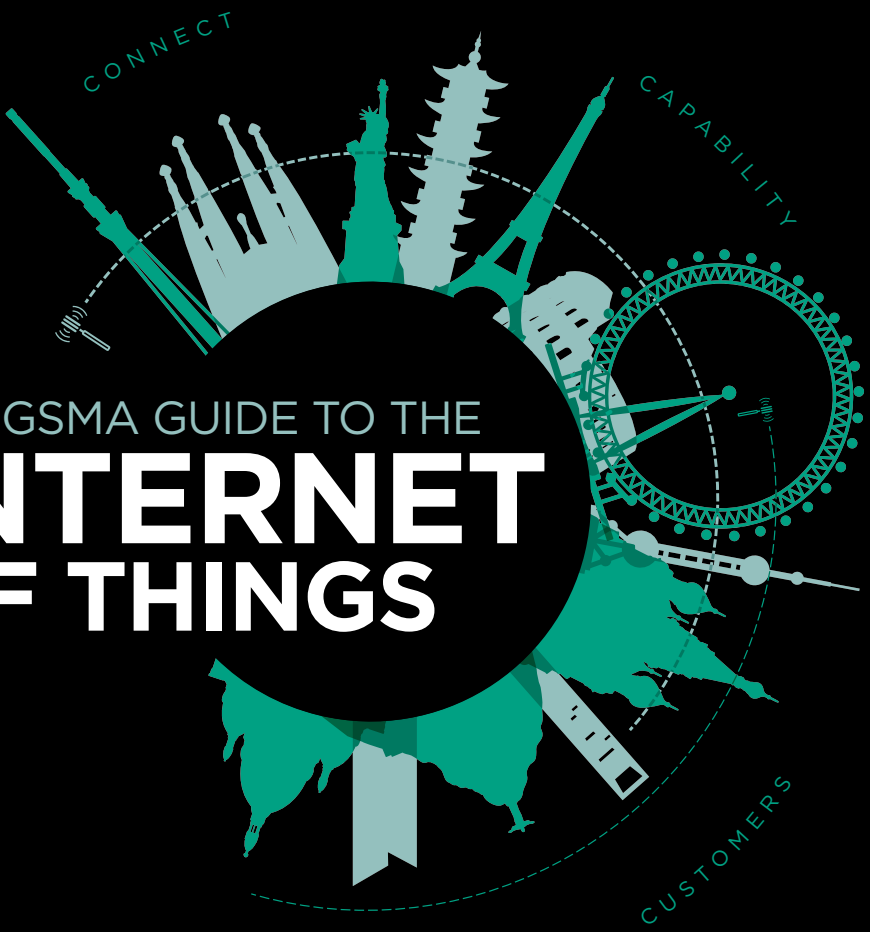


THE GSMA GUIDE TO THE INTERNET OF THINGS

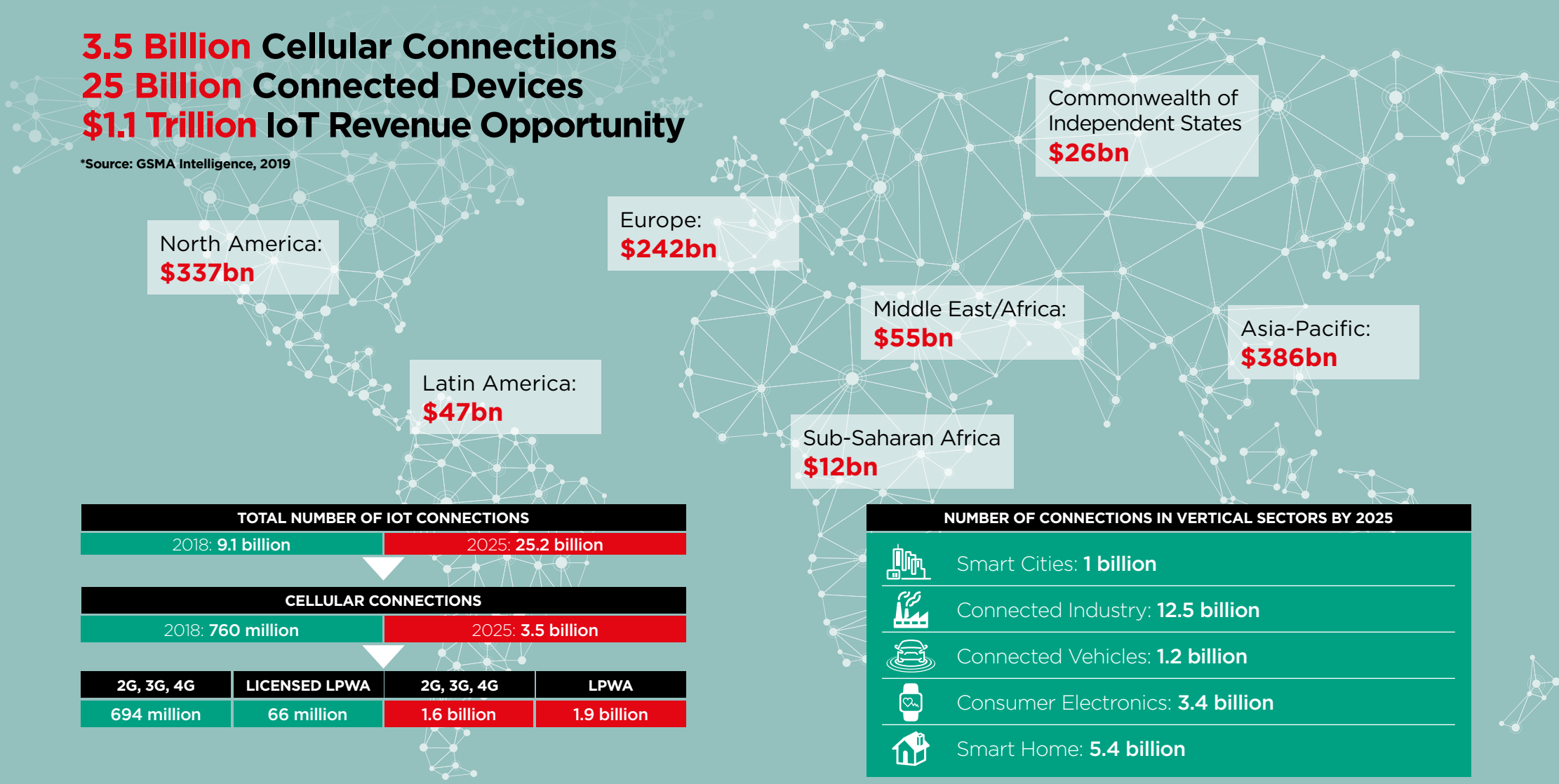
SCALING THE IoT
Enabling a world in which consumers and businesses enjoy rich new services, connected by intelligent and secure mobile networks

gsma.com/IoT

THE INTERNET OF THINGS BY 2025*

3.5 Billion Cellular Connections
25 Billion Connected Devices
$1.1 Trillion IoT Revenue Opportunity

*Source: GSMA Intelligence, 2019



TOTAL NUMBER OF IOT CONNECTIONS	
2018: **9.1 billion**	2025: **25.2 billion**

CELLULAR CONNECTIONS	
2018: **760 million**	2025: **3.5 billion**

2G, 3G, 4G	LICENSED LPWA	2G, 3G, 4G	LPWA
694 million	66 million	1.6 billion	1.9 billion

NUMBER OF CONNECTIONS IN VERTICAL SECTORS BY 2025

- Smart Cities: **1 billion**
- Connected Industry: **12.5 billion**
- Connected Vehicles: **1.2 billion**
- Consumer Electronics: **3.4 billion**
- Smart Home: **5.4 billion**

THE GSMA INTERNET OF THINGS PROGRAMME

What is the Internet of Things?

GSMA DEFINITION: The Internet of Things describes the coordination of numerous machines, devices and appliances connected to the Internet through multiple networks.

These connected devices include vehicles, utility meters, tracking devices, vending machines, consumer electronics and wearable technology, as well as smart phones and tablets.

The GSMA's Internet of Things Programme is an industry initiative focusing on the following areas:

CONNECT
Working with mobile operators and the wider ecosystem to raise market awareness and support of commercial licensed spectrum low power wide area solutions.

CAPABILITY
Working with mobile operators who are delivering value added services beyond connectivity and offering end-to-end solutions including big data, machine learning, analytics, edge computing and distributed ledger technologies.

CUSTOMERS
The Internet of Things Programme is enabling consumers and businesses to harness a host of rich new services, connected by intelligent and secure mobile networks.

KEY INITIATIVES OF THE GSMA INTERNET OF THINGS PROGRAMME

GSMA INTERNET OF THINGS

CONNECT

Mobile IoT

Raise market awareness and support of commercial licensed spectrum LPWA solutions.

CAPABILITY

Beyond Connectivity

Promote value added services including big data, machine learning, analytics, edge computing and distributed ledger technologies.

CUSTOMERS

Industry Engagement

Working closely with industry partners to align strategy and adopt new initiatives. Specific areas of focus include connected vehicles and drones.

IoT SECURITY

Enabling a trusted IoT where security is embedded from the beginning, at every stage of the IoT value chain.

IoT POLICY & REGULATION

Working to create a sustainable policy and regulatory environment to support the successful scaling of the IoT.

CONNECT

MOBILE IoT = TRUSTED IoT

Cost effective operator managed solutions to securely scale the IoT

Mobile IoT refers to low power wide area (LPWA) 3GPP standardised secure operator managed IoT networks operating in licensed spectrum, including Long-Term Evolution for Machines (LTE-M) and Narrowband-IoT (NB-IoT), designed for the 5G era. These are designed for IoT applications that are low cost, use low data rates, require long battery lives and often operate in remote and hard to reach locations, often beyond power sources.

LPWA technologies are connecting millions of devices. By 2025, there will be 3.5 billion cellular IoT connections with 1.9 billion LPWA connections. Mobile operators and their ecosystem partners are experienced and trusted providers of secure, managed IoT solutions, and are therefore best placed to extend their reach to serve the full range of IoT applications.

The adoption of these standardised technologies in licensed spectrum will allow cost effective delivery of services and eventually enable the supply of mobile modules for devices for a few dollars. Mobile IoT operators support roaming and interoperability to provide high quality, cost effective global coverage for IoT solutions.

www.gsma.com/MobileIoT

GSMA Mobile IoT Innovators

Backed by over 90 of the leading global mobile operators and vendors, and uniting over 2500 members, the official industry community for LPWA technologies in licensed spectrum is the voice of a vibrant and fast-growing ecosystem. The Mobile IoT Innovators help members accelerate the development IoT solutions, providing them with the opportunity to showcase at leading industry events for visibility in the wider market and a platform for new business opportunities.

www.gsma.com/mioti

CONNECT

Connected Cow: NB-IoT enables Precise Cow Oestrus Prediction Data

In China, most dairy farms rely on manual observation to find oestrum, which is time and labour consuming (often at midnight) with high rate of omission. Such practice makes it difficult to raise reproduction rate and milk output.

Connected Cow is a major innovative project conducted in a dairy farm with over 50,000 cows in Yinchuan city. Developed by China Telecom, Huawei and Aotoso, the "Little Shepherd" cow oestrum detection cloud system adopts NB-IoT. The NB-IoT sensor strapped on the neck of each cow can measure its body temperature to ensure the cow's health while detecting oestrum for timely mating.

Benefits

- **High detection rate** – the detection rate of the system can reach up to 95%, which effectively increases pregnancy rate, shortens pregnancy intervals, reduces cost, and increases milk output.
- **Realisation of comprehensive connection, wide coverage, and low energy consumption** – with NB-IoT network, the system can realise comprehensive connection with terminals up to 100,000 for a single system. The batteries can last for more than 6 years.
- **Stable performance** – NB-IoT sensor supports data storage, and can work at environmental temperatures of -30C to 45C with IP65 protection grade.

Besides cows, the system can also be applied in beef farms, dairy enterprises, and livestock farming associations. China Telecom started the NB-IoT sensor deployment to 50,000 cows, and up to 1.2 million by the end of 2017. The recent studies show there are 150 million cows worldwide, with huge demand to innovative IoT solutions like "Little Shepherd" from the industry.

CAPABILITY

Capturing Higher Value Services, Beyond Connectivity, at Scale

The GSMA is working with mobile operators on common enablers which facilitate global business models and reduced costs for operator managed services beyond connectivity.

Enablers for delivering services beyond connectivity:

- Analytics, Big Data and Machine Learning
- Distributed Ledgers, Edge Computing and Platforms

www.gsma.com/BeyondConnectivity

Analytics, Big Data and Machine Learning

Unlocking the potential of the IoT
The rapid growth of the IoT creates substantial opportunities for users to benefit from services which are based on data acquisition and storage, analytics and machine learning.

Big data and AI analytics tools give operators the opportunity to provide much more value, analysing data and developing intelligence. This provides much greater business value to customers, and the opportunity to help customers make use of that intelligence.

Smart London: Air Quality Monitoring with IoT Big Data Analytics

Poor air quality in London and many other cities is causing an acknowledged public health problem. Air pollution is now the world's fourth-leading fatal health risk. If cities are to continue to flourish and prosper then they must tackle this air pollution crisis.

The GSMA is working with the Royal Borough of Greenwich on an air quality initiative utilising mobile, IoT and big data technologies, which aims to improve the health prospects and quality of life for citizens, while providing city administrators with vital information to implement new solutions and quantify their success. **www.gsma.com/smartlondon**

CAPABILITY

Unlocking the Full Value of IoT Big Data across Verticals

Distributed Ledgers, Edge Computing and Platforms

In the IoT, distributed ledgers can help to authenticate devices, complete smart contracts, support micro-payments, share information and support key verticals, such as supply chains. For example, a distributed ledger can be used to record the origin of goods, progress through transportation channels, wholesalers, customs and supply to the end customer, along with supporting information, such as geo location and environmental monitoring data, to make the whole process more efficient, transparent and resistant to fraud.

IoT market analysts expect the edge to play a significant role in supporting IoT implementations in the future, as it creates efficiencies and scale in networks that makes IoT deployments more self-sustaining.

Mobile operators are well placed to enable edge computing to scale and enhance IoT deployments, additionally allowing options for data processing on behalf of customers to be further incorporated into their service offerings.

CUSTOMERS

Aligning Market Perspectives, Driving Adoption and Growing the Market across Key Vertical Sectors

The GSMA works closely with its partners in the industry to align its strategy and to ensure its initiatives are adopted. By determining common capabilities, we will make a positive impact on the industry, creating solid foundations for the Internet of Things.

Regular engagement and communication with the industry will lead to better market understanding, resulting in improved IoT products and services, superior user experience and greater connectivity, enabling the market to grow.

In particular, the GSMA is working with

- the automotive industry and wider ecosystem to accelerate adoption of cellular technologies (C-V2X)
- mobile operators and the drones industry to identify common challenges which would benefit from collective action
- governments and city planners to create smarter, more efficient cities;

CUSTOMERS

DRONES

Representing the interests of the mobile industry in the commercial drone market.

Drones are already used for a multitude of applications, particularly where they can offer commercial value and socio-economic benefits, such as disaster response, logistics and transport.

The mobile industry is the key enabler to the growth of the commercial market. Mobile networks can securely identify a drone and its location in order to help ensure the safety of commercial drones and to help mitigate privacy, safety and security risks. This makes mobile networks the preferred solution, offering drones superior wide area, high speed and secure connectivity.

www.gsma.com/drones

CONNECTED VEHICLES

C-V2X – On the Road to 5G

C-V2X (Cellular Vehicle-to-Everything communication) is commercially available today and provides levels of security, range, latency and reliability that have been proven to vastly exceed the capabilities of DSRC/802.11p. C-V2X is also the only connected vehicles technology with a long-term future and a sustainable roadmap to 5G-V2X to enable fully autonomous driving. The GSMA is working with the industry to accelerate the adoption of C-V2X technologies for connected and autonomous driving.

www.gsma.com/automotive

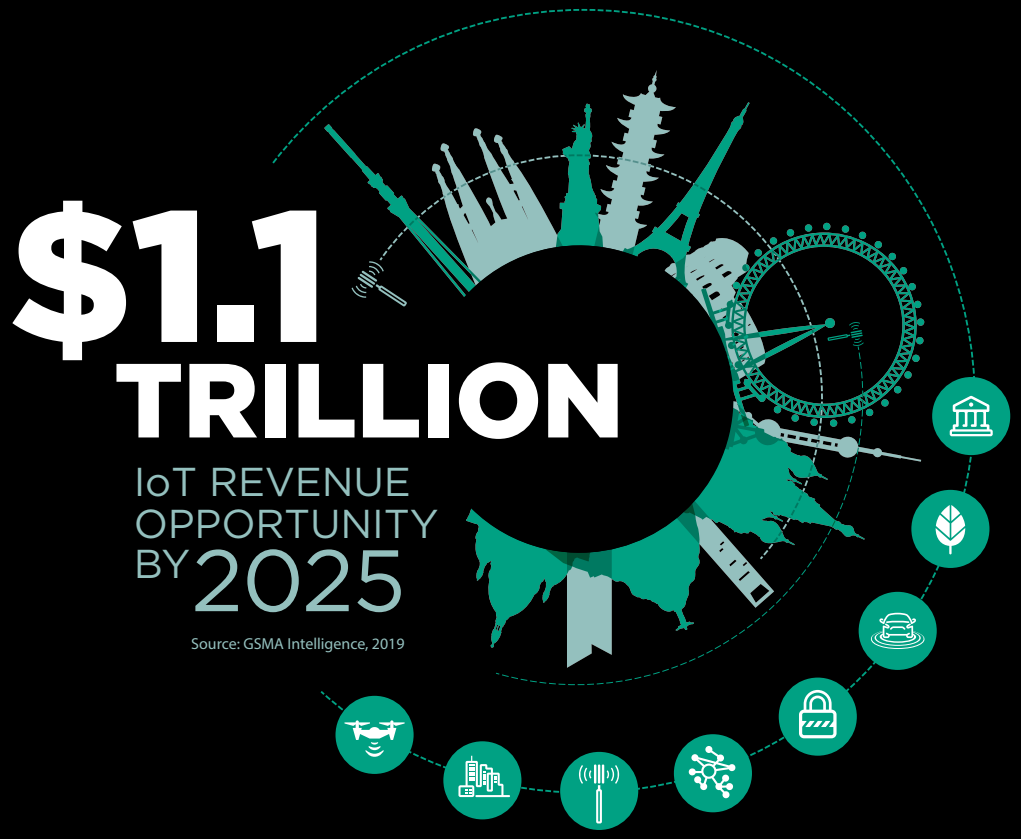
SMART CITIES

Creating Smart City Benefits through IoT Technologies

The growth of the Internet of Things will help drive cost efficiencies and deliver rich new services to smart cities. With vast experience and existing network infrastructure, mobile operators are the trusted partners for delivering IoT solutions.

The GSMA is helping mobile operators and cities work together to create sustainable, long-term benefits for businesses and citizens through IoT technologies.

www.gsma.com/smartcities



IoT SECURITY

Enabling a Trusted IoT

Without security, the Internet of Things will cease to exist. To enable a trusted market, companies have to take responsibility to embed security at every stage of the IoT value chain.

As cyber threat levels continue to rise, so does the need for IoT security by design and trusted service management by mobile operators. As the established providers of secure IoT services in licensed spectrum and with decades of extensive security expertise, mobile operators will ensure the long-term sustainability and growth of the market. Therefore, the GSMA, together with the mobile industry, has developed a comprehensive set of IoT Security Guidelines, backed by an IoT Security Assessment scheme, to provide a proven and robust approach to end-to-end security.

The GSMA IoT Security Guidelines:

- Include 85 detailed recommendations for the secure design, development and deployment of IoT services
- Cover networks as well as service and endpoint ecosystems
- Address security challenges, attack models and risk assessments
- Provide several worked examples

The GSMA IoT Security Assessment:

- Is based on a structured approach and concise security controls
- Covers the whole ecosystem
- Can fit into a supply chain model
- Provides a flexible framework that addresses the diversity of the IoT market

Over 15 leading global mobile operators, their partners, governments and industry bodies are using the guidelines and assessment to encourage industry-wide security for a robust IoT. The GSMA continues to work with mobile operators and the wider industry to further accelerate the adoption of the guidelines and the assessment.

To ensure your IoT products and services are secure, download the GSMA IoT Security Guidelines and IoT Security Assessment for free:

gsma.com/IoTSecurity

IoT SECURITY

Securing the Port of the Future
Secure IoT Solutions for the Smart City

Led by the University of Seville and the Port Authority of Seville, the Tecnoport 2025 project uses Internet of Things solutions to improve the efficiency of transport and logistics in south west Spain.

Implemented by a consortium of five companies, including mobile operator Telefónica, the project uses new wireless networks and sensors to improve the tracking and remote control of containers passing through the port, and to optimise the rail and river traffic in the area.

In line with the GSMA IoT Security Guidelines, Tecnoport 2025 uses a combination of virtual private networks (VPNs), private access point names (APNs), multiple-factor authentication mechanisms and other measures to keep the new IoT solutions secure.

In the fourth quarter of 2016, Tecnoport 2025 employed the new GSMA IoT Security Assessment scheme to test the security of two key components of the project – the managed connectivity platform that controls cellular connectivity, and the FIWARE-based Smart City Platform that aggregates the data generated by remotely deployed sensors connected via wireless networks. Telefónica has found that the assessment process has helped to highlight some important security features that hadn't been raised before, all of which were implemented by the Tecnoport 2025 team. Tecnoport 2025 are now planning to use a similar approach as the basis of other smart city services in the port and the city of Seville, considering that the assessment scheme strengthened the security of their networks and systems, with the IoT solution also increasing the competitiveness and efficiency of the port.

IoT POLICY AND REGULATION

Growing the Socioeconomic Benefits of the Internet of Things

The accelerating growth of the Internet of Things is transforming economies and societies. The GSMA is working to create a sustainable policy and regulatory environment to support the successful scaling of the IoT.

Promoting government support for the growth of IoT services is the most effective way of establishing a trusted network, capable of realising the socioeconomic benefits of the IoT. Governments and regulators can help build consumer trust by promoting an industry led approach to privacy and security, and fostering collaboration and a constructive dialogue across the various players of the IoT industry value chain aimed at identifying industry best practices.

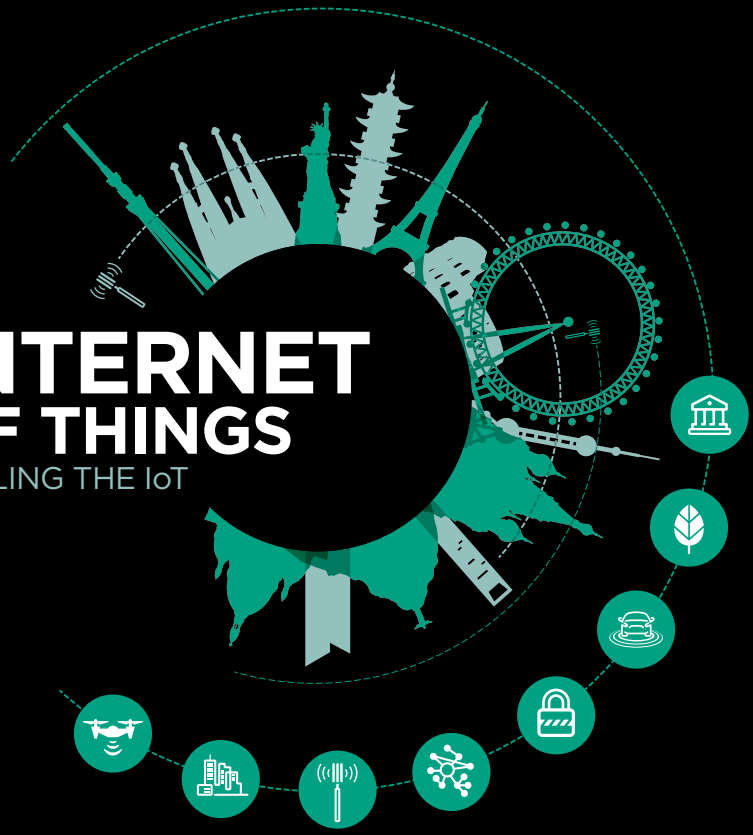
Building trust and providing a level playing field for all technologies will give confidence to consumers and the industry that will generate help to drive global adoption of the IoT.

The IoT spans multiple departments, organisations and industries, therefore new challenges arise. Working in collaboration, on a common and consistent approach, will maximise the market opportunity.

The IoT Knowledgebase for Policy and Regulation is an online tool to help policymakers and regulators unlock IoT opportunities in their regions, understand new IoT business models and learn about emerging policy and regulatory best practice from around the world.

www.gsma.com/IoTKB

GSMA



INTERNET OF THINGS

SCALING THE IoT

gsma.com/IoT