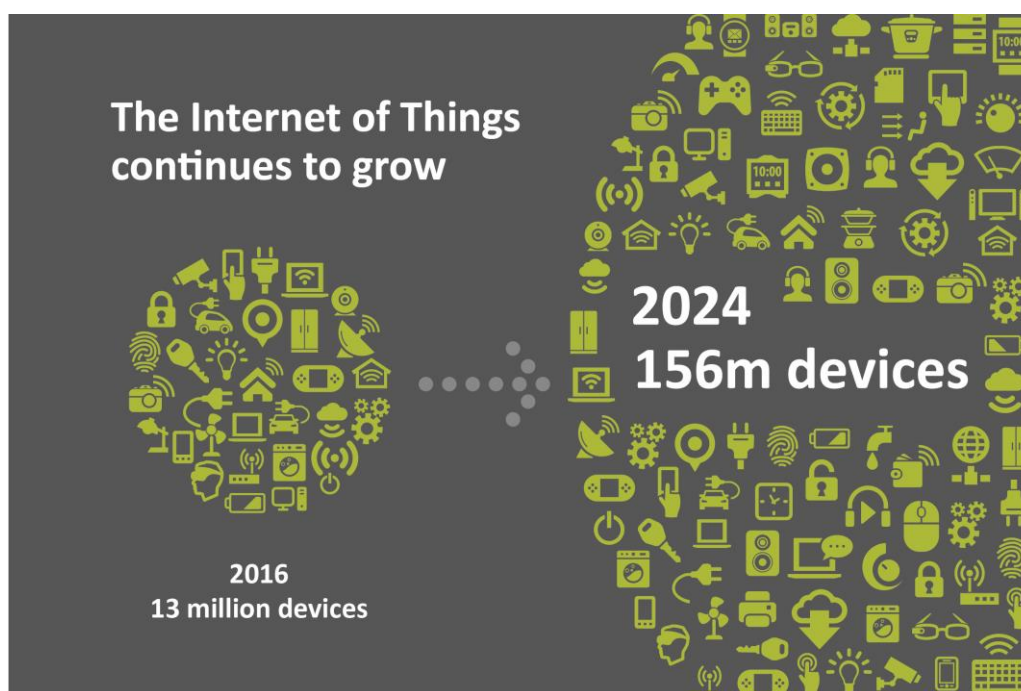


6. The Internet of Things

- 6.1 The Internet of Things (IoT) is a network of everyday consumer devices and other physical objects that are connected to the Internet to provide new services. As part of the Connected Nations Report, we intend to track and monitor the growth and development of IoT in the UK. IoT is set to enable large numbers of previously unconnected devices to communicate and share data with one another. We consider IoT an important developing area of communications networks. Our priorities in this area include ensuring the availability of infrastructure is not a constraint for the development of IoT.



Source: Cambridge Consultants IoT forecast

- 6.2 Over the next decade IoT connections and services are expected to grow rapidly and many of these new services, such as improved healthcare, energy and transport have the potential to deliver significant benefits to consumers.
- 6.3 We have an ongoing program of work conducting research and monitoring industry and technology developments. Over the past few years we have explored and identified priority areas to help and support the growth of the Internet of Things (IoT). As part of this
- we published a study⁵⁷ in 2014 with Machina Research, to assess the implications of the growing demand for IoT/M2M applications on spectrum over the next decade.
 - we published a statement⁵⁸ in 2015, named “Promoting Investment and Innovation in IoT”. In the statement, we recognised the incentive for stakeholders to invest in IoT

⁵⁷ https://www.ofcom.org.uk/data/assets/pdf_file/0040/68989/m2m_finalreportapril2014.pdf

⁵⁸ https://www.ofcom.org.uk/data/assets/pdf_file/0025/38275/iotstatement.pdf

networks and services and highlighted areas where IoT could deliver benefits to citizens and consumers in areas such as healthcare, transport and energy.

- c) we commissioned a study⁵⁹ last year to review progress in IoT over the past two to three years. It focused on new emerging applications, and new network and standards developments. The study also investigated the current market and technology trends and provided forecasts for those trends.

6.4 Overall our view is that industry is best placed to drive the development and standardisation of IoT technologies. However, given the potential for significant consumer benefits, we are keen to take the right steps to ensure the UK plays a leading role in developing the Internet of Things. Working with industry and Government, we will continue to create a regulatory environment which fosters investment and innovation in IoT.

IoT technologies

6.5 Technologies over which IoT networks and applications are deployed have improved considerably over the last decade. These technologies enable IoT devices and connections to communicate and share data wirelessly within a local network or the wider internet.

6.6 As IoT encompasses a wide range of devices that are continually collecting or examining data, from simple sensors to large industrial application tools, each device needs to be connected and accessible to work effectively. The devices then use the information they collect to provide a service to the consumer. An example of this is the automobile industry where car manufacturers can provide updates on maximising the performance of the car based on the driving patterns of the consumer.

6.7 Connecting a wide range of different objects and devices is critical for the success of IoT and compatible standards are therefore a key foundation for creating IoT networks where connected objects can securely communicate and share data.

6.8 For most consumers, exposure to the IoT has to date been limited to wearables, such as smart watches or fitness trackers, and smart home appliances, such as intelligent heating controllers. However, our research suggests that IoT is no longer limited to such short-range applications supported by general purpose technologies such as Bluetooth, ZigBee or wifi. The emergence of technologies that rely on global IoT specific standards is making IoT a more attractive commercial proposition.

6.9 These new technologies, more commonly known as Low Power Wide Area or LPWA networks, are designed for IoT applications and services that have low data rates, long battery lives and, if required, can operate in remote and hard to reach locations.

⁵⁹ <https://www.ofcom.org.uk/research-and-data/telecoms-research/general/review-of-latest-developments-in-the-internet-of-things>

Some Low Power Wide Area (LPWA) technologies

LoRa is technology for wide area networks designed to be deployed in the 868MHz band in Europe, which is exempt from licensing. This facilitates easier entry for application and service providers to new markets without requiring any prior authorisation. This technology also has long range capabilities i.e. a single base station or gateway can cover hundreds of square kilometres.

NB-IoT (Narrowband IoT) is a 3GPP standardised technology intended to improve coverage over existing mobile technology, enabling the deep in building coverage required for applications such as smart meters. It has been designed to support more than 50,000 devices per cell, in most cases it only requires a simple software upgrade of existing mobile networks and provides around 20dB additional link budget, enabling ten times better area coverage.

EC-GSM (Extended coverage GSM) is a 3GPP standard-based Low Power Wide Area technology for IoT. It covers similar use cases than NB-IoT but it is designed over existing GSM standards. It provides around 15dB additional link budget, enabling about seven times better area coverage.

LTE-M is a simplification of existing LTE technology for IoT, that is expected to offer slightly higher data rates than other LPWA technologies (up to 1Mbit/s) and is suitable for use cases such as enhanced tracking and health monitoring.

- 6.10 Some of these IoT specific technologies can be deployed on existing mobile networks. They can support many low powered devices and their IoT coverage extends significantly beyond the current mobile network footprint. Figure 31 shows the extension in coverage that mobile based technologies would provide.
- 6.11 As set out in section 5, operators are working towards extending their geographic 4G coverage. The green areas in the map indicate 2G coverage by the MNOs with the highest geographic coverage. This is a proxy for future 4G coverage. The amber areas show the extension in coverage over which IoT applications and services could be deployed. Overall coverage for IoT could deliver an improvement in coverage of over 20 percentage points (from current 77% to 98%).

Figure 31: Extended IoT coverage vs. traditional mobile coverage



Source: Ofcom analysis of operator data

- 6.12 UK mobile network operators are starting to offer their own end-to-end IoT platform solutions on their existing networks using current technologies. This offers mobile operators more control over the services deployed on their network as opposed to merely providing connectivity for over-the-top IoT services.
- 6.13 So far, there have been no commercial deployments of IoT technologies on mobile networks in the UK. However, several trials have been announced. A few operators have confirmed their plans to lab test NB-IoT and LTE-M, by the end of the year. This could potentially lead to full deployments on their live networks in the future, though they have no plans to use EC-GSM on their networks. Additionally, one operator is also looking at Non-3GPP technologies and LoRa in their future deployments for IoT services and applications.
- 6.14 Earlier this year, Vodafone⁶⁰ revealed that it had deployed over 50m connections on its networks worldwide, with around a million connections being added each month. Vodafone partnered with Huawei last year to open the world's first 'NB-IoT Open Lab'⁶¹ in

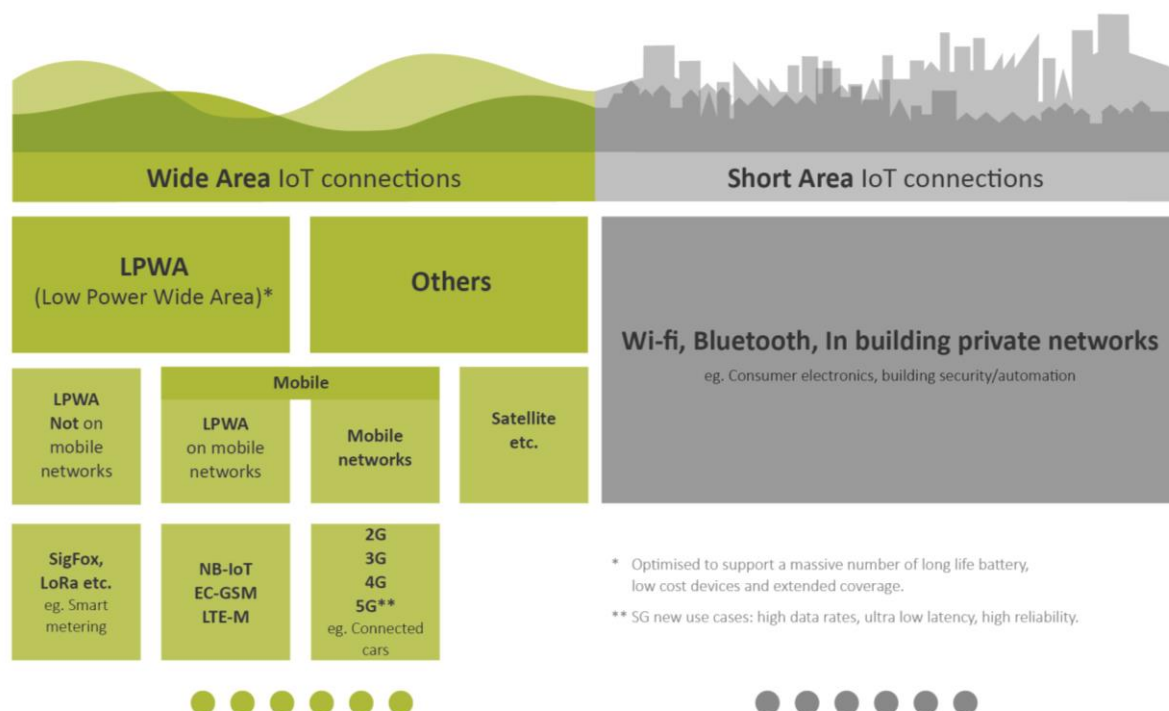
⁶⁰ <http://www.vodafone.com/business/press-release/vodafone-is-first-global-iot-provider-to-pass-50-million-milestone>

⁶¹ <http://www.vodafone.com/business/iot/Huawei-and-Vodafone-Announce-Opening-of-Worlds-First-Narrowband-IoT-Open-Lab-2016-04-26>

Newbury in Berkshire. This has been followed by a second lab opened in Düsseldorf, Germany in February 2017.

- 6.15 Current mobile networks and other non-cellular networks operating in licensed and unlicensed spectrum already support many IoT applications. In the future 5G, alongside other new technologies, may play a significant role in supporting many more connected devices (up to one million IoT devices per square kilometre) and support instant response communications. This could include autonomous vehicles, remote control of manufacturing, or a tactile internet experience (where a person can remotely interact with an object as if it was next to them).

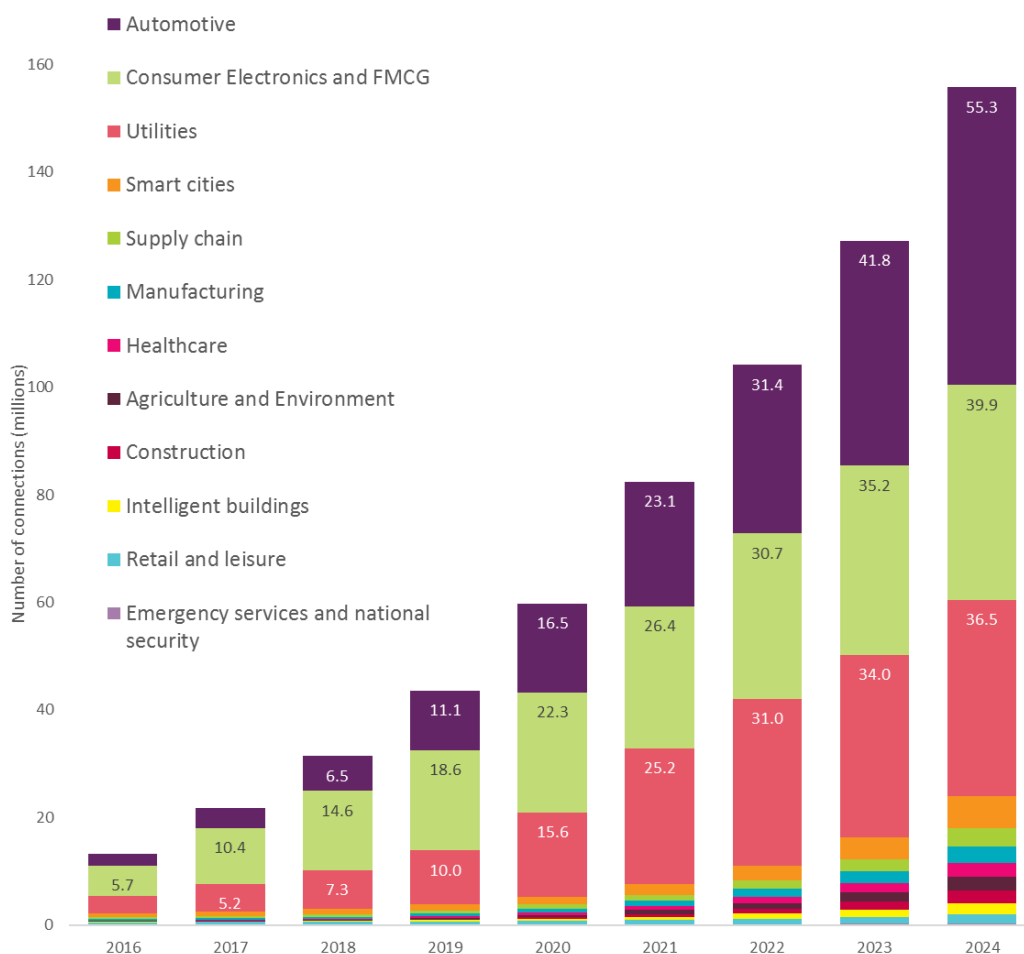
Figure 32: Technology and market developments of IoT connectivity



- 6.16 Despite the progress made on standards and technologies, IoT ecosystems remain complex. The current fragmentation in IoT connectivity and technical solutions has impacted equipment costs and reduced interoperability. This has acted as a barrier in the evolution of IoT as seen in our latest research, which provided a more conservative forecast for growth in IoT than a similar study⁶² we commissioned three years ago.
- 6.17 The latest study focused on 12 key growth areas in IoT and found the complex nature of IoT ecosystems resulted in slower advancements in the number of connections. The number of IoT connections in the identified sectors are predicted to grow from around 13m in 2016 to over 150m by 2024 in the UK.

⁶² https://www.ofcom.org.uk/_data/assets/pdf_file/0040/68989/m2m_finalreportapril2014.pdf

Figure 33: IoT forecast



Source: Cambridge Consultants IoT forecast for Ofcom

- 6.18 Much of the growth in the IoT sector is being led by the consumer wearables and white goods market, which now account for over 40% of all IoT connections. Looking further ahead, most of the future growth in the IoT by 2024 is predicted to be in the automotive, consumer electronics and utilities sectors (see Figure 33).
- 6.19 The Automotive sector is predicted to account for 55m IoT connections by 2024, representing more than a third of all connections. Majority of these connections are expected to be in the ‘connected car’ environment. So far, ‘connected car’ initiatives have been given impetus by a European requirement for new cars to provide automatic emergency services notifications in the event of an accident from April 2018.⁶³ More recently, several key automotive and mobile players have formed a 5G Automotive Association (5GAA) including Audi, BMW, Daimler, Huawei, Vodafone and Nokia. This association is aiming to develop cellular solutions for the delivery of entertainment, anti-collision, insurance, traffic control, telematics and car efficiency services.

⁶³ <https://ec.europa.eu/digital-single-market/en/news/ecall-all-new-cars-april-2018>

6.20 The forecasts from our independent study suggest that more than 80% of all connections in 2024 will come from 12 of the largest applications including smart metering, wearables, emergency calling and connected media. Although the scale of the number of connections reveals the significance of IoT in these sectors, it does not necessarily translate into revenue generated or provide a measure of the value associated with that connection.

Impact of public policy on IoT

- 6.21 Connectivity remains only a small part of the larger IoT landscape, which comprises of many different players including consumer equipment vendors, application and platform providers, service integrators and data aggregators. This means different IoT sectors face different commercial pressures, challenges and market dynamics.
- 6.22 Although major technology companies, including Apple, Amazon, Google and Facebook, have now entered the smart home and/or connected cars market to establish an early presence in the sector, public policy support continues to play an important role in the development phase of the IoT.
- 6.23 Government initiatives such as the plans to upgrade the UK energy system⁶⁴ are already underway to help consumers manage their energy supply efficiently. The number of smart meters is predicted to grow to 53m in the UK by 2020, with connectivity delivered jointly by Arqiva and Telefonica.
- 6.24 In 2015, the government announced a £40m research fund for the IoT⁶⁵, which helped support several 'Smart city' initiatives in London and City Verve⁶⁶ in Manchester. Other initiatives such as Bristol is Open in Bristol⁶⁷ and MK Smart⁶⁸ in Milton Keynes, also received public funding from their local councils. These initiatives aim to deliver smart health, transport and energy services.
- 6.25 Coverage and connectivity is key to the success of IoT. We intend to use the Connected Nations report to monitor and report on the deployment of IoT specific technologies such as NB-IoT and LTE-M on the networks in the UK. We will also continue to collaborate with industry stakeholders and other regulators in evaluating the resource availability and any need for dedicated and/or harmonised spectrum bands for IoT in the future.
- 6.26 To minimise the threat of security breaches on IoT networks, we are continuing to work alongside other bodies such as the National Cyber Security Centre (NCSC) and the Centre for the Protection of National Infrastructure (CPNI) to raise consumer awareness and minimise risk to consumers.

⁶⁴ <https://www.gov.uk/government/publications/2010-to-2015-government-policy-household-energy/2010-to-2015-government-policy-household-energy#appendix-7-smart-meters>

⁶⁵ <https://www.gov.uk/government/news/budget-2015-some-of-the-things-weve-announced>

⁶⁶ <http://www.cityverve.org.uk/>

⁶⁷ <http://www.bristolisopen.com/>

⁶⁸ <http://www.mksmart.org/>