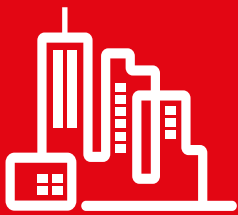**GSMA** Connected Living

Keys to the Smart City

How mobile operators are playing a crucial role in the development of smart cities

Executive Summary

In the future, cities will be much smarter than they are today. They will use information and communications technologies to enrich and enhance city life.

The most densely inhabited cities can remain efficient, lively and sustainable if they are effectively managed and are designed to minimise overcrowding, reduce pollution and tackle other issues for their citizens and business communities.

By harnessing the ongoing expansion in wireless connectivity, the Internet of Things (IoT) is delivering affordable, scalable, secure and proven services and technologies that can address cities' goals. With advances in utilities, fleet management, citizen engagement and other areas, many cities have the foundations in place to take the next step towards an integrated city, fit for future growth.

Mobile operators can provide the vital part of the communications infrastructure that enables a city to become smart. Operators can offer advanced secure networks, management platforms, a high quality of service and intrinsic knowledge of how to build a successful smart cities strategy. If cities engage with mobile operators early in their planning process, they will enjoy significant benefits arising from operators' local presence and fully standardised networks.

Mobile networks deployed in licensed spectrum are well suited to enabling both the development of smart new 'mega-cities' and retrofitting services into existing cities, where they already have extensive coverage and personnel. As a smart city is about more than just connectivity, mobile operators are able to help the city connect with local research centres, create investment opportunities and engage their citizens with compelling services. Ultimately cities can create a smart platform that can significantly change their operating and commercial models. This will enable them to attract companies and residents, in turn making them more vibrant and prosperous.

Together, pioneering smart cities and their mobile operator partners are leading the world in new service deployments and direct engagement with citizens. By developing a long-term, holistic smart cities strategy, and ensuring mobile operators are part of these conversations, cities are able to ensure that they and their partners deliver on the same objectives and build-in flexibility to incorporate new technologies and services in the future.

Introduction to Smart Cities

Cities are in a constant state of flux. From population growth to demolition of the old and creation of new infrastructure, a city is continually evolving. Global challenges, such as immigration, natural resource management and climate change, often manifest themselves directly in urban environments, where fluctuating populations and extreme weather conditions are increasingly the norm. Many cities were built on infrastructure that was designed for a population far smaller and far less active than they have today. The results are traffic jams, pollution and an increased cost of living.
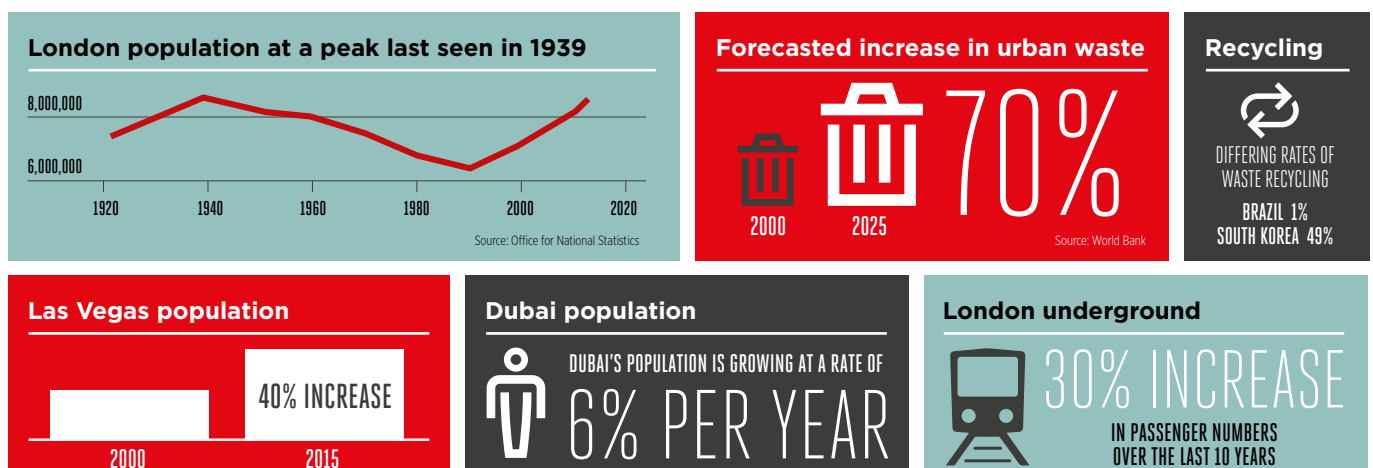
A city is comprised of its citizens, visitors, local businesses and government, together with the services and infrastructure available to help them go about their daily business. These include transport, security, communications and more. To create opportunities for economic growth, a city needs to build the right operating environment for its businesses, engage its citizens with meaningful local services and attract new visitors and new investment into the city boundaries.

Advances in communications technologies, exemplified in the growth and success of the Internet of Things (IoT), create an opportunity for cities to manage these issues, reinvent themselves and connect both their infrastructure and their citizens together

to equip the city for current demands and future growth. By harnessing connectivity, a city can benefit from both improved services and lower costs across a myriad of domains from waste collection to water quality to management of deliveries and authentication of citizens for smart services and travel. This will make the city a more attractive place to live and do business, drawing in new residents and investment.

The development of IoT communication technologies, platforms and services make smart cities easier to design, build and manage. Today's IoT propositions have both breadth, in terms of being applicable to multiple markets within the smart city, but also depth in terms of proven technologies, security and design for scalability.

IMPACT OF THE RAPID GROWTH OF CITIES

London population at a peak last seen in 1939

8,000,000

6,000,000

1920   1940   1960   1980   2000   2020

Source: Office for National Statistics

Forecasted increase in urban waste

70%

2000   2025

Source: World Bank

Recycling

DIFFERING RATES OF WASTE RECYCLING

BRAZIL 1%
SOUTH KOREA 49%

Las Vegas population

40% INCREASE

2000   2015

Dubai population

DUBAI'S POPULATION IS GROWING AT A RATE OF

6% PER YEAR

London underground

30% INCREASE

IN PASSENGER NUMBERS
OVER THE LAST 10 YEARS

Mobile Operators Can Enable Smart Cities Services

A city consists of myriad systems and services spread across a number of key vertical categories. The diagram below gives a flavour of the different smart cities services that can be rolled out. A city doesn't have to adopt every service to be considered smart, but they can be linked by common infrastructure, data sets and technologies. Mobile operators are able to focus on the infrastructure needed to deliver the whole, or focus on individual services to ensure smart cities roll out in the required way.

TRANSPORT				ENVIRONMENT		
	PUBLIC TRANSPORT	TRAFFIC MANAGEMENT	PARKING		AIR QUALITY	WEATHER SENSING	FLOOD CONTROL

SAFETY				UTILITIES		
	STREET LIGHTING	CROWD CONTROL	CCTV		SMART METERING	WASTE MANAGEMENT	SEWERAGE

HEALTHCARE				GOVERNMENT		
	DISEASE CONTROL	EMERGENCY RESPONSE	PATIENT AUTHENTICATION		CITIZEN ENGAGEMENT	MUNICIPAL SERVICES	INFRASTRUCTURE MONITORING

ENTERTAINMENT AND TOURISM				COMMERCE		
	EVENT MANAGEMENT	RECREATION FACILITIES	SHOPPING MALLS		DELIVERY LOGISTICS	RETAIL	ADVERTISING

How Mobile Operators Can Support Smart Cities

As the ambition of smart cities grows, so the related ecosystem of technologies and service providers expands. Although every city is different, topographically, culturally and economically, there are many commonalities between cities of different sizes and locations. Cities will generally benefit from strong partnerships with companies that have local presence, skills and knowledge. Such partnerships will support smart cities in the long term, especially as unique local use cases arise.

Mobile operators can be a local, knowledgeable partner to cities and are uniquely positioned to understand both local city dynamics, as well as domestic and international best practices. They often have a commercial presence in the city, and have advanced, secure networks that are designed to scale. Mobile operators have experience in many different deployment models, such as smart cities-as-a-service or deployment platforms. Moreover, they can do far more than simply deploy IoT services on an ad-hoc basis, instead supporting a holistic approach that allows the city to identify pain points and ensure that a solution covers multiple services. Once connectivity and power are in place, an enormous number of sensors can be connected and services deployed.   These sensors generate vast amounts of data, and mobile operators are well placed to capture this data and integrate it with other sources to provide a single view of the city.

Without a holistic view, deployment flexibility is very hard to achieve, and services that rely on data from multiple sources will not necessarily be able to integrate the data together. For example, if an IT partner for a smart street lighting system is not aligned with the provider of transportation systems, it will be difficult to add parking sensors to street lights, or create smart lighting that changes with traffic flow. An integrated approach enables new services to be added, and all the opportunities presented by IoT data to be realised. Mobile operators are able to take this approach, and ensure that all service providers deliver on the same core technologies and strategy. Moreover, operators can help the city measure key performance indicators that will enable the city to gauge acceptance of new services and benchmark itself against other cities, so deployments can be tweaked and changed to maintain satisfaction.

66 The main challenge of the smart city is the ability to truly transform data exchange by creating values for city managers for industrial operators in the city and especially for the citizens themselves. This requires a communications infrastructure and secure collection and processing of data, while being open and able to act as a marketplace. Orange has been recognized as being capable of providing this architecture by several French regions and energy operators. 99

Francois Richard, Smart Cities Director of Partnerships and Regulation, Orange

Smart Cities Building Blocks

Mobile operators can help municipalities build out smart cities services from initial vision, pilots and deployments. An integrated strategy for deployment, developed with core partners, enables services to be rolled out in a constructive way. A holistic approach encompassing the different elements is key to the success of smart cities services. Learnings, knowledge and experience are retained, meaning that process improvements and historic learnings can be applied to new services and features.

A successful smart cities strategy includes:

BUILDING LONG-TERM PARTNERSHIPS

LOCAL OR CENTRAL GOVERNMENT COMMITMENT

DEFINING A VISION FOR THE FUTURE

TAKING A STANDARDS BASED APPROACH

CREATING INVESTMENT OPPORTUNITIES

CITIZEN ENGAGEMENT THROUGH THE USE OF TECHNOLOGY

Each of these building blocks is critical to the success of smart cities. The city must take a strategic approach to each block and build their objectives and plans around the delivery and buy-in of each component. Mobile operators are well placed to form partnerships with cities and partake in establishing these elements.

Building long-term partnerships with mobile operators

A strong partner is able to help with specifying, building and integrating all of these building blocks, leading to a quicker delivery of smart cities services. Some partners may be able to help address specific issues that the city may run into, but generally the strongest partners are going to be those who can take a holistic view and address as many opportunities as possible. Mobile operators are well suited to be a primary partner for cities, as they have a long track record of building and supporting commercially viable, scalable services for a wide variety of consumers and vertical markets. They have experience of managing highly complex technical projects, and connectivity is the common component of any smart cities deployment. Mobile operators can also play a pivotal role in enabling innovative business models and developing the standards required to drive the connected world to the next level.

Multiple communications technologies and IT platforms are available to the city from a myriad of vendors. Finding the right approach can be a daunting prospect, but generally a long-term relationship with a mobile operator will mean that the services grow with the city, regardless of the technical approach.

As an example, AT&T has built a framework to help cities better serve their citizens. The framework includes four pillars: secure connectivity, technology and platforms, vertically integrated solutions, and alliance members. There are also five solution domains included in the framework: energy and utilities, transportation, public safety, citizen engagement and infrastructure.

To support the framework and help create more connected communities, AT&T has formed alliances with Cisco, Deloitte, Ericsson, GE, Hitachi, IBM, Intel, Qualcomm Technologies, Inc., and Southern Company, their first utility. AT&T will bring the smart cities framework to several initial spotlight cities and universities that include Atlanta, the Georgia Institute of Technology, Chicago, Dallas, Chapel Hill, Miami, and more.
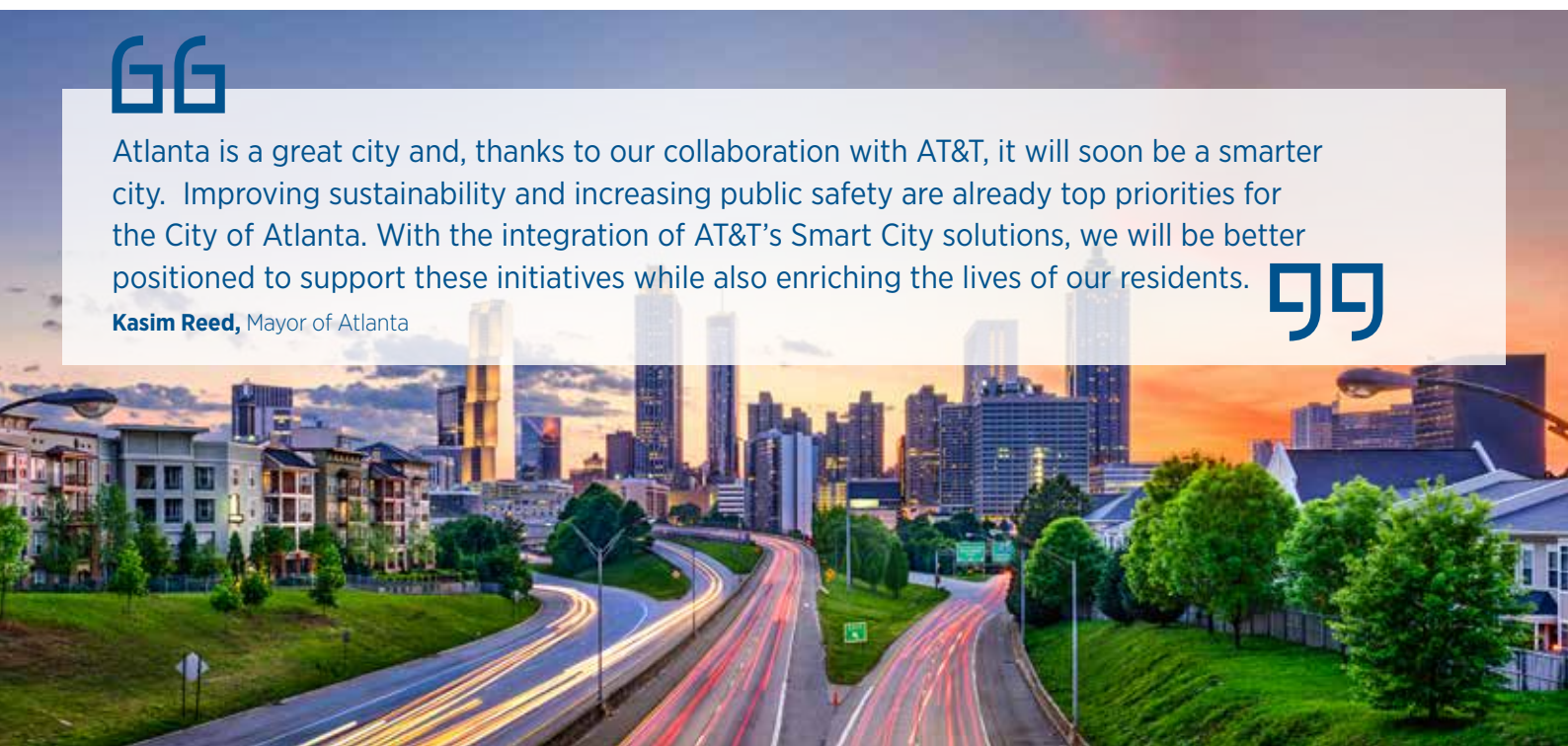
A long-term mobile operator partnership means that local requirements can be built into new technology frameworks. The city is able to request new services be introduced, as both parties have visibility over a development roadmap.

> Atlanta is a great city and, thanks to our collaboration with AT&T, it will soon be a smarter city. Improving sustainability and increasing public safety are already top priorities for the City of Atlanta. With the integration of AT&T's Smart City solutions, we will be better positioned to support these initiatives while also enriching the lives of our residents.
>
> **Kasim Reed,** Mayor of Atlanta

Local or central government commitment

To build a successful strategy, the city must talk to a wide variety of stakeholders, including citizens, technology partners and urban planners. Above all, the city's high-level leadership must be fully committed to delivering smart cities services and ensuring that the benefits can be realised a long time into the future. Mobile operators are often already engaged with local and national governments on various aspects of planning and programme delivery, and understand how to work with governments to build a case for new deployments of technology which enable smart cities.

Every city is different and will have different requirements based on its location, culture and funding models. Mobile operators understand this, and can help a city approach a smart cities programme with clear objectives that are supported by local or central city governance.   Mobile operators can also advise on whether the city's ambitions can be met on budget with the available technologies at their disposal.

The local government is accountable for the success of the smart cities service to their citizens. To ensure that smart cities objectives can be met in timescales agreed by all the stakeholders, the performance of departments and services can be tracked against agreed KPIs. Mobile operators are able to collate data from different sources and provide interfaces that the city can use to track and monitor KPI data.

The government of Dubai has committed to turning Dubai into a smart city, as part of the 2021 Dubai plan. The aim is to ensure that future growth is sustainable, the city's infrastructure is integrated and connected, and the city is safe, healthy and resilient against future concerns. This involves the buy-in of multiple departments who have had to commit to distinct smart cities KPIs. For example, the city's success will be measured on the reduction of CO_2 emissions, the amount of waste generated and the number of road fatalities, each of which can be addressed by a different department to deliver smart, connected services. Dubai has engaged the UAE's mobile operators to help achieve this vision, build a connected environment and integrate different data sources from multiple departments together.

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The introduction of the Smart Dubai platform marks a significant step towards the UAE's smart city transformation. du has supported the UAE leadership's smart city vision by introducing the infrastructure with the capabilities of empowering all UAE entities to step into a smart future. At du, we consider our contribution as being an essential mainstay to the local economy, as well as the facilitator of a collaborative ecosystem between a whole host of public and private players.

Osman Sultan, Chief Executive Officer, du

Working with a mobile operator to define a vision for the future

A city leader with vision, commitment and a budget can be a powerful force to create new services for local citizens and businesses. A mobile operator can help this leader understand the technical capabilities and help build a realistic set of objectives, programmes and KPIs based around this vision, allowing the city to establish an achievable path into the future.

Smart cities can successfully create scale in their smart services with a holistic strategy and a roadmap of future services. An integrated approach removes many issues and ensures that there is a vision and future for the city that benefits all stakeholders. City departments can use common tools and KPIs to create their smart services, leading to lower cost deployments, as well as simplifying the support and maintenance of them over their lifetime.

Tainan, the oldest city in Taiwan, has developed an integrated strategy in partnership with mobile operator FarEasTone (FET). This has enabled the local government to launch innovative services based on FET's proven cloud infrastructures. With its rich cultural history and ancient building complexes, Tainan is a major tourist destination. For the 2016 Chinese New Year holiday, Tainan City Tourism Bureau held a three-day AnPing District tourist promotion event by combining FET's cloud infrastructure with over 600 beacons transmitting information to consumers using the local tourism app. By working together and building a common vision, this promotional event created more than four times the rate of tourist participation than any other past event. This is a clear example of how smart city services can be provided effectively and efficiently by working with a mobile operator as a key partner.

Mobile operators offer a standards based approach

Proprietary systems are not well suited to long-term engagements and the integration of multiple services. The success of smart cities services is reliant on the use of open standards. Mobile operators understand that data and services need to be open and formatted in such a way that they can be shared and read by multiple platforms in the city domain. Open standards are the best way of creating a system in which any stakeholder can participate. Some cities view their smart services as an operating system for which external developers can create applications using available data sources.
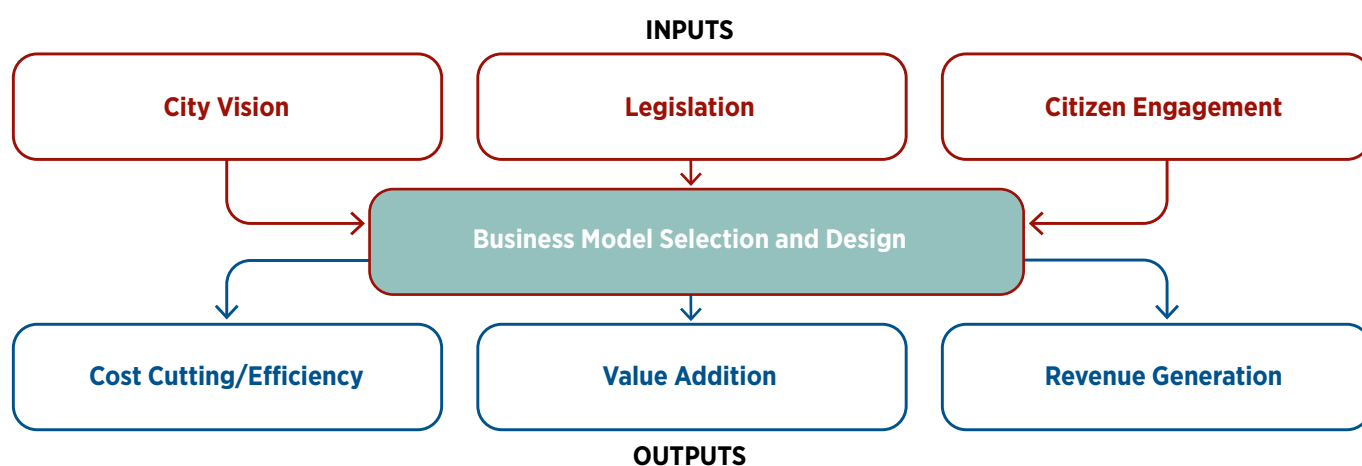
The Open and Agile Smart Cities (OASC) alliance is promoting an open smart cities market in which interoperability and standards boost competitiveness, ensuring smart cities do not suffer from vendor lock-in, and can compare themselves like-for-like against global benchmarks. The European initiative FIWARE, which delivers open source software and API specifications for Smart Cities services, is a key partner in the OASC. Supported by both Telefónica and Orange, FIWARE is seeking to drive innovation around big data and applications for smart cities.

Creating investment opportunities

To maximise the potential of smart cities, it is important to create an investment environment that encourages the introduction of new concepts and applications that can be monetised and take advantage of the city's evolving status. It may be that the city itself provides funding to potential collaborators, or that it creates a working environment designed to attract the right talent. Once smart cities are up and running, the efficiencies that they can present to the wider world help bring in investment from new businesses and visitors. Mobile operators are able to work with smart cities to create those new opportunities in a variety of ways, such as creating dedicated services for the city and its citizens or stimulating innovation in the wider ecosystem, for example, through start-up and developer programmes.

Cities looking to develop smart services can deploy business models that can be managed through monitoring appropriate KPIs. Ranging from subscription-based services to externally funded propositions, there is a broad range of potential business models, and smart cities have to find the model that best fits their ambitions (see diagram on page 12).

INPUTS

| City Vision | Legislation | Citizen Engagement |

Business Model Selection and Design

| Cost Cutting/Efficiency | Value Addition | Revenue Generation |

OUTPUTS

Smart cities technologies present opportunities for new, innovative, business models that can drive adoption. Mobile technologies can enable the city to effectively create business opportunities through the monetisation of assets and services, and the data that they generate. Many technologies can generate environmental, resource, and operational efficiencies, where innovative funding models involving the private sector can sometimes allow cities to reduce or entirely displace the required capital expense. Many mobile operators are prepared to adopt innovative business models that involve sharing the risks and the rewards with the city administration.

Citizen engagement through mobile technology

Smart city services generally need to engage local residents to ensure success. They are more likely to succeed if citizens can see the benefits of these services directly. Better infrastructure driven by mobile operator communications and data technologies has direct benefits for citizens. New services create a better quality of life, save money and time for citizens. In the South Korean capital Seoul, the local government has created numerous smart participatory services to improve the quality of life for its citizens. Seoul's eco-mileage system rewards households and businesses with refunds and vouchers based on the reductions they make in greenhouse gas emissions.

When citizens see the benefits of smart cities services, they can engage, support and promote them amongst their local communities, creating a virtuous circle. Transparency around the usage of data can quicken this process. Citizens will change their behaviour if new services meet their needs. Research in Mexico City found that 87% of the trips in the city were by more than one form of transport. As a result, the city has integrated its bike-share system with other means of public transport, resulting in a shift of 14.5% of journeys from driving to multi-modal transport.[1]

Mobile Operator Technology Enablers

Mobile operators are experienced across the realms of communications, platforms and data, and have the ability to integrate these into commercial smart cities services. They can help a city with both the design of services as well as the technology infrastructure needed to support a smart cities rollout. Mobile networks have evolved significantly over the past few years, and now offer services and technologies that can support smart city deployments that are secure, scalable and robust.

Mobile operators can provide cities with a range of technology enablers, including:

Optimised Communications Networks

Many mobile operators have well established 4G networks, which meet very high-bandwidth, low latency requirements with an exceptional quality of service that's designed to scale and can support transport, security and emergency services. Operators can also support lower tier bandwidth requirements, via 2G and 3G networks, which are now being supplemented by new Low Power Wide Area (LPWA) networks. These LPWA technologies, designed specifically for the Mobile Internet of Things (Mobile IoT), are based on 3GPP standards and can support a range of mobile network bandwidth and performance requirements, and are suitable for many smart cities applications

LPWA networks for the Mobile Internet of Things (Mobile IoT)

Mobile IoT networks can support low cost, long battery life, low bandwidth, and high volume connections in licensed spectrum. They can enable simple on/off type applications, such as street lamp control, monitoring of environmental conditions, such as air quality or river levels over time, as well as basic status updates from many types of sensors or equipment, even if they are battery powered and located in inaccessible places for years. Mobile IoT networks are ideally suited to connecting parking sensors, streetlights, weather stations and many other devices used to enable smart cities services.

Mobile IoT networks will also extend urban mobile coverage further to reach deeper indoors and underground, enabling richer and more pervasive smart cities services.

Standards body 3GPP is finalising three different licenced spectrum variants of Mobile IoT technologies, which will be ready for commercial deployments in 2016-2017. Further information on these technologies can be found at **www.gsma.com/connectedliving/mobile-iot-initiative/**

Each of these technologies has the same broad characteristics:
- **Very low power consumption**
- **Optimised for brief messages**
- **Very low module cost**
- **Good indoor and extended outdoor coverage**
- **Scalable**
- **Secure**
- **Easy to maintain**
- **Suitable for integration into a unified IoT platform**

As Mobile IoT networks operate in licensed spectrum, they are not at risk of congestion, and have far fewer constrains on power outputs and duty cycles than networks employing unlicensed spectrum.
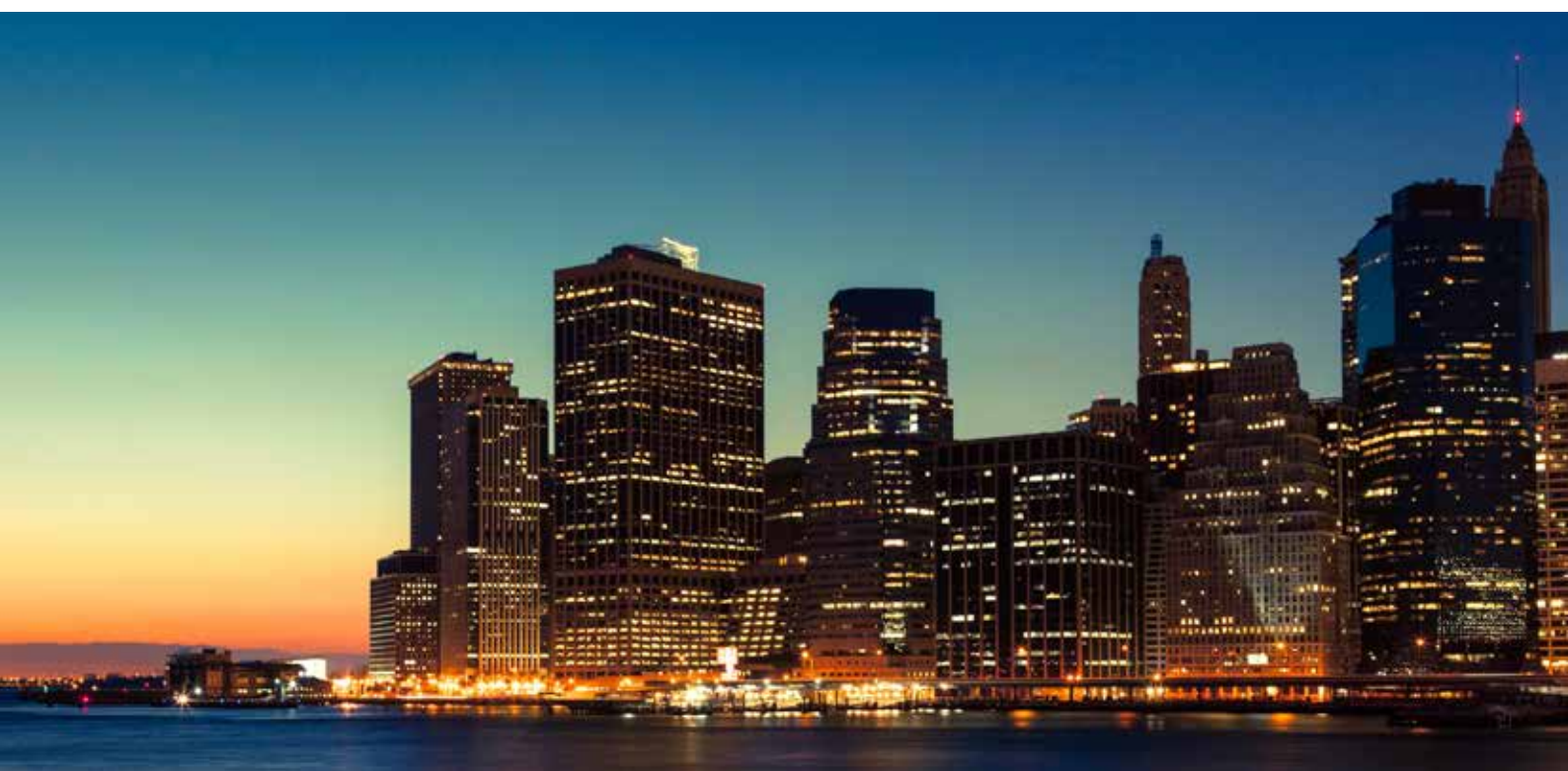
Remote provisioning and asset management

Inaccessible assets are difficult to maintain. The high cost of visiting and servicing these assets in hard-to-reach places, such as on top of lampposts or in hazardous areas, means that it is far more efficient to manage sensors remotely. Automated network provisioning by mobile operators allows large volumes of devices and sensors to be quickly added to the network to support any new applications. In addition to this, it is now possible to buy IoT equipment and sensors with pre-installed SIMs that can be simply added to the smart cities network of choice, via the introduction of Embedded SIM technology, significantly reducing the maintenance requirements of equipment connected to mobile networks. Many mobile operators also provide device management services, which can significantly reduce the cost of managing city assets.

Service development and deployments

Mobile operators have local on-the-ground teams who can work closely with their city partners to plan and deploy services. Rapid application development through their IoT platforms allows quick development of new services and many mobile operators also have labs which are used to test services before they go live. These facilities and associated expertise enables the rapid introduction and optimisation of new devices and sensors to the smart cities environment and can also reduce the cost of deployment. Mobile operators carry out in-depth planning to ensure that their network coverage is optimised for smart cities services.

Sophisticated data management

Once connected, smart cities will begin to generate large volumes of data from their mobile connected assets. This data can be used to yield insights into city operations that would not have been apparent in the past. Mobile operators can help cities understand and integrate their data assets, such as by building a dashboard to give a holistic view of city operations. Information can then be actioned in real-time or stored for historical analysis.

The full potential of this data can then be unlocked by making it available to the broader development community through IoT Big Data. For example, cities could make their data available through a virtual marketplace, enabling stakeholders to develop innovative new services by accessing open APIs and harmonised data formats. This approach enables cities to stimulate innovation and developers to easily locate and access a range of data sources and associated analytics. Mobile operators can act as data brokers by helping cities prepare their data for sharing as well as operating the virtual marketplace.

Mobile operator Telefónica is part of the European initiative FIWARE, which delivers open source software and API specifications for smart cities services. With this platform, Telefónica has built an innovative offer for smart cities named ThinkingCity, which allows cities to offer direct access to real time, contextual information, via harmonised APIs and data models, regardless of the data source. As a result, developers, integrators and innovators can create data-intensive applications that enrich the ecosystem and turn a city into a vibrant innovation space. For example, a new satellite navigation service can exploit real time data, including parking spaces and local weather data, harmonised across several cities in different countries.

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The City of Valencia is forward thinking with a clear vision for the future and has now taken a decisive step toward becoming a leader in the smart cities world rankings. By using an essential tool, the VLCi (Valencia Ciudad Inteligente) platform supplied by Telefónica, to reach the objectives to which it aspires as a smart city.

Rita Barbera, The Mayor of Valencia from 1991 to 2015

Security expertise

Analysts have indicated that security issues are a significant inhibitor to the deployment of many new IoT services. Whilst many service providers to smart cities may see their particular security requirements as being unique to their market, this is generally not the case. Almost all smart cities and IoT services are built using device and service platform components that contain similar technologies to many other communications and IT solutions.

Mobile operators have a long history of providing secure products and services to their customers. To help ensure that the new IoT services coming to market are secure, the network operators together with their network, service and device equipment partners have built up significant security expertise that they can share with cities and service providers who are looking to develop IoT services. The GSMA has published a comprehensive set of IoT Security Guidelines, which can be applied in smart cities implementations. The guidelines can be found at:
www.gsma.com/iotsecurity

Robust authentication and identification

Developed by the GSMA and its mobile operator members, Mobile Connect is a secure universal log-in solution. Simply by matching the user to their mobile phone, Mobile Connect enables a user to log-in to websites and applications quickly without the need to remember passwords and usernames. It's safe, secure and no personal information is shared without permission.

Smart cities can benefit from the secure log-in offered by Mobile Connect in a number of ways. It's an ideal way for local governments to control access to their services, whether it be through a local portal or in-person at government offices. Citizens can use Mobile Connect on their mobile phone to authenticate themselves to access a variety of services from healthcare provision to the use of municipal facilities, such as recycling centres.

mobile connect

Conclusions

Cities sit on a wealth of potential. There is an overwhelming trend towards the introduction of new smart services and opening up of city data to improve quality of life for citizens. This will create efficiencies in the city and new business opportunities for many different stakeholders. Mobile operators are at the heart of this change, providing connectivity solutions and advanced services to cities around the world.

A city looking to implement smart cities services needs to consult with their local mobile operator, and engage them in a long-term partnership to reap the rewards that technological change can bring to the city of the future.

To find out more visit: **www.gsma.com/smartcities**
To contact us email: **smartcities@gsma.com**