

# The value of 5G for cities and communities



O<sub>2</sub>



# Foreword

Of all the ingredients that keep our economy and society moving, arguably top of the list is mobile. Mobile motors our modern world; put simply, Mobile moves Britain.

The impact of mobile on our lives will be accelerated with the arrival of 5G in a few years. Wireless connectivity will go from something we experience through personal devices, to an integrated infrastructure of buildings, transport and utilities, providing unprecedented benefits for citizens, businesses and cities alike. This ubiquitous connectivity will help make energy grids more resilient, slash unproductive commutes and free up time in our over-stretched public services.

In my view, too much time is spent analysing the technology and not enough time on what it means for citizens. This report examines the difference 5G-enabled cities will make to people's lives and pockets, what it means for their council bills and the gains at a city level. Because if we agree the benefits are tangible, we can agree what needs to happen to make them real and not a distant utopia.

## **Our research finds:**

Every household will be £450 better off a year – £145 will be shaved off their energy bills through super-smart grids and their council bills will be £66 cheaper thanks to connected refuse collection and smart fridge 'shelfies' will allow them to cut food waste by £236 a year. In addition, an extra 1.3 million electric cars will be brought onto the roads as a result of 5G-proofed energy grids that can withstand mass electric car charging, saving each owner £1,600 in annual fuel costs.

Local authorities will collectively share an annual £2.8 billion of efficiency savings, from reduced social care costs for the elderly through 5G monitoring, to savings through smarter street lighting.

Waiting times for GP appointments can fall, as 1.1 million hours of GP time is freed up through telehealth, improving productivity through less workplace absence.

All contributing to a total of £6 billion in productivity savings (time and cost) for cities.

The worrying thing is none of these benefits are assured. 5G works a bit like a patchwork quilt. It needs a high level of collaboration to hardwire the technology into our cities' infrastructure. The danger is we treat it as an afterthought, when in fact it needs to be planned in now.

We need a world where connectivity is as prized as an energy performance certificate by home buyers and sellers. Where connectivity is checked off by building regulations. Where digital infrastructure has equal billing with physical.

Britain was a pioneer of mobile technology, but without an urgent remedy we risk squandering the benefits and losing the digital leadership we have worked so hard to establish.

To realise the benefits of 5G-enabled smart cities we must work together to design and build in the technology now.

**Mark Evans,**  
**CEO, Telefónica UK**



## Leading by example

I recently travelled to Asia to see how 5G is being designed into infrastructure. What struck me is the level of coordination and cooperation between regulators, local and central government, operators and vendors that happens when everyone is focused on a singular goal – better mobile connectivity.

These markets are racing to deliver next generation connectivity to showcase their expertise to the world – not because they need it, but because they can.

With all stakeholders aligned on the benefit, any barriers are quickly removed. In Japan, success is improvements in security through better facial recognition and thermal imaging. In South Korea, 5G will evolve its edge in gaming and video streaming, while China sees benefits in process engineering and automated production. While the benefit may change from country to country, it's clear the model works – when there are high levels of alignment on the outcome, from top to bottom, the whole industry gets behind it to make it happen.

Our report shows how 5G will tackle some of the biggest issues we face – whether improving our health and social care, reducing traffic congestion and overcrowding on our city transport systems, or helping combat issues like fuel poverty or powering a nation of electric vehicles – bringing benefits at the citizen, council and city level.

At O2 we've already seen how an outcomes-focused model works through our partnership with the City of London and in Aberdeen. Collectively focusing on the outcome of better mobile connectivity led to us deploying networks of small cells across existing infrastructure that will future-proof both cities, paving the way for 5G when it arrives. It's this high-level collaboration and access to sites that is required to achieve better solutions.

If we could replicate this across the UK, we could collectively reduce the UK's running costs to make every pound work harder and smarter for its citizens. Our report shows the potential benefits across healthcare, energy, transport or retail and commerce that could be achieved if 5G is built into the fabric of our cities – this must be the outcome that aligns us as an industry.

Rather than working together, we and other mobile operators are thwarted because access to sites comes with barriers. Going forward, regulators, operators, vendors, landlords and industry need to align on the prized outcome of 5G connectivity and move forward with Government and local authority support to unblock these hurdles to better connectivity.

**Derek McManus,**  
**COO, Telefónica UK**

# Defining a smart city

In order to understand how 5G will benefit citizens and make cities function more efficiently and sustainably, it is important to first have an understanding of what cities are.

Professor Bill Hillier, Research Professor at The Bartlett School of Architecture's Faculty of the Built Environment at UCL defines cities as socio-physical systems. In the physical sense, they are very large collections of buildings and physical infrastructure held together by a complex network of space. In reality, cities are even more complex networks of activity, movement and interaction, driven by human behaviour.

Understanding the interaction between a city's physical infrastructure, its multiple networks, and society is important if we want to make cities smarter.

Connectivity plays a crucial role in the functioning of cities, facilitating our day-to-day lives and interactions for the social and economic benefit of all.



Throughout this report these icons indicate the advantages of 5G to:



Households



Councils



Cities



The UK

Find out more about the next generation connectivity that will power our cities on the next page.

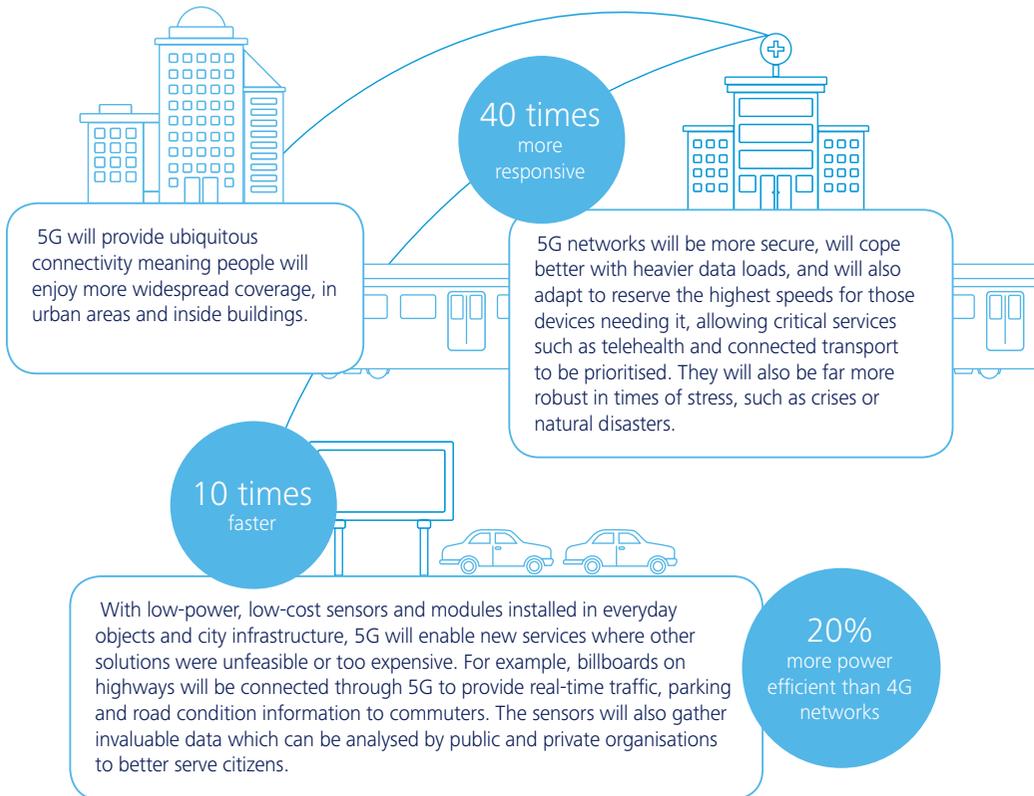
# What is 5G?

5G or 'fifth generation' network connectivity is the next wireless technology being developed by mobile network operators like O2, expected to launch in 2020.

The 3G and 4G networks focused on connectivity via personal devices, whereas 5G will integrate with infrastructure, buildings, appliances, vehicles and products to deliver unprecedented benefits for citizens across transport, healthcare, energy, commerce and leisure.

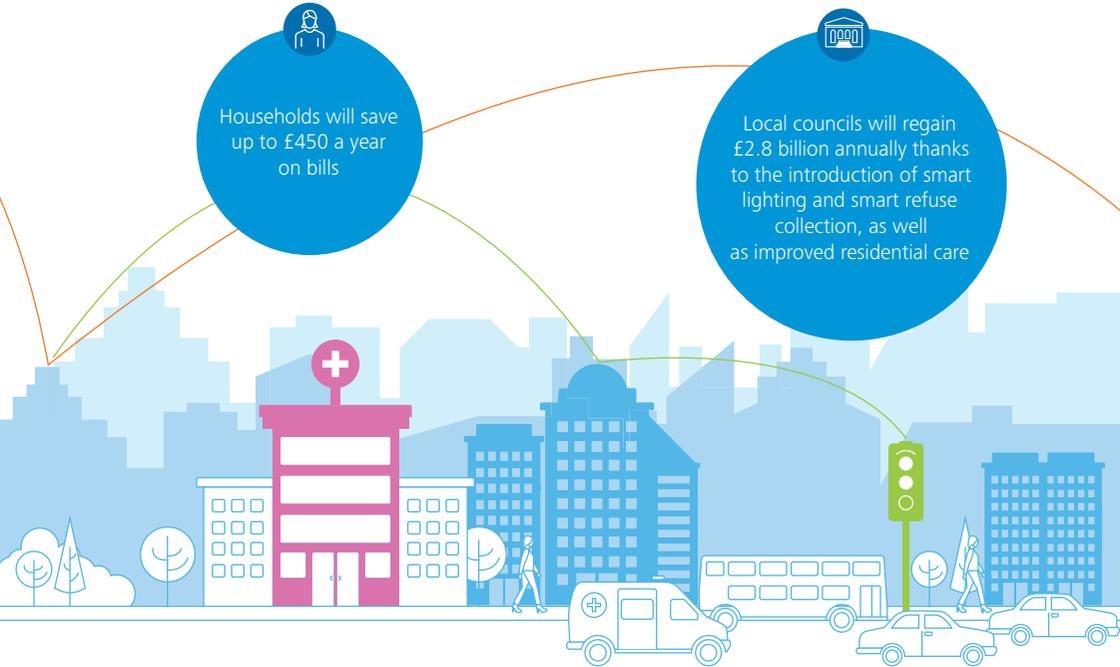
5G networks are expected to deliver a latency (a measure of the delay in end-to-end transmission) as low as 1 millisecond. A drastic reduction compared to 4G networks at 40-60 milliseconds.

The high bandwidth and speed of 5G will support services such as ultra-high definition video streaming, large file downloads and virtual reality applications. Peak data rates are estimated at 10Gbps, allowing people to easily stream 4K and 8K videos on smartphones.



# The 5G-connected smart city

5G will provide a new level of underlying connectivity to transform services and create new digital ecosystems that will deliver cost and time savings and new amenities to a city's inhabitants.



**This report focuses on the advantages of 5G technology in four key sectors:**

## Healthcare

Thanks to its responsiveness and speed, 5G-enabled technology will power improvements in telecare and telehealth imaging and data collection, aggregation and analysis.

## Transport

Commuters will benefit from 5G-enabled road systems that will reduce traffic congestion by 10%, saving the economy £880 million a year, while sensors on the railways will cut unplanned train cancellations.



Total productivity savings of £6 billion for the UK's cities



5G will free up 1.1 million hours for GPs by facilitating telehealth video conferencing and real-time health monitoring



**Energy**

5G technology will help unlock the next generation of smart energy grids. These will be more robust, more responsive and have greater capacity to deal with increasing demands more efficiently.

**Retail and commerce**

Enabled by 5G, the role of artificial intelligence will grow. By 2025, UK citizens will spend £1.4 billion using chatbots, a 45,000% increase on 2017's forecasted spend.

# Healthcare

Thanks to its responsiveness and speed, 5G-enabled technology will power improvements in telecare and telehealth imaging and data collection, aggregation and analysis.

5G connectivity will enable the widescale adoption of high-quality telehealth video conferencing, allowing people to conduct GP consultations on their smartphones or devices.

It will also provide the reliable and secure connectivity that will enable the widescale adoption of digital health monitoring devices.

Its uninterrupted connectivity will evolve the use of technology like accelerometers, which are found in most smartphones, turning them into a tool which alerts social care services if you fall, or sensors that can share your vital signs with your healthcare professional to help manage chronic illness.

By 2025, an ecosystem will have developed which will bring all these elements together to move towards a preventative healthcare system.

## Did you know?

UK patients make 5 GP visits per year.

Over 80s make 12-13 per year.

An average GP appointment takes 10 minutes.

An average GP visit with booking and travel time takes 50 minutes.



## Replacing just 5% of GP appointments with telehealth video conferencing will...



Free-up 1.1 million hours per year for the NHS, to be reinvested in additional patient consultations.



Reduce GP visits by 9.4 million per year or 2.5%, saving £1.3 billion in lost productivity through workplace absence.



Save individuals 3.3 hours per year, meaning less time in GP waiting rooms exposed to other infections and viruses.

## 5G will enable the widespread adoption of wearable monitoring devices that will...



Reduce NHS hospital re-admissions (i.e. those who leave hospital but are readmitted within 30 days) by 30% through aftercare monitoring.



Save our cities £463 million per year and decrease overall bed occupancy rates by 6%.

## For those caring for elderly relatives, 5G-enabled telecare will...



Allow them to consider alternatives to placing loved ones in private residential care or employing carers to check on them, saving households an average of £489 per week.



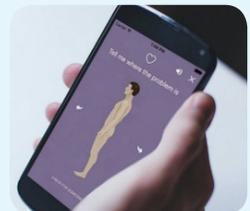
Reduce council social care budgets by 5%, saving £890 million – to be reinvested in other services like education or policing.

Read about how 5G will help reduce congestion and harmful CO<sub>2</sub> emissions in the next section.



## Babylon Health

Babylon Health offers a digital healthcare app via a combination of artificial intelligence and video and text consultations with doctors or specialists. The app allows people to speak to a GP 24/7, 7 days a week using their smartphone, whether they're at the office, working from home, or on a business trip. In late 2017, Babylon partnered with the NHS to launch the free service, 'GP at Hand' for 3.5 million patients in greater London. The company hopes to expand on this pilot in the future, and is also working on plans to launch an artificial intelligence (AI) tool to diagnose illnesses.



# Transport

As increasing numbers of city workers commute from out of town, and city populations continue to grow, cities' transport infrastructures and commuters' patience are coming under increasing pressure. By hardwiring 5G technology into a city's transport design and infrastructure now, traffic and rail management systems can be upgraded to cope more efficiently with the increased demand.

The introduction of low-power, low-cost 5G sensors on key public transport infrastructure, such as railway lines and traffic lights, will play a crucial role in helping transport services and councils reduce traffic congestion.

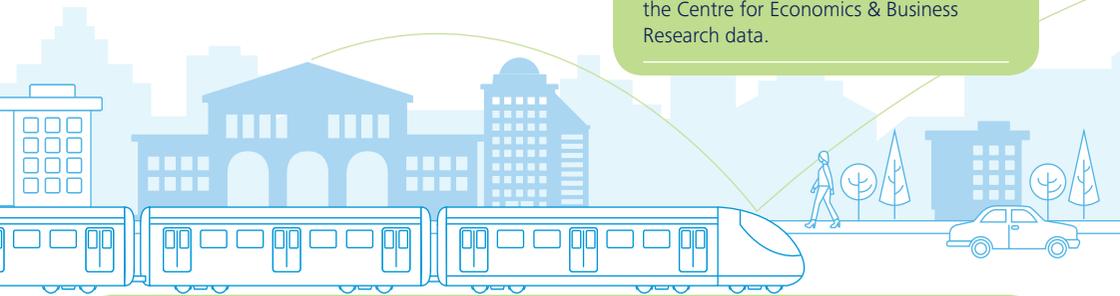
Meanwhile, commuters will be better connected to street-level data via mobile journey planning apps linked to connected street furniture, like lamp posts or bus stops, helping them plan their journeys better.

## Did you know?

Train cancellations or delays resulting in employee lateness or absence, cost the UK economy £10 billion per year in lost productivity.

38% of train cancellations or delays are caused by asset maintenance according to Network Rail.

The average driving commuter spends 32 hours a year in traffic, according to the Centre for Economics & Business Research data.



## The introduction of 5G technology in the rail sector will...



Reduce train delays and cancellations caused by maintenance. 5G sensors enable predictive maintenance, reclaiming an estimated £440 million in lost productivity for the UK economy.



Regain the average rail commuter 2.6 hours a year, usually lost to train delays and cancellations.



Save the average rail commuter an additional 2.4 hours per year as e-ticketing removes the need to queue for paper tickets.

## A 5G-enabled road management system, able to respond to traffic pressures at unprecedented speeds, will...



Reduce the time spent stuck in traffic by 10% for the UK's 5.6 million city workers who commute in private vehicles, giving them back an average of 3.2 hours a year.



Save the UK economy £880 million a year in lost productivity caused by congestion.



Reduce CO<sub>2</sub> emissions by 370,000 metric tonnes per year.



A recent trial of this technology by Transport for London reduced traffic delays by 20%.

In future, driverless cars are expected to generate unprecedented levels of data (4TB per hour), helping councils develop even more effective management plans.

## Applying 5G sensor technology to street furniture such as lamp posts or bus stops will...



Help indicate to drivers via smartphones or connected vehicles where there are parking spaces available in real time.



Reduce congestion in busy parking areas.



Trials of dynamic smart meter pricing in US cities such as LA, Portland (Oregon) and Columbus (Ohio) which fluctuates based on real-time demand, has grown parking revenue by 27%, according to Accenture.

Read about how 5G will play a crucial role in ensuring electricity grids are dynamic and robust enough to facilitate the mass take up of electric vehicles in the next section.

## 5G-connected bus stops mean smoother rides

O2's partnership with Transport for London (TfL) already provides data connectivity to over 9000 London buses, enabling ticket validation, automatic vehicle location and control and helping commuters plan their journey by providing real-time data on bus arrival times.

In the future 5G connectivity will evolve bus travel so commuters can purchase e-tickets, plan their onward journey using interactive maps, or transmit data perhaps to let the driver know how many people are waiting.

On a broader scale, TfL uses anonymous, aggregated data to inform its wider transport model – helping it understand trends in how and when people travel around London, and adapt its transport systems and schedules in response. In the future, collecting this data in real-time will help networks like TfL further reduce congestion – which currently costs the UK government £13 billion a year.



# Energy

5G technology will help unlock the next generation of smart energy grids. These will be more robust, more responsive and have greater capacity to deal with increasing demands more efficiently.

Low-power, low-cost 5G sensors fitted along the grid will help it detect and respond to spikes in demand caused, for example, by the mass charging of electric vehicles. This will reduce the chance of blackouts (total power failure) and brownouts (voltage reductions, which can damage sensitive equipment).

As well as real-time, uninterrupted data collection, this will help drive more dynamic energy pricing based on real-time demand. This data will be shared with citizens through household smart meters, better informing them about their usage, so they can adjust their energy consumption and reduce their bills.

Households will also have more choice around energy suppliers through the creation of micro-grids – small-scale power grids that can operate independently or in conjunction with the area’s main energy supply – allowing them to split their supply between regional suppliers and local micro-grids, resulting in more competitive pricing from suppliers.

These benefits combined will create efficiencies and cost savings for the UK economy, its cities and residents.

## Did you know?

During winter 2011, National Grid reported spare capacity to be 17%. By 2015, it was down to 1.2%.

In 2015, the UK experienced 533 hours of blackouts, costing £23.4 billion in lost productivity (including £9 billion in London, £1.2 billion in Birmingham).

The UK’s energy grid capacity will need to increase by 30% for the widescale adoption of electric vehicles to become a reality by 2040.



## 5G-connected smart grids that drive dynamic pricing, enable two-way communications, and allow citizens to choose where they buy energy will...



Reduce net energy consumption per household by 12%. Households currently spend an average of £1,208 on gas and electricity a year, so this will save the UK £3.9 billion, or £145 per household at today’s prices.



Save 6.4 million metric tonnes of CO<sub>2</sub>, the equivalent of taking nearly 1.5 million vehicles off the road.



Enable households with solar panels to sell surplus energy back to the local community.



Help those living in fuel poverty by allowing them to better manage consumption.

**5G sensors and wireless technology will also be applied to local council infrastructure, making it smarter, which will...**



Save the average city £1.3 million in electricity bills through the adoption of smart LED street lighting, which can be dimmed or brightened remotely as needed, as used in Glasgow City Council's Intelligent Street Lighting Project.



Save an estimated 70% in energy bills for each council in the UK – a total saving of £91m for the UK.



Save further energy and resources for councils through the deployment of IoT technologies, such as rubbish collection enabled by 5G-connected smart bins which will save councils £1.8 billion annually.



If passed to individual households, this efficiency will take £66 off annual council tax bills.

**By being more responsive to real-time demand and supply fluctuations, smart grids will...**



Save the UK economy £3.4 billion annually by mitigating the loss of productivity caused by blackouts and brownouts.

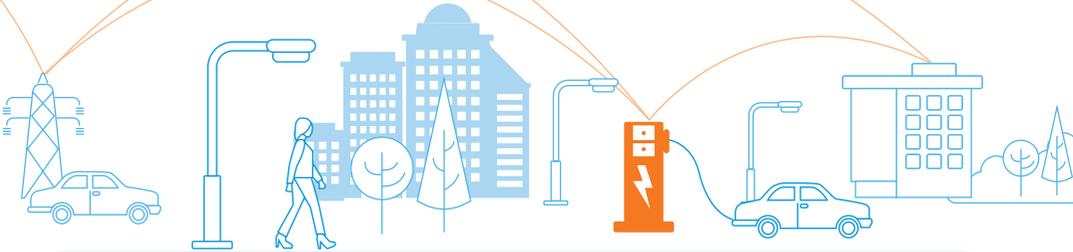


Help the Government enable the widescale adoption of electric vehicles by 2040, by providing and distributing the extra capacity needed for charging them – helping put an extra 1.3 million electric cars on the road by 2025.



In turn, this will mean those who swap to electric vehicles will reduce their fuel bills by £1,662 per year.

Read about how 5G modules will seamlessly connect household appliances to retailers in the next section.



**Smart Malaga**

Since October 2014, Telefónica has been working on a project in Malaga, Spain, to centralise the management of traffic, street lighting and the other public services – feeding the information into a smart city platform named Plataforma. As part of the project, it has converted over 70% of its street lights to smart, connected LED lamps. This technology has enabled light levels to be adjusted according to season and time of day, while monitoring more effectively for lamp failure. The city has shaved £2.2 million off of its annual energy bill in this manner.



# Retail and commerce

The retail sector has been pushing the limits of mobile technology to track, target and entice shoppers into stores with discounts and advertising for some time. But the higher speeds and improved mobile connectivity enabled by 5G will take retailers and commercial businesses' understanding of how their customers shop to new levels.

5G will evolve the fixtures and fittings of physical stores to become better connected to shoppers' smartphones and home appliances. It will allow retailers, advertisers and service providers to leverage real-time mobile data to deliver an easier, more engaging and hyper-personalised experience to citizens.

Alongside these changes, social media platforms and chatbots will evolve the way citizens communicate with businesses, by helping avoid lengthy calls or visits to a store in the case of a problem.

People will also be able to connect their home devices and appliances seamlessly – meaning they can manage more at their fingertips – helping them save time and money.

## Did you know?

24% of all the UK's monetary transactions – worth £125 billion – are predicted to be made via mobile phones by 2025.

The role of artificial intelligence in the retail experience will grow exponentially – UK citizens will spend £1.4 billion with the help of chatbots, a 45,000% increase on 2017's forecasted spend.

## 5G connectivity will make purchasing goods and services on-the-go quicker, easier and more secure, saving...



91 hours per year for every household that moves to doing the weekly food shop on a mobile.



6 minutes for every customer service interaction through the introduction of chatbots, which will respond to over 38 million requests per year across banking, healthcare and retail.



£2.5 million per year for citizens buying tickets to entertainment shows, by reducing fraud through the widescale adoption of e-tickets for events.

As e-commerce continues to grow, 5G will also help overcome some of the challenges in last mile services, where parcels often end up at the wrong address or in the wrong hands during the last leg of delivery. Low-cost 5G modules will enable better tracking services and allow couriers or drones to redirect parcels moments ahead of delivery.



## Bricks and mortar retail spaces will evolve alongside increased mobile spending to create valuable in-store experiences that bridge the mobile and physical world...



Smart billboard advertising will change in response to the mobile data collected from those in its vicinity. This is already being explored by Yahoo! and on London buses.



Retailers will be able to manage stock more efficiently through 5G 'smart shelves' that collect data, ensuring the right products are stocked at all times.



More efficient use of their physical space means stores will open in areas previously ruled out by higher rental costs.

## Shops of the future

Shops in Farfetch's Store of the Future concept use various technologies to connect their customers' on and offline behaviour to improve their shopping experiences. By tracking signals capturing "customer intent" – the offline equivalent of 'cookies' – they can learn which products need restocking and improve pricing strategies based on consumer demand.



## From Inspiration to Action

Online shopping is being transformed by the growth of mobile. At luxury online fashion retailer YOOX NET-A-PORTER GROUP, more than 50% of sales are now via mobile. YNAP is leveraging WhatsApp as a key channel to drive direct sales – even selling a single item for over £80,000 via the service.

## Meanwhile, 5G-connected home appliances will seamlessly integrate into the retail experience, providing live information and helping households with purchasing decisions. For example...



Smart fridges will send 'shelfies' of their contents to citizens' smartphones allowing them to check the contents before buying excess food.



Helping reduce food waste by 50% per year, saving households £236, and cutting the average UK household's carbon emissions by 340kg per year – the equivalent to 7% of the emissions from an average car.

## Targeted advertising on London Underground

O2 has partnered with out of home media owner, Exterion Media to introduce Abi, a new insights tool for marketers that draws on anonymous aggregated data from its 25 million customers, to generate actionable behavioural detail about London Underground users. This helps Exterion prioritise its display advertising according to its audiences, for example changing adverts along the escalators to suit those passing by.



# Methodology

## Key assumptions

- This report examines the potential benefit of 5G-enabled cities in the UK. Challenges related to infrastructure build-out and spectrum auction costs were not factored into any scenario.
- The year 2025 is used based on the assumption that 5G penetration will be close to 100% in UK cities.

## Summary of savings from 5G implementation in cities

### Productivity savings

\*Based on GVA (or, Gross Value Added, a measure of the total productivity of the UK) per capita – calculated to be at £26,621.45 per annum for 2016 – divided by average working hours from the Office of National Statistics (ONS), and multiplied by hours saved from a reduction in inefficiencies.

Description	Saving (£m)
Building a 5G-enabled road ecosystem to enable a reduction in commuters' time spent sitting in traffic by 10%.	£880
Introducing 5G sensors to help reduce avoidable cancellations and delays through predictive maintenance.	£440
Helping cities manage the likelihood of blackouts and brownouts.	£3,400
Replacing just 5% of GP visits with telehealth services.	£1,300
<b>Total</b>	<b>£6,020</b>

### Cost savings for councils and the NHS

Description	Saving (£m)
Fitting all street lights in UK cities with remote-controlled LED lighting – collective council saving (UK).	£91
Introducing connected refuse solutions such as smart bins – collective council saving (England).	£1,800
Reducing 30 day readmissions on the NHS by 30% with the introduction of healthcare monitoring devices – UK-wide saving for the NHS.	£463
Reducing social care expenditure by 5% with the introduction of healthcare monitoring devices – collective council saving (UK).	£890
<b>Total</b>	<b>£3,244</b>

# Definitions

Term	Definition	Scope	Figure	Source
Households	A house in the UK and its occupants recorded as a single unit of measurement.	National	27,089,900	ONS
Local council	A body which has jurisdiction or control throughout its defined administrative area.	Local	353	LGMA
Population demographics	The spread of the population across various cities and local regions as defined by the ONS.	City	N/A	Demographia World Urban Areas
Population in 2017	The population of residents in the UK as recorded by the ONS.	National	65,648,054	ONS
Population in 2025	Juniper Research's in-house forecasts based on previous population levels and growth rates.	City	35,592,100	In-house forecast
Productivity (GVA)	The measure of the value of goods and services produced in a regional or national economy.	National Population in 2025	£1,747,647 million	ONS



# About the research



The research has been prepared on behalf of O2 by Juniper Research. All findings in the report are the responsibility of Juniper Research, which is an independent research and forecasting consultancy that specialises in identifying and appraising new high growth market sectors within the digital ecosystem for clients within both the private and public sector.



Juniper Research is acknowledged as a leading analyst house in the digital technologies and mobile sector. Juniper specialises in identifying and appraising new high growth market sectors within the digital ecosystem. Market sizing and forecasting are the cornerstones of our offering, together with competitive analysis, strategic assessment and business modelling. Our global clients range from mobile operators through to content providers, vendors and financial institutions.

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