case, we outline the characteristics of these cities, the opportunities they offer, potential sources of funding, their likely approach and the potential role of the mobile operator.

The section then goes on to consider emerging smart city business models, how the performance of smart city services can be evaluated and how they can be scaled both within a city and across cities.

Where a city falls on the matrix below will determine the potential opportunities, the likely sources of funding and what kind of approach a mobile operator should take.



Source: GSMA

Cities that govern assets centrally and have potential access to significant funds

Characteristics

- These cities typically have a significant and dedicated centralised budget for ICT or the development of a local technology cluster.
- In some cases, these are greenfield cities in Asia, such as Songdo in South Korea, or the Middle East being built in partnership by a newly formed administration and property developers.
- Some well-established wealthy cities in Asia, such as Singapore, and the Middle East, such as Abu Dhabi, also fall into this category.
- Cities preparing to host a major sporting event, such as Rio de Janerio, may also have a large centralised budget for smart city services.

Potential opportunities

- These cities are likely to invest heavily in ICT to better inform central planning and drive economic growth.
- Many greenfield cities are also looking to use ICT as a competitive differentiator to help them attract employers and citizens from other cities. These new municipalities want to demonstrate to prospective inhabitants that they will be able to keep the traffic moving, provide efficient public transport and keep the city safe and clean.

Primary sources of funding

- These cities are more likely to consider making significant capital investments. For example, In Singapore, the Land Transport Authority ran tenders and awarded contracts to develop a system to provide citizens with easy access to public transport and traffic information. As well as awarding a contract to NCS, the IT arm of SingTel, LTA also buys cloud-based services from Microsoft's Azure platforms. "Governmental funding is important in the initial stage to keep things going but then as the ecosystem evolves public funding must be reduced and private sector should increase their contribution," said Prof. Jung-hoon Lee, Associate Professor in Graduate School of Information, Yonsei University, South Korea, in an interview for this report.
- These cities may also be prepared to support ICT and start-up companies directly. In South Korea, for example, the Busan Metropolitan Government's App Development Centre provides start-ups with office space, and also, at no cost, equipment for app development, together with testing and consultation services for the apps they are developing. The goal is to establish a sustainable open innovation business architecture to make smart city services become profitable through a multi-phased public-private partnership approach.

Approach

- Top-down, often driven by an empowered chief information officer (CIO) or chief strategy officer (CSO) charged with thinking about how to harness ICT, including mobile networks and services, to build a smarter city.
- The CIO will typically look to a systems integrator or vendor, such as Accenture, Cisco or IBM, to build an overarching ICT architecture that they can use to get a broad view of the way in which the city works. IBM, for example, has installed its intelligent operations center, which is designed "to coordinate and share data in a single view creating the big picture for the decision makers", in Rio de Janeiro in preparation for the forthcoming football World Cup and Olympics.

Role of the mobile operator

- A smart city initiative in a centralised, well resourced city is likely to be led by a systems integrator, but telcos should aim to engage early enough and deeply enough to ensure they secure a pivotal role, rather than simply being a commodity supplier of connectivity.
- In greenfield cities, a telco could seek to engage with multiple stakeholders in addition to the municipality, to ensure that its smart city solutions are considered during the planning phase. These stakeholders might include property developers, utilities, fire and police departments and regional development organisations, as well as systems integrators and technology vendors.

Cities with decentralised asset management and potential access to significant funds

Characteristics:

- In these cities, the municipality tends to have a relatively large budget, but has little room for manoeuvre, as funds are dedicated to specific services, such as public transport, schools, road-building or emergency services. It is generally difficult for the city administrations to reallocate money from one service area to another in the way that a private company can.
- ICT (and mobile technologies) tend to be evaluated separately by individual city departments, such as the fire service, the transport authority or the waste management service.
- Heavily regulated private companies may own and operate key assets, such as the electricity grid or water network, rather than the city administration.
- The cities in this category tend to be well-established, large and relatively wealthy cities in Europe and North America, such as London, New York, Amsterdam and Barcelona, without a strong tradition of central planning. In London, for example, 32 boroughs run local services, such as street lighting and waste management.

Potential opportunities:

- Individual city departments may be able to invest large sums in ICT that can significantly improve efficiency, provide an assured return on investment, will create jobs, generate revenue or will make a major difference to the effectiveness of mission-critical services, such as public transport, social support and emergency city services, such as police.
- Private sector companies may be prepared to fund smart city services that enable them to interact with an affluent base of citizens.
- Businesses based in these cities may be prepared to pay for smart city services that make them more efficient and effective.
- These cities tend to have large numbers of affluent citizens who may be prepared to pay for smart city services that remove some of the frustrations of everyday life.

Potential sources of funding:

- Public-private partnerships are significant sources of funding for these cities.
- Banks may also be prepared to fund the rollout of smart city infrastructure that could be used to sell new services to consumers and companies.
- A municipality may be able to raise funds for smart city projects with a clear business case. For example, smart city projects that improve a city's resilience may enable a municipality to reduce its insurance premiums. However, the city administration will typically look to partner with private companies, rather than try to fund new infrastructure entirely from the public purse. Although Amsterdam smart city initiative was initiated using a EU grant, Amsterdam's Climate Street project is supported by a climate and energy investment fund created when the electricity and gas company was privatised. Initiated by Amsterdam City and local utility Liander, the project is managed by Club van 30, supported by Vodafone, Amsterdam City, Home Automation Europe, Plugwise, JCDecaux, Philips, TNT, L.A.J.Duncker and TAUW.
- These high-profile cities may be able to attract national government funding for trial projects on the basis that, if the pilot proves successful, other cities will see the benefits and invest in similar programmes. For example, the SFpark project in San Francisco, which captures and distributes real-time information on available parking spaces, is 80% funded by the U.S. Federal Government. The project may generate a small amount of revenue for the city by increasing utilisation of parking spaces and by better matching parking tariffs to demand. Most of the other smart city projects in San Francisco are also financed through grants or through public private partnerships in which companies provide funding and city officials give their time – San Francisco's administration tends not to make a financial contribution, only human resources.
- Similarly, in the European Union, the European Commission has launched the Smart Cities and Communities European Innovation Partnership[6] to pool resources to support the demonstration of energy, transport and ICT innovations in urban areas. The Partnership, which runs yearly calls for proposals, plans to award funds of €365 million in 2013, up from €81 million in 2012. Each and every demonstration project financed under the scheme must combine all three sectors – energy, transport and ICT. The EU plans to help to establish strategic partnerships between those industries and European cities to develop and roll out the urban systems and infrastructures of tomorrow.
- The European Union also financed a number of smart city projects through its Seventh Framework Programme for Research (FP7). In just one example, it contributed two million euros towards the iCity project, in which Barcelona, Bologna, Genova and London are taking a common approach to building an open data platform that software developers can use to create applications. The iCity project is funded through the Competitive and Innovation Framework Programme.

Approach to smart city projects

- Typically bottom-up with private companies and city agencies experimenting with ICT solutions and services that solve a specific city problem. However, the central municipality may provide data and some staff time to facilitate trials and pilots by local companies and interest groups. This approach can tap the creativity of many different stakeholders, but the resulting services may not be interoperable and may overlap.
- Some of these cities may go as far as building a centralised marketplace for public and private data that can support the creation of citizen–centric apps and services. Cities that run and manage these kinds of smart city competency and project management programmes tend to employ advisory boards on which both cities and technology companies are represented. The Greater London Authority, for example, doesn't have a CIO, but it is assembling a Smart London Board, which will advise the administration on its smart city strategy.
- In some cases, these cities may be influenced by a visionary, such as a mayor, a leading architect, an urban developer, planner or a chief strategy officer (CSO), who will bring different agencies together to co-operate on specific projects. A compelling high-level vision (underpinned by a business case) that appeals to city leaders might cut across traditional silos and catalyse cross-department co-operation.

6 http://ec.europa.eu/energy/technology/initiatives/smart_cities_en.htm

Role of mobile operator:

- In these decentralised cities, a mobile operator should consider engaging with two related city services, for example, parking and traffic management, to develop a solution that would benefit both. This might allow operators to create an integrated view across different services and establish relationships with multiple stakeholders.
- A mobile operator can also deliver value to the city through the analysis of the data generated by its networks to yield new insights that could enhance public and private services. For example, a mobile operator's location data may show that in certain areas of the city drivers spend a relatively long time looking for parking spaces.
- To gain credibility, a mobile operator could consider working with a respected university and partners actively pursuing smart city projects.

Cities that govern assets centrally and have limited access to funding

Characteristics

- These are cities that see the value of central planning and coordination, but lack the public funds or access to private funds to fully implement this vision.
- These cities, such as New Dehli or Nairobi, are typically in developing Asia or Africa. However, the financial crisis has also pushed some southern and eastern European cities into this category.

Opportunities:

- The limited funds in these cities are likely to be spent on the political priorities of the city administration, whether that be fighting crime, increasing resilience or reducing traffic congestion.
- Individual citizens or companies may be prepared to pay for smart city services that remove some of the frustrations of city life, such as advance notice of power outages.

Potential sources of funding:

- Revenue-sharing/public-private partnerships in which the participants share the risks and the benefits. A private company, such as a telco, might fund the deployment of smart city infrastructure, for example, on the basis that it will receive ongoing management fees once services are up and running. In some cases, revenue sharing models may be appropriate. However, in cases where the revenue streams aren't large, other benefits to a commercial service provider, such as churn reduction and strategic relevance, may also need to be considered. In many of these public private partnerships, the participating private companies are looking for a "pioneer smart city" to develop and refine solutions they can then sell on to other cities.
- Examples of public private partnerships in the smart city space include the Istanbul in Motion trial, which aims to make public transport in the city more efficient and cost-effective. The project was initiated by IBM and Vodafone, which reached out to the Istanbul Municipality and the costs of a trial have been shared between IBM, Vodafone and the city.

Approach

- These cities are keen to main central control, while tapping the funding and creativity of the private sector. This may lead to the establishment of a central entity that coordinates the efforts of private companies. These cities can learn from successful smart city agency launches in such cities as Helsinki. The city founded Forum Virium Helsinki - a centrally coordinated forum which can act as an advisor, connect relevant stakeholders or fully execute a project - in 2005, with the involvement of private sector companies Elisa, Nokia, TeliaSonera, Tieto and YLE Finnish Broadcasting Company. A subsidiary of the City of Helsinki Group, Forum Virium Helsinki develops new digital services in cooperation with companies, the City of Helsinki, other public sector organisations and Helsinki residents.

Role of the mobile operator

- Mobile operators might consider establishing PPPs and working directly with city leaders. There may be opportunities to obtain access to data held by the municipality or special licenses to test new services in exchange for investment in the city.
- Wherever possible, mobile operators need to achieve economies of scale by deploying standardised solutions. While many of these cities will look for custom-built solutions, these may be very expensive to maintain and upgrade over time.

Cities with decentralised asset management and limited access to funding

Characteristics

- Typically smaller cities in Europe and North America, such as Liverpool, San Francisco, or Charlotte (North Carolina), with relatively small municipal budgets and no strong tradition/culture of central planning. However, some of these cities may be able to tap into various sources of private funding.

Opportunities

- Private companies may be prepared to help fund projects that will directly benefit them. For example, a utility may be prepared to install smart metering infrastructure that will help it reduce the peak loads on its grids.
- These cities may prove to be good test-beds for business models based on open data and innovation marketplaces (see next section).

Sources of funding

- Many projects in these cities are funded by the private sector. For example, Utility Duke Energy provided $4.1 million to set up the energy efficiency project in Charlotte, North Carolina, while Cisco and Verizon contributed a further $1 million each. The project, called Envision Charlotte, is focused on uptown Charlotte's business community and targets only office buildings with more than 10,000 square feet. The project, which uses connected electricity meters to better match supply and demand and educate employees on more efficient energy usage, is managed by Envision Charlotte, a partnership between Charlotte City Center Partners, Duke Energy, Verizon Wireless, Cisco, The city of Charlotte, the Bank of America, Wells Fargo, and The Environmental Defence Fund. For Duke Energy, the project helps it anticipate and meet peaks in demand, without having to invest in costly new generating infrastructure. The North Carolina Utility Commission re-pays Duke part of the lost revenues resulting from reducing energy consumption. The metering infrastructure was provided by Cisco and connectivity by Verizon, which provides its 4G LTE network deployed in Uptown Charlotte and repeaters in some buildings to ensure connectivity.
- Telcos might also consider funding small-scale smart city services out of research and development budgets. Deutsche Telekom, for example, funds and manages the projects it has set up in Friedrichshafen, its smart city test bed, on the basis that it be able to sell the resulting solutions to other cities. DT's partners in Friedrichshafen include Alcatel-Lucent, Samsung, the German Association of Towns and Municipalities and the University of Bonn.
- National governments or the EU may also be prepared to fund small-scale trial projects on the basis that they could be replicated elsewhere. Glasgow, for example, has won a competition by the UK government, securing it £24 million to implement smart city projects; The government also provided funding for smart city feasibility studies, giving £50,000 each to 30 other cities across the UK.

Approach

- These cities may create open data web portals that make selected datasets, for example, in transport, public spaces and business community sectors, available to application and service developers. For example, San Francisco's online open data depository provides a platform that third parties have used to create apps and services, such as a map of privately-owned, but publicly-accessible, spaces in the city and a service that shows people where they can recycle, reuse or compost specific products and materials. In Barcelona, the city and the local government provide 68 open datasets.
- These cities may also be prepared to let private companies make use of municipal infrastructure to test new ideas. San Francisco is setting up a "Living Innovation Zone" to enable businesses to access city assets in exchange for testing new technologies and services. This approach, which mirrors that taken by San Jose and Paris, is designed to encourage the deployment of innovative smart city services without impacting the city budget. Participating companies are effectively given access to a test-bed, which enables them to trial new services in a real city environment rather than a lab.

Role of the mobile operator

- Mobile operators might consider testing big data business models, combining data from multiple sources (see next section), in these kinds of cities.
- When it comes to actual deployments, mobile operators need to exploit economies of scale by replicating the same solution across other cities, reducing the pressure to make money on the first deployment. Decentralised, low budget cities are more likely to be open to off-the-shelf solutions than centralised cities in which the municipality wants to retain a high level of direct control.

Generic considerations

In addition to the classification above, operators may find other city surveys useful (e.g. the city power and service analysis provided in the Arup's C40 Climate Action in Megacities report and the smart grid archetypes in cities developed by Accenture in the report Accelerating Smart Grid Investments).[7]

In most cities, regardless of the size of their budget and their degree of centralisation, the following factors should be taken into account:

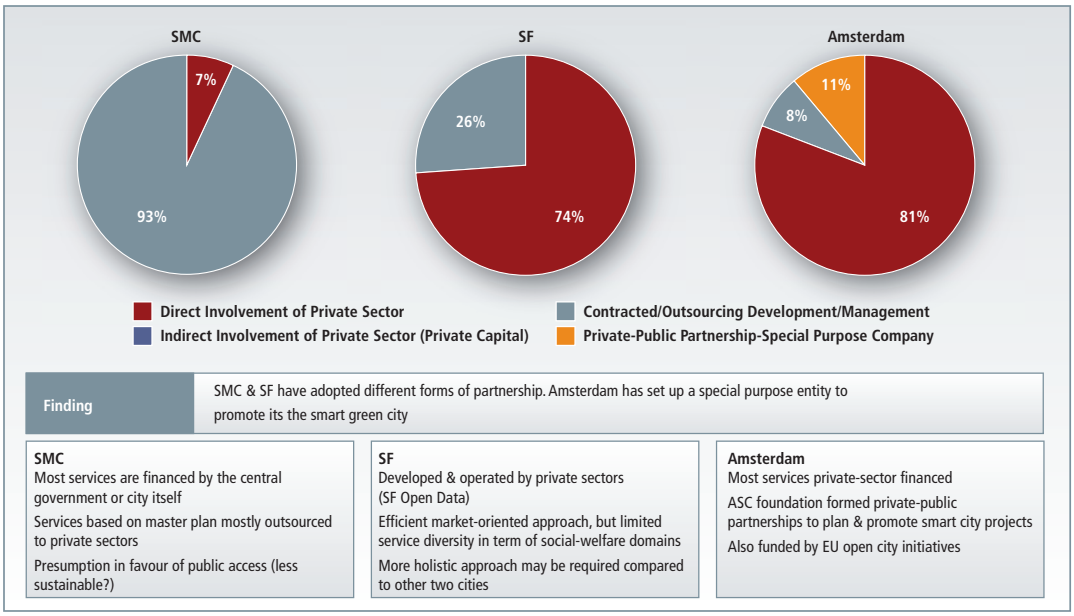
- As the smart city market is still in its infancy and cities are not yet mature buyers of "smart" services, procurement processes are likely to be slow and cumbersome. City officials will typically want to run open tenders for infrastructure/services and will be nervous about lock-in to a single vendor. In these circumstances, rival mobile operators need to consider working together, to present the city with a low-risk and comprehensive solution. Private sector consortiums can also be simpler for the city to deal with, providing a single point of contact. On the downside, the involvement of many stakeholders will require tight project control, coupled with the governance flexibility to adjust to inevitable changes in the scope of the project.
- Smart city solutions can't be too rigid and must be able to adapt to changes in local priorities. ICT research firm Gartner notes: "The absence of any strategic planning is unacceptable, but it is essential to use techniques that help deal with uncertain futures, like scenario planning. They would lead to alternative strategic plans (depending of how technology, economy and society would interact to shape the future) and to identify those commonalities across plans that indicate relatively safe bets for investment."[8]
- Politics tends to play a pivotal role and political leadership can be the key to overcoming smart city inertia. "The lessons from Seoul, San Francisco, Amsterdam and so on is that you need strong political leadership with a broader vision," said Shane Mitchell, Head of Urban Programs, Innovation. Public Sector Practice, Cisco Internet Business Solutions Group, in an interview for this report. "Any operator has to get mindshare with political leaders and you are able to get that by doing some real projects. There is no quick fix."

7 http://www.arup.com/Publications/Climate_Action_in_Megacities.aspx
http://www.accenture.com/in-en/Pages/insight-smart-grid-investments-summary.aspx

8 http://blogs.gartner.com/andrea_dimaio/2012/12/14/smart-cities-are-not-intelligent-they-are-astute/

- "Greenfield" smart city opportunities and centralised municipal tenders are few and far between. Most projects will be implemented in "brownfield" cities. The majority of these cities – even those with balanced municipal budgets -- will be seeking private funding to complement their existing resources. The development of public-private partnerships, in which the participants share the risks and the benefits, are high on the agenda of most smart cities.
- The formation of partnerships is crucial. "The very generic partnership is when the city hires IT companies to develop and maintain the services. Data centre management is one example for maintaining the services," said Prof. Jung-hoon Lee, Associate Professor in Graduate School of Information, Yonsei University, South Korea, in an interview for this report. "Some cities want to keep data centre as internal human resources for control purposes where as others have them outsourced. We found that there are pros and cons for every partnership depending upon the level of participation from private companies to develop and serve smart city services." The graphic below shows the different approaches to partnerships taken by Seoul (SMC), San Francisco and Amsterdam.

Partnerships type & Collaboration (based on sample of services in 2012)



Source: Toward a framework for Smart Cities: A Comparison of Seoul, San Francisco & Amsterdam by Jung-Hoon Lee, Associate Professor Graduate School of Information, Yonsei University, Seoul, Korea & Marguerite Hancock, SPRIE, Stanford University, 2012

Emerging business models for smart cities

Some smart city applications, such as connected street lighting or connected waste collection systems, can result in significant financial savings for the municipality, making it relatively straightforward to build a business case and a business model for the value chain. However, broader smart city services, which cut across several different sectors, don't always have a clear short-term business case.

For some services, the business case may be longer-term – an intelligent transport system might reduce congestion, increasing economic activity in the city and ultimately lift the local government's tax intake. A pollution monitoring system might enable a city to improve its air quality, attracting more talented people and new businesses, while reducing the burden of cost on the local health authority from having to treat people with respiratory disorder.

For telcos, there may also be strategic benefits in being involved in smart city services, which could open up new business models, involving the use of real-time analytical data, in the medium-to-longer term.

Innovation marketplaces and open data

As well as increasing the operational intelligence of municipalities and enabling the development of new services for citizens, the large volumes of real-time and historical data captured by smart city projects could be of significant value to private companies. For example, retailers and restaurateurs might be prepared to pay for real-time data on how people move around the city, which helps them anticipate busy periods or pinpoint where to open new stores. Transport timetables and information about location and amenities in public spaces, such as parks, have become the basis for many mobile applications for citizens and companies.

The challenge for smart city service providers is to find a cost-effective way to monetise this data. One way may be through some kind of innovation marketplace in which both real-time and historic information can be bought and sold as part of a secondary market. In an interview for this report, Margarethe Theseira, Senior Manager at Greater London Authority Economics, said that the mobile operators that supply datasets into the iCity platform could potentially charge private companies to use that data as the platform has functionality which would allow this to happen. (However, she believes public services shouldn't pay to make use of data supplied by mobile operators and other private companies.)

Of course, the commercial use of smart city data, which goes beyond high-level statistics on the economy or the location of city assets, will need to be subject to checks and balances that safeguard the privacy of individual citizens.

Some cities, such as San Francisco and Helsinki, Paris and Barcelona have created open data web portals that make selected data generated by city services available to anyone, including application and service developers. Mandated by the mayor, San Francisco's online open data depository provides a platform that third parties have used to create apps and services, such as a map of privately-owned, but publicly-accessible, spaces in the city and a service that shows people where they can recycle, reuse or compost specific products and materials.

Mobile operators have a track record of keeping large volumes of sensitive data secure. In time, they may be able to play a strategically important role as a data broker that is able to generate revenues by providing insights to both companies and individuals. "Mobile operators are holding back because they aren't sure of the business model," noted Jen Hawes-Hewitt, a Global Intelligence Smart Cities Strategist at Accenture, in an interview for this report. But she believes operators will be able to monetise the data they capture. "Open data shouldn't equal free data."

Deutsche Telekom envisages that in time only a relatively small portion of machine-to-machine (M2M) revenues will be generated by connectivity. It anticipates that the majority of the revenues from M2M services will come from systems integration and data intelligence. In four to five years,

DT believes that data will become the primary value driver behind M2M and smart city services. "With billions of devices to be connected, we will have a lot of data…sooner or later we will need someone to handle that data or provide it to others," said Jürgen Hase, Vice President of M2M Competence Centre at Deutsche Telekom. "Data is very important, it is the currency of the future".

Mobile operators may be prepared to add some anonymised data, generated by their networks and services, to open data initiatives to encourage other service providers to do the same and begin to seed this market. Or mobile operators may be prepared to share some of their data as part of a broader trust and relationship building exercise with city administrations and app developers. Another possibility is that mobile operators trade data with other service providers, again subject to privacy safeguards.

However, in some countries, privacy concerns means that telcos (and other service providers) are not allowed to "own" customer data, potentially limiting the data-based services they can develop and offer commercially. In these cases, telcos need to work with regulators to explore how they can use customer data to enhance the lives of citizens, while making an appropriate return on investment.

Cloud-based, pay-as-you-go models

For municipalities and real-estate developers, making use of cloud-based or managed smart city services, billed on a pay-as-you-go basis, is likely to be more cost-effective than deploying their own dedicated infrastructure. As well as reducing the need for up front capital spending, a service provider may be able to achieve economies of scale and scope that a municipality or developer could not.

A telco could, for example, provide a connected parking service to the city, charging the municipality a fee in exchange for directing drivers to empty spaces, operating car parks and collecting charges.

In the medium to long term, citizens may also shift to cloud-based services and solutions, in which the individual no longer owns the assets, but pays for the use of them as part of the service. For example, a homeowner might simply pay monthly for a solution that keeps their house at an optimum temperature when it is occupied, rather than buying a boiler or air-conditioning, installing insulation and paying for the power they use. A telco could provide that service, subcontracting the energy supply and building work to specialists.

However, some local governments are concerned about the implications of cloud-based services for citizen privacy and data ownership. Moreover, they may not be prepared to give any one service provider a monopoly, thus limiting the opportunities to achieve economies of scale.

Citizen engagement

To be successful, most smart city services will need to engage citizens. For example, a traffic management system won't fully realise its potential unless large numbers of drivers actually sign up to receive alerts and information. One way to engage citizens is to use crowdsourcing techniques, through social networks and other media, to source ideas and information and assess how much individuals value particular services. They can also encourage individuals to take ownership of specific local issues. For example, individuals could be encouraged to "adopt" a pot-hole and ensure that it gets fixed – an approach that has been put forward by such cities as New York in the US, York in the UK, Krakow in Poland and Bangalore in India.

In this context, visibility and transparency are important. It needs to be easily apparent to citizens how a service works and what it is trying to achieve. Smart city solutions should ideally be supported by apps and web portals people can use to provide input, feedback and exchange information and ideas. Service providers could also use mobile messaging to canvas citizens' opinions directly or to alert them to events that might impact them – mobile can provide an immediacy that may be valuable in some situations. However, service providers should limit such messages both to avoid irritating citizens and to ensure they take such communications seriously.

Service providers can, of course, also engage with stakeholders, including individual citizens and app developers, in person. Deutsche Telekom, for example, uses its "T-Lab" to conduct customer research and run focus groups involving both consumers and software developers. In the case of greenfield cities undergoing construction (which don't have any citizens yet), service providers may have to rely entirely on market research among potential citizens to gauge the value of potential smart city projects.

Evaluating smart city projects

Establishing frameworks for the evaluation of costs and benefits of smart city projects is crucial to justify the investment from municipalities, private sector and financial institutions.

While most private industry projects are subject to rigorous validation processes to calculate and compare their returns on investment, few cities have any established processes in place for smart city projects. Many municipalities view these projects as experiments or research and development, rather than projects that deliver specific financial and operational benefits, and do not use very rigorous or well-developed evaluation mechanisms.

Where evaluation mechanisms are in place, city administrations tend to use a diverse set of key performance indicators (KPIs) to evaluate the success of specific projects. These KPIs may reflect the city's environmental and social goals, as well as its economic objectives. For example, officials might evaluate a road toll system by measuring cost savings, return on investment, greenhouse gas reductions, congestion and citizens' perceptions. However, in cases, where a city makes a large upfront investment, financial metrics are likely to be very important, so city officials can demonstrate that tax payers are getting good value for money.

Still, there is a potential mismatch between the broad set of socio-economic and environmental KPIs used by cities and the narrow, financially-focused KPIs typically used by private companies. For a mobile operator, return on investment will clearly be a key metric. But this needs to be measured in a holistic way. A smart city project might reduce churn, improve the telco's reputation (net promoter score) and open up longer-term revenue opportunities to provide managed services, which could be realised four or five years after the project was first initiated. In other words, traditional telco metrics, such as ARPU and number of connections, aren't necessarily appropriate when it comes to evaluating the potential return on an investment in a smart city project.

Here are examples of the KPIs used by live smart city projects and trials to evaluate their success:

Istanbul in Motion - public transport project in Istanbul, Turkey

- Reduction of costs of transport;
- Reduction in pollution, resulting in healthier living conditions and attractive location for business.

Envision Charlotte - energy efficiency project in Charlotte, USA

- The goal is reduce the use of environmental resources by up to 20% for each of the four project's pillars (energy, water, air, waste) within five years;
- Quantitative analysis of energy reduction by a 3rd party;
- Citizens' awareness;
- Whether Charlotte's image is "greener"..

Amsterdam Climate Street – energy efficiency and waste management project in Amsterdam, The Netherlands

- Energy and cost savings;
- CO2 reductions.

Smart municipal recycling service in Cubas de la Sagra, Madrid, Spain.

- Savings by the city from the reduced number of trucks on the streets;
- CO2 reduction from decreasing congestion on the streets.

In some cases, the impact of smart city projects may be difficult to evaluate in the short-term. Some benefits, such as changes in citizen behaviour, may take time to bring about, requiring a medium-to-long-term perspective.

Scaling up smart cities projects

Do smart city projects scale, and what are the potential benefits of scalable and interoperable solutions?

In an environment where funding is limited, smart city projects need to be as scalable as possible. If a smart city service provider can deploy reusable and interoperable solutions (even those with customisable elements), the design and development costs can be spread across a larger customer base, generating economies of scale.

As specific smart city solutions become tried and tested in real deployments, service providers need to transition from running every project as a small-scale test-bed and aggressively seek scale. Given the scarcity of funding, mobile operators need to generate economies of scale by making their smart city solutions as replicable as possible – ideally, they need to be planning the next deployment, while working on the initial deployment.

There are two main ways in which a smart city project can be scaled – it can be expanded within a city and it can be replicated in other cities. Both can be hard to achieve.

Expansion within a city

One of the chief obstacles to taking a smart city project from the pilot stage to full commercial deployment can be the diversity of the players involved and the difficulty in aligning their interests and objectives to generate the necessary funding. Many smart city services are set up as research and development projects and are funded on that basis, so they aren't necessarily built to be self-sustaining. Whereas a city might be able to secure a grant from a government to install a few dozen electric vehicle charging stations, for example, it will likely struggle to raise the funds to blanket the city with such stations.

This issue can be compounded by the relative autonomy of city agencies – they don't always coordinate their activities or pool funds in the way a large scale or holistic smart city solution might require. Although city-wide sensor networks, for example, could be used for a variety of purposes, such as monitoring air quality, traffic congestion and weather patterns, and should, therefore, be funded centrally, few administrations have a budget they can use for projects that cut across different municipal agencies. "One of the challenges is organisational," said Melanie Nutter, Director, Department of the Environment, City and County of San Francisco, in an interview for this report. "Each city agency works somewhat independently – we don't have smart city budgets."

Another hurdle is technical uncertainty: A city may be reluctant to deploy a large scale solution until more technical standards have been developed and it knows it won't be locked into a single vendor and proprietary solutions.

Today, some smart city solutions, such as connected street lighting, connected garbage collection and connected parking services, can save or make significant amounts of money for a specific city department. To facilitate the development of a smart city, the money saved or generated could be put into a central budget designed to support the roll out of services that lack a short-term business case, but can improve the quality of life in the city and help attract talented people and growth companies.

Here are some examples of smart city projects that are beginning to be expanded within the same urban area.

- Envision Charlotte, in Charlotte USA, is looking to extend its energy efficiency solution beyond business parks to other energy users and potentially apply the same technologies to other utility services, such as water provision.
- Amsterdam' Climate Street project is developing a blueprint for sustainable shopping streets, which could be deployed in other parts of the city.
- In South Korea, the Ministry of Knowledge Economy, and the KT and SK Telecom-led private consortiums are planning to extend the smart grid services they are developing to other cities and integrate them with smart cities services.

Replicating a solution in other cities

A telco's ability to replicate a smart city solution can be jeopardised by the need to deploy tailored solutions. Rather than buying off-the-shelf systems, city administrations may favour fully-customised solutions delivered by local companies. Customised solutions, which will lack economies of scale, may be expensive to both develop and maintain, making them ill suited to wider deployment. To date, most early smart city solutions have been purpose-built to the requirements of local municipalities, but there are signs that the sector is beginning to move towards adopting standardised solutions that can be more easily replicated across cities. For example, many of the proposals in a competition for smart city funding run by the UK government were based on off-the-shelf solutions designed to keep costs down.

One way to generate scale is to create a standardised technological platform that app developers can then use to build services that can be rolled out across multiple cities. A telco could, in effect, release a software development kit (SDK) that will enable third party app developers to create services on top of its core smart city platform. For example, the smart city platform would release information on available parking spaces using standardised APIs, so app developers could easily offer the same parking apps across multiple cities. The availability of a large number of compatible apps would make the underlying technological platform more attractive to multiple cities. Having already created a smart city platform that is generating economies of scale, KT is building an SDK designed to accelerate the development of compatible services and applications.

A telco should also consider an international partnership with a major technology company or systems integrator that will help it transplant smart city solutions across national borders. Such international partnerships will remove the need to start from scratch with new partners in each city. Vodafone Global Enterprise, for example, has formed a partnership with IBM, while KT has partnered with Cisco. After implementing smart city services in several greenfield cities in South Korea, KT and Cisco are now engaged in similar projects in the Middle East and Malaysia. Clearly, the telco needs to ensure that any such partnership is structured in a way that enables it to capture a significant portion of the value from smart city projects.

The alternative approach is for a mobile operator to partner with a systems integrator within the same telecoms group – this is the approach taken by Deutsche Telekom and Telefonica. DT's T-Systems division spearheads its smart city initiatives, sourcing connectivity from T-Mobile and the fixed-line division as appropriate. Telefonica, meanwhile, has set up a new business unit, Telefonica Digital, which competes with the core business in some respects and yet uses many of its assets. Telefonica treats its investment in Telefonica Digital as a long-term, strategic investment in a start-up that isn't expected to make a financial return in the near-term.

Here are examples of smart city projects that may be replicated in other cities.

- In Singapore, the Land Transport Authority's mytransport.sg portal has prompted the creation of 23 mobile apps since it was set up in 2010. NCS, the IT arm of SingTel, is looking to use its experience in Singapore to create urban transport solutions for other cities. It has entered into a partnership with MHI Engine Systems Asia and the National University of Singapore to develop an Urban Mobility initiative to explore the use of advanced technologies to improve urban mobility.
- Deutsche Telekom is rolling out services developed in its test-bed in Friedrichshafen to other German cities.

The importance of standards

One way to make smart city solutions more scalable would be employ technical standards that would assure potential buyers that they are not buying a system that will become quickly obsolete. Today, that is a risk. Smart city solutions are generally not based on standards and may have to be replaced if and when the market moves to standardised solutions.

Moreover, the lack of standards means that systems from different vendors are not generally interoperable, so a city either needs to buy all the relevant ICT systems from one vendor, spend time and money on systems integration or accept that these systems won't be able to work together and exchange data.

Common protocols and standards could help solve the systems integration problem and enable municipalities to buy smart city solutions from multiple vendors. The widespread deployment of standardised solutions may also enable suppliers to achieve economies of scale. "There is a role for the mobile industry to start creating standards," said Peter Manolescue, M2M Innovation Manager at Vodafone Netherlands, in an interview for this report. "It might go a long way to solving the integration problem. Cities reconfigure themselves all the time, so you need a system that is very flexible. It mustn't cost very much to change and it mustn't cost very much to manage."

Conclusions and next steps

Although the smart city should be viewed primarily as a medium-to-long term strategic opportunity, now is the time for mobile operators to engage in this fast emerging market. Mobile operators' services could become an essential part of the city's social infrastructure, creating a platform for future revenue-generating services. The data captured by smart city solutions can be valuable - retailers and restaurateurs, for example, might pay for real-time data on how people move around the city, which helps them anticipate busy periods or pinpoint where to open new stores.

Smart cities may also open up other new sources of revenue for telcos. In the medium to long term, there may be a shift to cloud-based services and solutions, in which the city or the individual no longer owns the assets, but pays for the use of them as part of the service. These cloud-based services will depend upon connectivity, authentication and billing – core telco competences.

Next steps

Build city intelligence: Mobile operators should consider investing in building market intelligence and acquiring knowledge of city customers. At a minimum, operators need to understand the smart city agenda of municipalities to answer such questions as: What are the key challenges faced by each city? What city assets are controlled by municipalities and which assets are in private ownership? And who are the buyers and principal users for various smart city services?

Engage with municipalities: There are different models for successful engagement with municipalities. One of them involves partnering with private companies and international organisations to highlight to municipalities and local authorities the benefits of mobile-based smart city services. In 2013, the GSMA , for example, will run several summits for smart city CIOs. Moreover, mobile operators will need to develop marketing messages that will be understood by the cities that do not always think in terms of net present value and return on investment.

Review internal approach to smart city planning and organisation: Dedicated smart city divisions are not a must, but telcos are likely to need a distributed network of specialists across the organisation who can support the development of different city angles. Mobile operators need to combine a mix of vertical, M2M and cross-functional skills (e.g. cloud-based services and dealing with open data) to work successfully with smart city municipal teams.

Develop evaluation framework for smart city projects: Mobile operators, the GSMA and municipalities should consider working together to develop a robust evaluation framework for the impact of mobile-based smart city services and initiatives.

Participate in standardisation initiatives: Mobile operators and the GSMA should consider working with the municipalities to assess where more standardisation is needed. For example, there may be a need to develop standards–based data formats for municipal services. Operators also could to provide support for standards development work and get involved with national and international organisations, such as BSI (British Standards Institution) and City Protocol, to jointly develop the standards.

Get involved in interoperability work: Mobile operators are encouraged to get involved in the GSMA-led interoperability discussions, launched in March 2013.

Develop privacy guidelines for smart city services: Mobile operators, the GSMA and municipalities should consider jointly workingk with regulators and international organisations, such as the European Union's DG Connect, to develop privacy guidelines for smart city projects.

Smart Cities

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