GSMA Connected Living

GSMA SMART CITIES GUIDE: TRAFFIC MANAGEMENT

Why mobile operators are key partners for cities seeking to deploy sustainable traffic management solutions

INTRODUCTION

Designing and building an effective transport network is one of the biggest challenges facing cities. As the urban population grows, so the city's public and private transport systems become strained, and even small issues and incidents can adversely affect a whole network that is already operating close to its limits. Congestion and delays on transport systems can cost a city many millions of dollars in lost productivity, and affect the quality of life of citizens as they spend more time travelling to their destination. The problems caused by congestion are immediately obvious – time wasted, increased pollution and safety concerns, impacting economic development and souring citizens' relationships with their local government. Cities need to address fundamental issues, such as the time drivers spend looking for parking places, improving road safety, ensuring public transport is routed effectively and giving citizens the ability to use multiple means of mobility to reach their destination.

Mobile operators are well placed to help cities build a smart transport system. Various network technologies and services offered by mobile operators can help cities connect transport services to a central control point. The city can then maximise efficiency and improve the management of its transport networks.

Transport options can now flex to meet citizens' needs. In the past, public transport has operated on fixed routes, but the emergence of new 'mobility-as-a-service' business cases open up transport networks to become much more flexible in how citizens pay for, and use, cities' transport services. The integration of different transit mechanisms, such as bus networks and bike sharing, becomes easier to achieve, freeing up the transport planner to concentrate on service quality rather than service support.

The flexibility enabled by connected services can improve the quality and breadth of transport provision. These improvements can enhance citizens' quality of life by reducing air and noise pollution, attracting new business investment or encouraging a healthier lifestyle through more walking and cycling. Therefore, developing connected transport services tends to be a core part of any smart city's objectives.

HOW MOBILE TECHNOLOGIES CAN TRANSFORM URBAN TRAVEL

SMART PARKING

Parking-related issues can be high on smart cities' agendas. Whether it be reducing parking spaces to encourage citizens to use other means of transit, maximising the use of existing parking spots, or ensuring that all parking revenue is accrued, mobile networks have a role to play.

Mobile connectivity can be used to communicate the availability of parking spaces to both the city administration and citizens either through dashboards and apps, or through physical displays on the roadside. Integrated systems can highlight available parking spaces to drivers and route them to the parking spot. The data from connected smart parking sensors can also be used to enable dynamic pricing. If a parking lot is fairly empty, pricing can be adjusted to encourage more people to park there. This can also be linked to other data from connected sensors such as those measuring air quality – if air quality is poor, parking prices can be raised to discourage people from driving into the city centre.

Introducing smart parking solutions help urban planners maximise their use of available space and ensure that parking does not dominate a city. Careful use of the technology enables both citizen engagement and timely enforcement, ensuring that parking space revenue and utilisation is maximised. Smart parking solutions can also curb congestion by reducing the number of drivers on city roads who are simply looking for parking spaces.

Smart parking solutions can help venue owners, as well as city transportation departments. Supermarkets, stadiums and other venues can make use of smart parking solutions to ensure that their car parking is not abused.

Smart parking solutions from mobile operators can take one of several forms. Most common is the use of connected sensors embedded into the pavement to register if a vehicle is present in the parking space above them. Other sensor technologies can be used, as can cameras connected to licence plate reader platforms. Smart parking solutions typically only need a small amount of communications bandwidth, literally notifying a central server if a space is empty or taken. As the sensors collecting this information are typically not connected to a power supply, they must rely on internal batteries to communicate with the server. This means that both power and network usage must be optimised in order to maximise the lifespan of sensors in the pavement. New Mobile IoT networks ensure that smart parking services from mobile operators can be low cost and low power, enabling battery-powered devices to have a long lifespan.

Other connected sensors can also help build up a picture of parking availability – sensors placed on the entrance and exit to a car park, as well as video analysis of empty parking spaces can give a good idea of how many parking spaces are free and can also be integrated into a city's dashboard to provide real-time reporting.

CASE STUDY

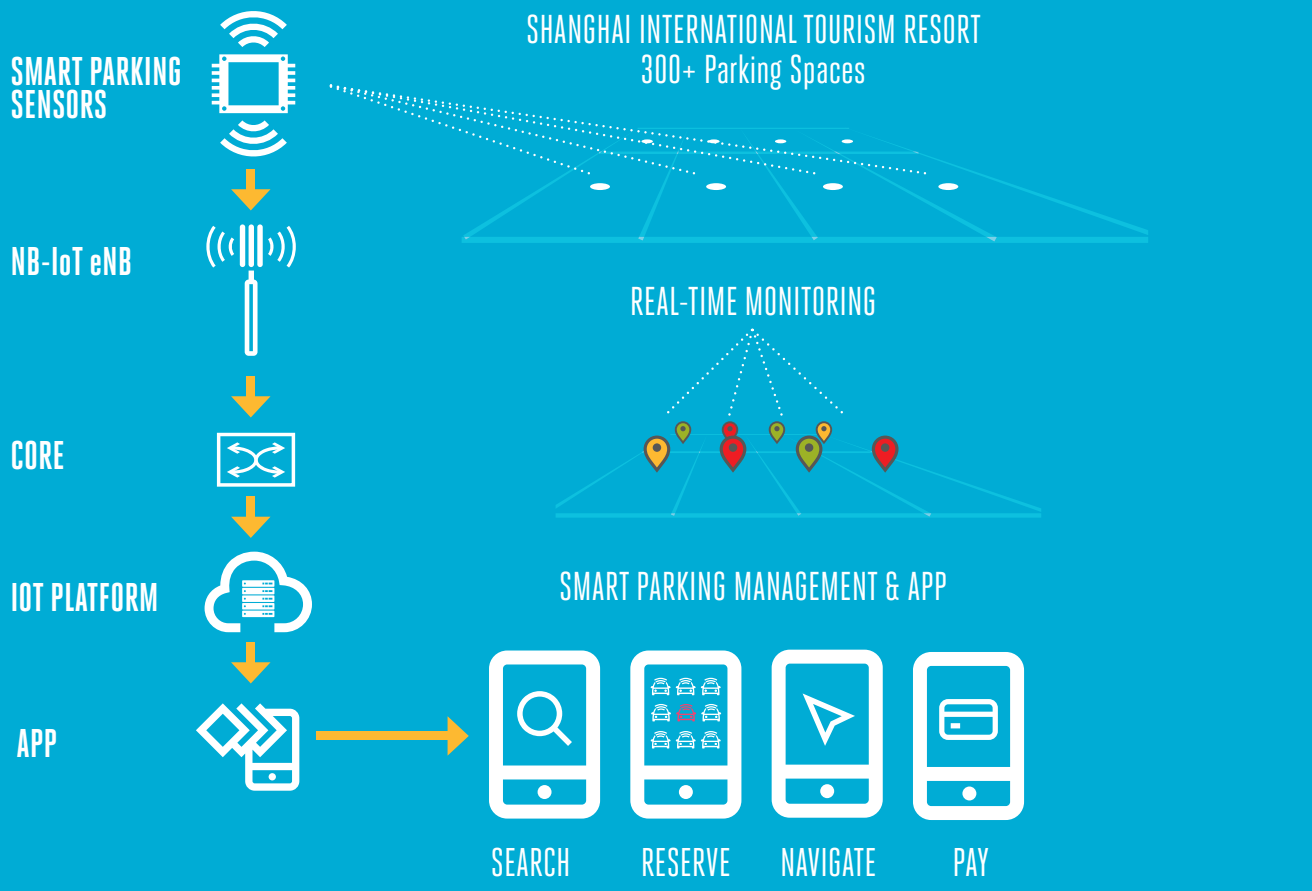
SHANGHAI

Leading mobile operators globally, including China Unicom, Deutsche Telekom, Vodafone and Etisalat, are working with Huawei on smart parking trials employing a type of Mobile IoT technology, known as NB-IoT. Huawei and China Unicom have installed a smart parking demonstration in a parking lot of the Shanghai International Tourism and Resorts Zone. The parking lot has been equipped with 334 NB-IoT enabled sensors. With partners Fangle (the sensor supplier) and u-blox (the module supplier), Huawei provided the end-to-end smart parking solution, which includes terminals, base stations, servers, and mobile phone apps.

> *"The NB-IoT connectivity enables drivers to search for and book parking spaces, navigate their way to an allocated parking space, pay for the parking directly using a mobile handset, and manage their parking needs with mobile phone apps."*

The solution is designed to help tourists find parking spaces and relieve traffic pressure in the surrounding streets. Located in the Pudong district of Shanghai, the zone is one of Shanghai's six key development areas, and is home to Shanghai Disneyland. The NB-IoT connectivity enables drivers to search for and book parking spaces, navigate their way to an allocated parking space, pay for the parking directly using a mobile handset, and manage their parking needs with mobile phone apps. The city can then see the parking allocation, and reduce the opportunity for missed payments, allowing revenue to be maximised.

The smart parking demonstration is part of a wider smart city initiative by China Unicom following a strategic cooperation framework agreement signed with the Shanghai government in May 2016. This partnership includes the rollout of a dedicated NB-IoT network covering all of Shanghai to improve the operation management capabilities and efficiency of the city. China Unicom is already considering further cooperation with industry players to develop NB-IoT applications in new areas such as smart metering, crowd management and environmental monitoring.



- Show available Parking Lot
- Compare Parking Prices
- Reservation/Order Management
- Navigation/Multi-Level Parking Guidance
- Parking Lot Status/Alarm Report
- Online Charging

Source – Huawei

TRAFFIC MANAGEMENT

Many cities are crippled by traffic congestion, which impacts the quality of life of their citizens and the productivity of their businesses. Cities around the world recognise that they need to tackle congestion and the problems it causes through both better urban planning and better management of traffic to prevent congestion and minimise it when it occurs.

Mobile technology can help address city congestion: Connected sensors and mobile data can be used to both monitor congestion and also to direct traffic in dynamic ways to prevent congestion building up or getting worse.

Connected sensors for traffic management can be placed in a wide variety of locations and can collect a wide variety of data. In-vehicle sensors can monitor their speed and location. Sensors can also be placed on the street, with licence plate readers and CCTV cameras offering a good view of congestion in real-time. Sensors can also be integrated into the road surface itself, counting the number and type of vehicles passing overhead in any given timeframe. A combination of these sensor types gives a very accurate picture of traffic levels, and also allows a wider view across the city, rather than at just one specific location.

Today's traffic management technologies typically only measure traffic at specific locations, and do not have the intelligence to see what is causing the congestion further up the road. In the past, these systems have had to be supplemented by citizens calling in to report issues that need resolving. In many cities, existing sensors are at the end of their lifespan, and can be replaced with connected sensors with minimal disruption.

The use of sensors connected by a mobile operator means that real-time data across a wide area of the city can be monitored and appropriate actions taken. By installing further connected sensors in street furniture, such as traffic lights and road-sign displays, vehicles can be directed down different routes or congestion cleared by turning traffic lights green. A fully dynamic system is able to monitor traffic and take appropriate actions, such as automatically turning lights green.

Smart cities are increasingly using dashboards and traffic control centres to obtain a single view of all the traffic in the city. By bringing all of the available data from sensors, cameras and city employees into a single point, quick decisions can be made and acted upon. Connected systems enable three approaches to traffic management:

1. Preparation for known changes, issues and restrictions, such as roadworks or road closures, whereby the city is able to inform people travelling within the city of changes, while using connected traffic lights and signs to re-route vehicles away from the affected area.

2. Dynamic changes in response to incidents, such as accidents or weather problems. Lights can be changed on the fly and traffic stopped or routed around obstacles in real-time.

3. Urban planning. By looking at accurate traffic trends, urban planners are able to permanently alter the roads infrastructure to reduce traffic. This could be by widening roads to increase capacity, redesigning junctions to reduce bottlenecks or providing out of town parking facilities. The data available to enable such planning is far more accurate and comprehensive than from the traffic surveys that have been conducted in the past.

CASE STUDY

TAINAN

Mobile operator Far EasTone has introduced the cellular vehicle probe (CVP) system in Taiwan, which tracks anonymous mobile users using data communications among base stations. With the widespread usage of mobile phones and densely-distributed base stations, the CVP system provides an economic way of monitoring congestion. By closely collaborating with the Transportation Research Center of National Chiao Tung University, Far EasTone has successfully delivered a high coverage, accurate, and rapidly updated (every 5 minutes) CVP-based traffic information system.

The Far EasTone CVP system also tracks the routes and origin-destination pairs of anonymous users, which can be used to monitor the level of service of roadway systems and identify traffic demand patterns for heavily-congested bottlenecks. This information is then used to dynamically fine-tune traffic signal timings or to identify how best to change road layouts. The CVP system stores historical data for three years, and can be used to retrospectively evaluate implemented transportation policies.

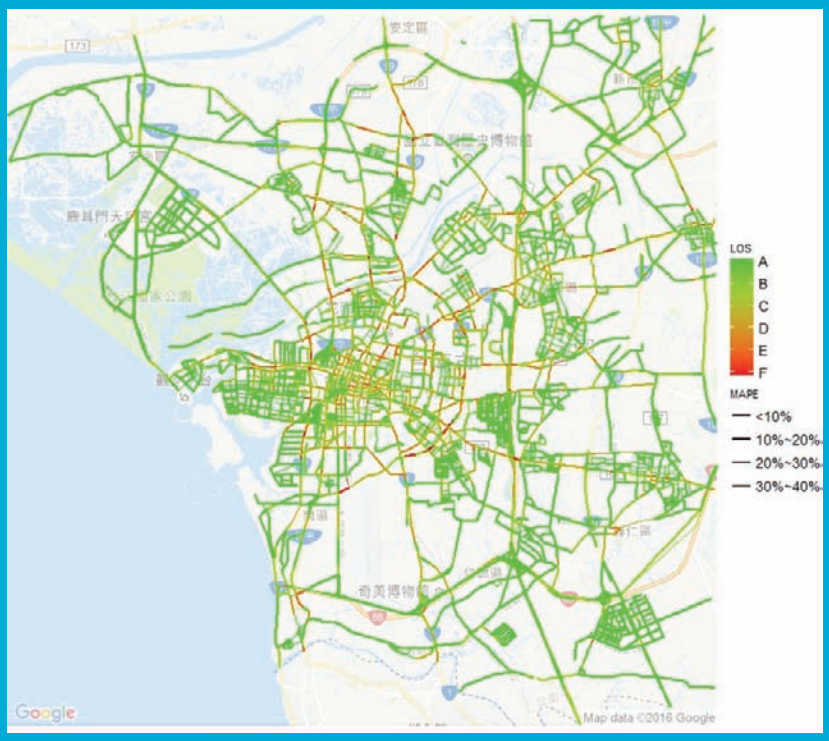


Figure 1
A snapshot of real-time level of service map of Tainan City network

USING MOBILE DATA FOR TRAFFIC MANAGEMENT

Mobile data, combined with information captured by connected sensors, is a powerful tool for understanding traffic behaviour and reducing congestion. Location data captured by a mobile network gives an accurate view of where a mobile device is and how it is moving around. Many mobile operators are investigating how to use their sources of real-time and historic data to understand traffic patterns and create tools and enable predictive analysis.

> *"By tracking smartphones and vehicles together, an extremely comprehensive picture of how people are moving around a city can be established."*

When reviewing the location data captured by mobile networks, analysts can assume that people travelling at certain speeds and in certain groupings are travelling by car or bus. In fact, the same data can be used for multiple services – there is no need to track individual vehicles to understand traffic flow if that data is already available when analysed in an appropriate way. The data can also be combined with other sources, such as the growing number of connected cars on the road, or connected sensors on the roadside. By tracking smartphones and vehicles together, an extremely comprehensive picture of how people are moving around a city can be established.

By applying appropriate analytics to the available data, mobile operators can provide city administrations with dashboards that highlight roads and incidents and understand how they are affecting traffic.

CASE STUDY
PULLY

Four main traffic arteries traverse Pully in Switzerland, and the town suffers from a high volume of through traffic. In response, it is investing in modern methods to improve the traffic situation and make it easier to access the town centre, thereby improving the quality of life of its residents.

Pully is alleviating congestion on its roads by harnessing anonymised and aggregated mobile phone data to improve traffic flows in the town. Swisscom and Pully's administration are working together on a planning method that will improve infrastructure and traffic planning by making traffic flows clearly visible. The new method can obtain much more precise data than previous approaches. It is also able to depict traffic streams in their entirety.

Gil Reichen, Mayor of Pully, says: "We want to use it to get a realistic picture of the traffic volumes and the length of time that traffic spends in the town centre. These results will enable us to implement city planning measures that really meet the needs of the residents of Pully."In a follow-up phase, Swisscom and Pully are planning to work closely with universities to develop further simulation models, which will allow traffic forecasts to be drawn up, for example, for major events. The data is anonymised and aggregated to safeguard individual privacy: None of the data can be traced back to individuals.

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>
> **Gil Reichen,** Mayor of Pully

MOBILITY-AS-A-SERVICE

Smart cities need to ensure that their citizens are able to get from A to B as simply and as efficiently as possible. Enabling citizens to move through the city by whichever means they choose makes the city a better place to live and allows everyone to use services available to them at any time, no matter their background or ability.

'Mobility-as-a-service' is a relatively new concept that describes a shift away from ownership of vehicles towards service-led mobility. Younger people are not as wedded to the idea of car ownership as older generations. This is driven in part by the rise of transport-sharing services, as well as the opening up of public transport to dynamic routing. Car-share, bike-share, taxi hailing services and dynamic bus routing all play a part in creating a mobility-as-a-service environment.

Mobile operators can connect all of these different mobility services together to provide a single, holistic interface into multiple modes of transport. By connecting multiple services to a mobile network, the city is able to introduce several services:

SINGLE PAYMENT

- The city can enable travellers to make a single payment for use of multiple services. This could be on a pay-as-you-travel basis or a single monthly payment for unlimited usage of multiple travel types. Mobile services can enable citizens to be easily authenticated when they use different travel services, and payment can be taken as appropriate. Mobile services can also provide the citizen with up-to-date information about the status of travel modes around the city, so they can make informed choices about how best to reach their destination

- Each citizen could be allocated a mileage or usage allowance. For example, different tiers of pricing could be introduced, with the top tier able to use up to 2,500km travel per month, and the bottom tier using 50km travel per month. This encourages usage of public transport and ride-share services. Using the data captured by connected sensors and smartphone authentication, smart cities can track individual's usage and bill people accurately.

DYNAMIC ROUTING

- Citizens request travel from point A to point B and the city's travel services can be used to most efficiently route and carry a person along that route. Also the city can plan their travel provision around events and incidents much more effectively. If a major event is being held, the city can dynamically route buses or set up ride share information around the event, providing a much improved travel experience for the citizen, and making them more likely to travel via public transport in the future. travel services, and payment can be taken as appropriate. Mobile services can also provide the citizen with up-to-date information about the status of travel modes around the city, so they can make informed choices about how best to reach their destination

ENABLING DYNAMIC RIDE SHARING

- Shared ride services are becoming more and more popular, with the flexibility to be able to personalise pick-ups and drop offs at any time of day in a safe, low cost convenient manner. Smart cities are beginning to embrace these ride-sharing services, and a number of start-ups are offering services. For example, Padambus in Paris offers a dynamic rideshare system for public bus travel, providing a fleet of minibuses that are able to pick people up as needed and group travellers together to their destination, creating a dynamic, efficient bus route that is not reliant on fixed stops and routes. Bridj, operating in Washington DC, Boston and Kansas City in the U.S., offers a similar service. With tailored local pickup points, direct trips offer time savings of 40-60% over traditional bus routes.

USAGE ANALYSIS

- The city can access a huge wealth of data about how people travel around the city and how the transport options are used. Using this data, smart cities can optimise their travel networks for most of their citizens, leading to a better quality service, and attracting more travellers to use the city's mobility options.

> *"By acting as a hub, mobile operators can be highly effective partners for smart cities looking to implement mobility-as-a-service."*

Mobile operators are well suited to acting as "smart mobility aggregators": they can provide a digital platform for making payments for transit services, issue smart tickets through authentication of digital devices and offer the communication services required to bring the transit service, passenger and city authority together into one single solution. By acting as a hub, mobile operators can be highly effective partners for smart cities looking to implement mobility-as-a-service.

The travel needs of each demographic group will be slightly different. Commuters tend to travel in rush hour, school children may take dedicated transport to school, disabled people will have unique requirements, and travel patterns at the weekend can be completely different from those on a weekday, as people travel to leisure destinations, rather than work.

INTEGRATED INTELLIGENT TRANSPORT SYSTEMS

As smart cities evolve, different systems in the city will be able to communicate with each other. Connected cars are already widely available, and more and more cities are connecting and monitoring their transport infrastructure. The ability to integrate these systems will enable new services to be deployed. When vehicles, passengers and infrastructure can communicate with each other, the city can be adapted to their needs on a daily basis. Traffic lights can be turned green for emergency vehicles automatically, buses can be held at stations until trains arrive, tolls can be charged for distance driven, and pedestrians can have priority over vehicular traffic in some areas.

So-called intelligent mobility and transport system (ITS) programmes have been implemented around the world. ITS integrates technologies and applications that allow wireless data exchange within the transport system, between vehicles (V2V), and between vehicles and infrastructure (V2I), while also covering vulnerable road users, such as pedestrians, cyclists and motorcyclists.

The key to this type of programme is to connect a range of sectors and technologies, such as vehicle manufacturing, transport information systems, communications technologies, logistics and distribution and infrastructure management.

“Traffic lights can be turned green for emergency vehicles automatically, buses can be held at stations until trains arrive, tolls can be charged for distance driven, and pedestrians can have priority over vehicular traffic in some areas.”

CONNECTED VEHICLES

Connected vehicles can communicate with each other and their surroundings. Benefits to the driver include prevention or automatic notification of crashes, speeding and congestion. The GSMA anticipates there will be a significant increase in the number of new cars equipped with mobile connectivity to meet demand among regulators and consumers for safety and security features, as well as infotainment and navigation.

Connected vehicle technology can support:

- Fleet telematics, which allow emergency services and commercial fleet operators to increase utilisation of their vehicles, improve driving standards and fuel efficiency, reducing emissions and vehicle wear.
- Links to infrastructure systems, which manage traffic flows on roads, including urban traffic management and control, roadside variable message signs to inform drivers of reduced speed limits, traffic jams and other safety messages.
- Communication with public transport, such as selective vehicle detection, traffic light control and real time passenger information.
- Connected tolling systems that allow drivers to bypass queues at toll booths, and enable smoother traffic flow, improved safety and greater mobility around a city.
- Vehicle-to-vehicle (V2V) systems, where vehicles interact with each other using wireless networks, sending information about road conditions, speed, location, direction of travel, braking, and loss of stability, typically using dedicated short-range communications (DSRC) in the 5.8 or 5.9 GHz frequency bands, and/or a mesh radio network.
- Vehicle-to-infrastructure (V2I) systems that allow wider area dissemination of traffic and safety information, as well as vehicle tracking and recovery, emergency call (e-Call), the set-up of Wi-Fi and 3G hot-spots, reservation of and guidance to parking spaces.

MOBILE OPERATOR CAPABILITIES FOR TRAFFIC MANAGEMENT

In the long term, the roads will be full of autonomous vehicles and the relationship between people and public and private modes of transport will change dramatically. However, technology is already changing our relationship with modes of transport in a number of ways.

CONNECTED SENSORS

Sensors are critical to the functioning of a smart city. They can collect a wide range of data from across the city, much of which is relevant to planning, using and operating transport networks. Sensors can be placed on the street, in vehicles or in smartphones, giving a huge base of data with which to monitor and manage transport activities around the city.

Connected sensors can be used in many different ways by the city or citizens. They can tell when a parking space is free, the number of vehicles queuing at a junction or how many passengers are riding on a bus at any given time. As sensors become increasingly diverse, more and more are being installed in cities, collecting more detailed data and yielding greater benefits. For example, the City of Boston publishes the data from every collision involving pedestrians, cyclists or vehicles, and uses this information to better inform urban planning. On a larger scale, the City of Los Angeles has connected all of its traffic lights to a central server allowing them to be monitored and green light timings altered on a real-time basis to prevent the build-up of congestion.

Sensors can be connected using a wide range of network technologies from mobile operators, including Mobile IoT networks and 2G, 3G and 4G networks, all of which offer good existing coverage across urban areas, as well as security and privacy of data collected.

> *"Connected sensors can tell when a parking space is free, the number of vehicles queuing at a junction or how many passengers are riding on a bus at any given time."*

BIG DATA ANALYTICS

Harvesting the data from connected sensors can give many insights into how citizens use transport, how planning can meet their needs, and what information can be shared with citizens to enhance their travelling experience. By combining multiple sources of data, such as weather and traffic information, complex analysis of travel patterns can be undertaken. This is turn can enable the development of adaptive services, and the introduction of predictive tools that allow the best transport service to be offered based on forecast and real-time environmental, traffic, and other related data.

In London, some train operators are trialling predictive loading of train carriages on their trips in and out of city. By combining data from ticket sales, movement sensors and CCTV, train operators are able to anticipate how each carriage will load up with passengers. By sharing information on the loading of each carriage as a train comes into the station, train operators are encouraging passengers to spread along the train, maximising the loading. By using data to maximise the use of the existing capacity, costly investments in new infrastructure can be avoided or delayed.

Mobile operators work with leading data analytics companies to integrate analytical logic into their management platforms. This enables operators to build portals and reports that highlight both normal and unusual travel patterns. Equipped with the correct tools, a user can focus on specific aspects of the transport system, highlight areas of concern and build reports for transport operators to show the popularity of services, as well as highlight issues and opportunities for improvements.

MOBILE IOT NETWORKS

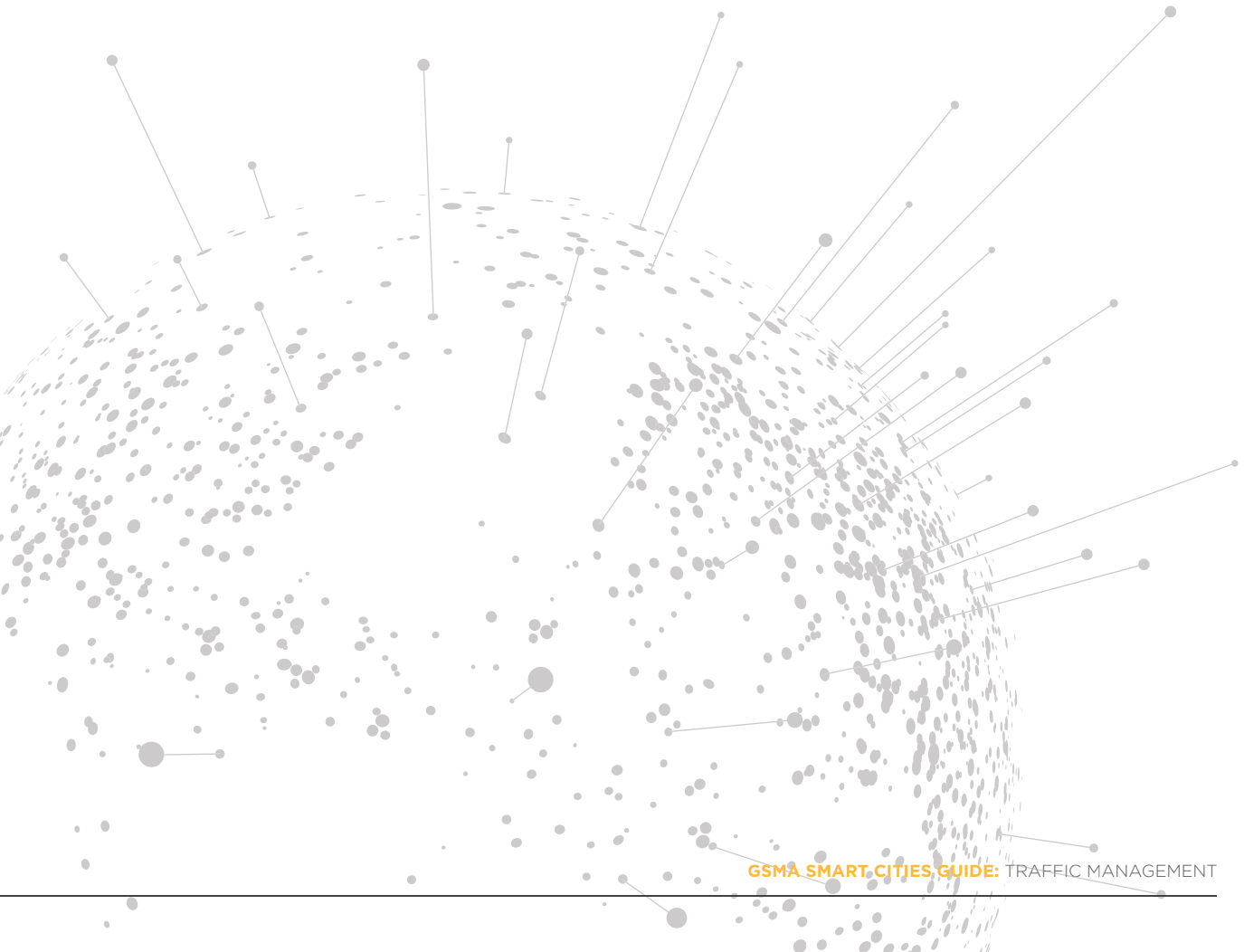
Mobile operators are starting to deploy new networks specifically designed for use by IoT connections.

These 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, as well as basic status updates from many types of sensors or monitors, 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 city services.

Mobile operators' Mobile IoT networks can also provide coverage deep indoors and underground, enabling richer and more pervasive smart city services.

Standards body 3GPP is finalising three different variants of Mobile IoT technologies for use in licenced spectrum. They will be ready for commercial deployments in 2016-2017.

Further information on these technologies can be found at: **http://www.gsma.com/connectedliving/mobile-iot-initiative/**



DIGITAL PAYMENTS

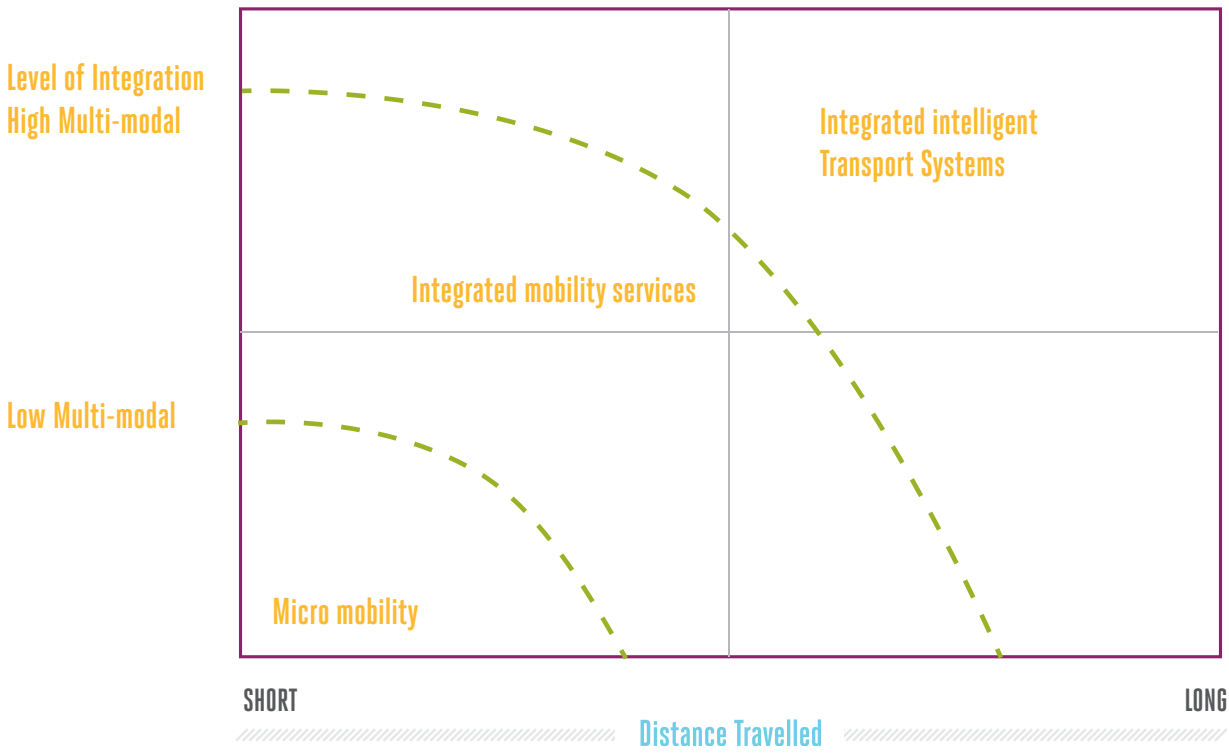
Payments are an intrinsic part of any smart transportation system – whether it be road tolls, parking charges or public transport fares, the ability for travellers to make payments on the move is an important part of a smart transportation strategy. Mobile operators across the world are able to support mobile payments for transport in several ways:

- Toll collection: Operators can install either RFID readers for e-tag pre-paid tolls, or licence plate readers for post-paid tolls. The use of this type of technology has several benefits:
  - Lower congestion by removing toll booths which create bottlenecks in a road network,
  - Increased revenue collection by speeding up the passage of vehicles,
  - Lower fraud through the use of a more secure system
- Pre-payment: Operators can connect sensors to payment systems so that travellers who have pre-paid for parking or transit can be authenticated and the balance taken from their pre-paid account.
- Payments on the move: The ability to use several payment methods on public transport or at parking stations significantly improves the travelling experience as passengers do not have to find the right change or queue while others are paying. Connected payment terminals allow fast, secure payment for all passengers.

PUTTING A SMART TRANSPORT SOLUTION INTO ACTION

To make the most of transport services, a city needs to understand how best to utilise the data and connectivity options available to them. How to implement these new services can depend on how far the typical traveller wants to go across the city. Should the city facilitate short trips to local amenities, or prioritise longer distance trips across the urban area or integrated trips onto other cities as well? The city administration also needs to consider the use of private versus public transport modes and how both forms can be introduced into a mixed modal transport model.

The chart below shows how these different considerations could be bought to bear through a city's planning process:



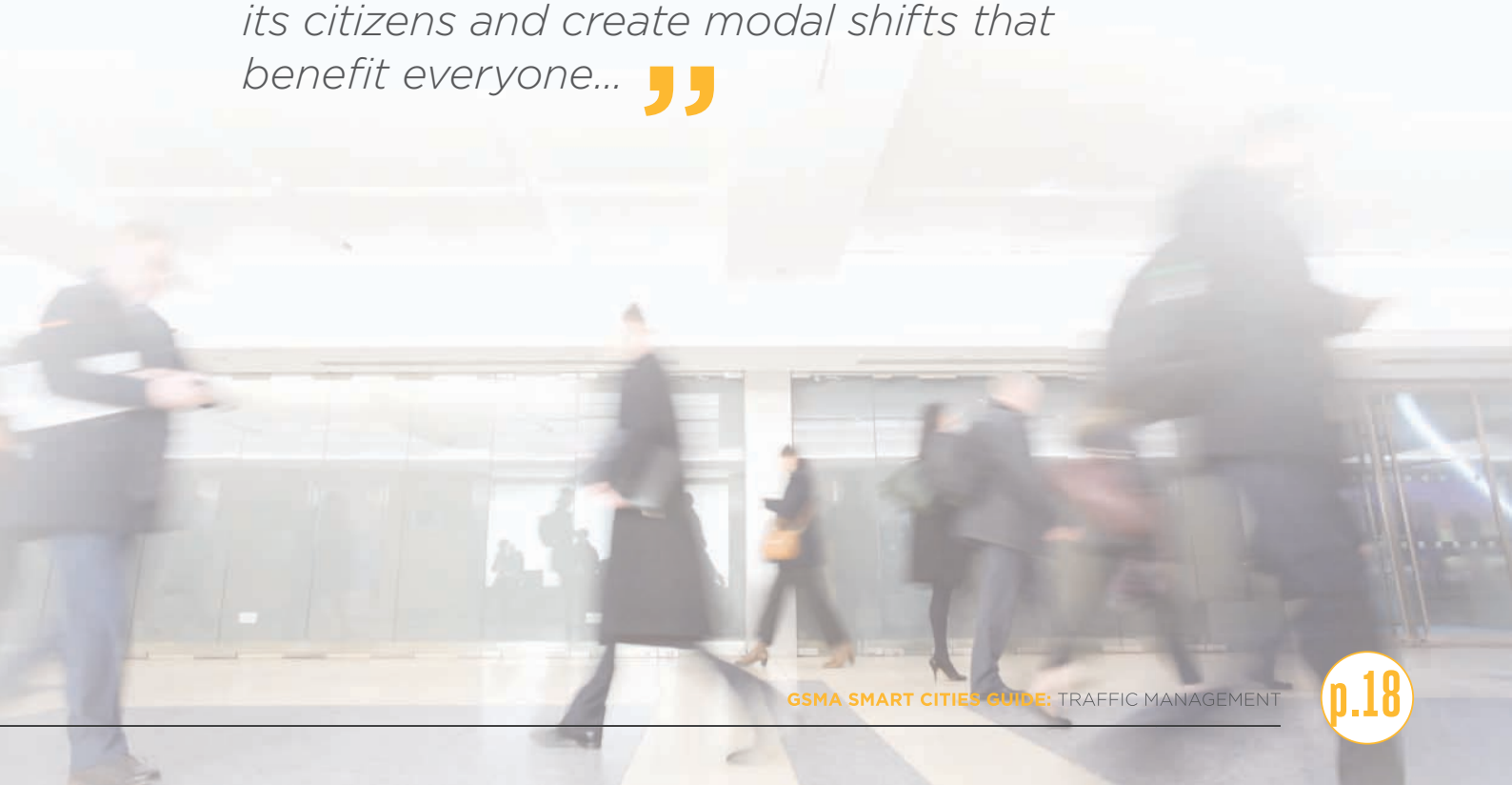
Micro mobility solutions are designed for short distance travel, with the use of a single means of transport. For example, cycling, short bus or car journeys. This form of transport benefits from simple connected services, such as intelligent bus stops, local traffic information and connected bicycle share systems.

Integrated mobility solutions introduce the concept of mobility-as-a-service. People travelling across a city, using more than one mode of transport, will benefit from connected services supporting single payment solutions, complex route planning applications, real-time data on transport status and customer services available through the day.

Integrated intelligent transport systems look at a citizen's total transport needs as they travel across, around and onto other cities, via public and private transport. People driving into a city for work can be identified, routed to appropriate drop-off points and encouraged to use public transport for portions of their journey. The city can be adapted as different transport needs emerge, whether it be the reservation of parking spaces for travellers into the city, connected tolling systems or the tracking of people around the transport network to ensure capacity is meeting demand. Citizens across the city and beyond will benefit from an intelligent transport network.

All of these different approaches require a broad range of data to be collected and appropriated in the correct way – and the systems need to be dynamic enough to cope with unforeseen events, such as weather-related issues or large events that result in transport networks being used in different ways. By connecting the city's transport assets and monitoring traffic and public transport, the city can begin to understand how to better serve its citizens and create modal shifts that benefit everyone, and potentially avoid costly capital investments in new infrastructure, as a result.

> *"By connecting the city's transport assets and monitoring traffic and public transport, the city can begin to understand how to better serve its citizens and create modal shifts that benefit everyone..."*



CONCLUSIONS

Mobile networks and services can help municipalities improve and manage transport through a city, whether it be by car, bus or on foot. Mobility is changing as passengers and travellers are given more options and more flexibility in how they get from A to B. How the city manages transport will also change, as citizens become more demanding and employ more diverse modes of transport. Transport options in a smart city can become much more efficient and relevant through the use of connected sensors, big data, apps and mobile payments. As they provide the connectivity that is enabling these changes, mobile operators are best placed to advise on how to meet the transportation challenges of the future.

About GSMA Smart Cities

Cities are getting smarter every day, using information and communications technologies to enrich and enhance city life. The growth of the Internet of Things will have a fundamental impact on the development of smart cities, helping to drive efficiencies and delivering rich new services. However, without effective strategies in place, cities will be unable to capitalise on these benefits. As part of the GSMA Connected Living programme, the Smart Cities project is working with mobile operators and cities to create real, long term benefits for businesses and citizens through IoT technologies.

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