



Welcome to Technology's Business Briefing

25 June 2019

Forward-looking statements caution

Certain statements in this presentation are forward-looking and are made in reliance on the safe harbour provisions of the US Private Securities Litigation Reform Act of 1995. These statements include, without limitation, those concerning: our IT transformation programme and converged network investment, our cost reduction and transformation programmes, our planned R&D investment and our rollout of 5G.

Although BT believes that the expectations reflected in these forward-looking statements are reasonable, it can give no assurance that these expectations will prove to have been correct. Because these statements involve risks and uncertainties, actual results may differ materially from those expressed or implied by these forward-looking statements.

Factors that could cause differences between actual results and those implied by the forward-looking statements include, but are not limited to: market disruptions caused by technological change and/or intensifying competition from established players or new market entrants; unfavourable changes to our business where Ofcom raises competition concerns around market power; unfavourable regulatory changes; disruption to our business caused by an uncertain or adversarial political environment; geopolitical risks; adverse developments in respect of our defined benefit pension schemes; adverse changes in economic conditions in the markets served by BT, including interest rate risk, foreign exchange risk, credit risk, liquidity risk and tax risk; financial controls that may not prevent or detect fraud, financial misstatement or other financial loss; security breaches relating to our customers' and employees' data or breaches of data privacy laws; failures in the protection of the health, safety and wellbeing of our people or members of the public or breaches of health and safety law and regulations; controls and procedures that could fail to detect unethical or inappropriate behaviour by our people or associates; customer experiences that are not brand enhancing nor drive sustainable profitable revenue growth; failure to deliver, and other operational failures, with regard to our complex and high-value national and multinational customer contracts; changes to our customers' needs or businesses that adversely affect our ability meet contractual commitments or realise expected revenues, profitability or cash flow; termination of customer contracts; natural perils, network and system faults or malicious acts that could cause disruptions or otherwise damage our network; supply chain failure, software changes, equipment faults, fire, flood, infrastructure outages or sabotage that could interrupt our services; attacks on our infrastructure and assets by people inside BT or by external sources like hacktivists, criminals, terrorists or nation states; disruptions to the integrity and continuity of our supply chain (including any impact of global political developments with respect to Huawei); insufficient engagement from our people; and risks relating to our BT transformation plan.

BT undertakes no obligation to update any forward-looking statements whether as a result of new information, future events or otherwise.

A close-up photograph of a bundle of fiber optic cables, with many individual strands fanning out. The background is a blurred image of a person's face, suggesting a focus on human technology interaction.

Introduction to Technology

Howard Watson, Chief Technology and Information Officer



Market context

Best converged technology

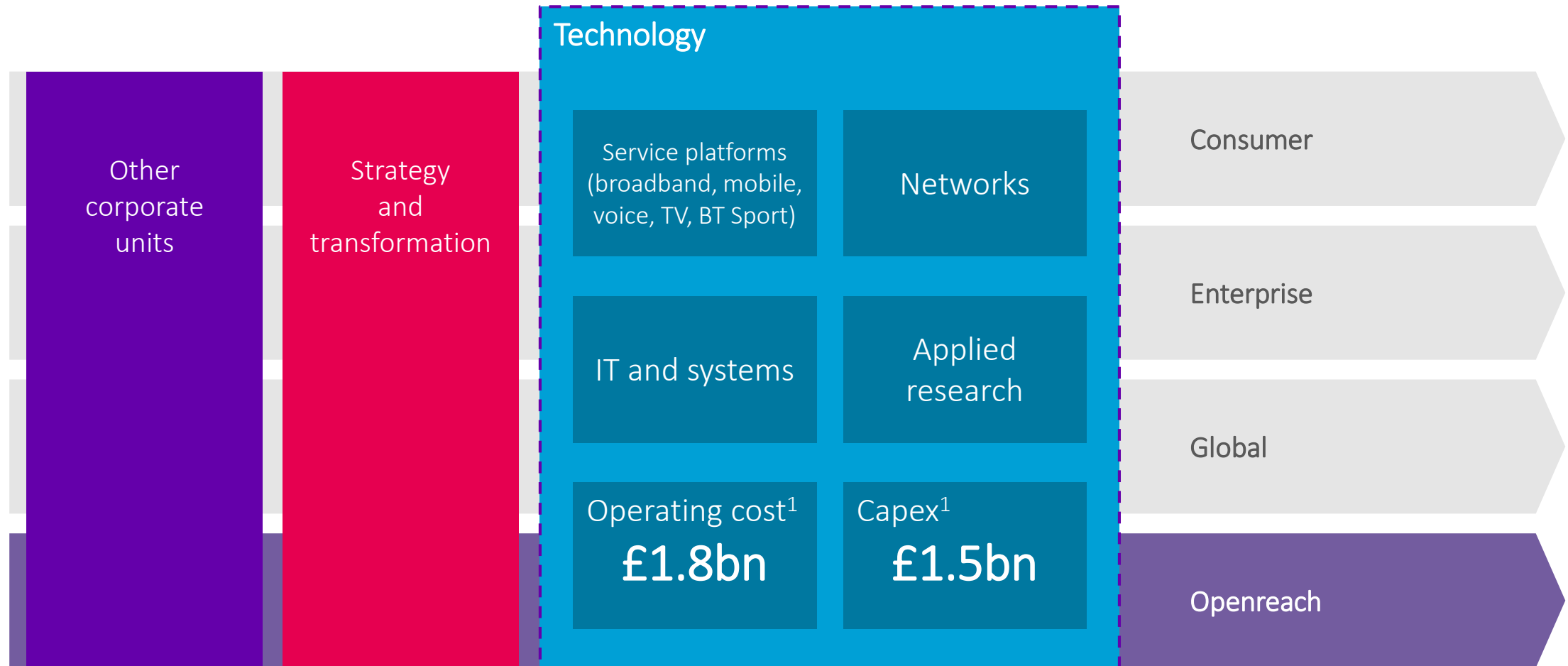
Differentiated customer experience

Our IT transformation journey

Finance and transformation

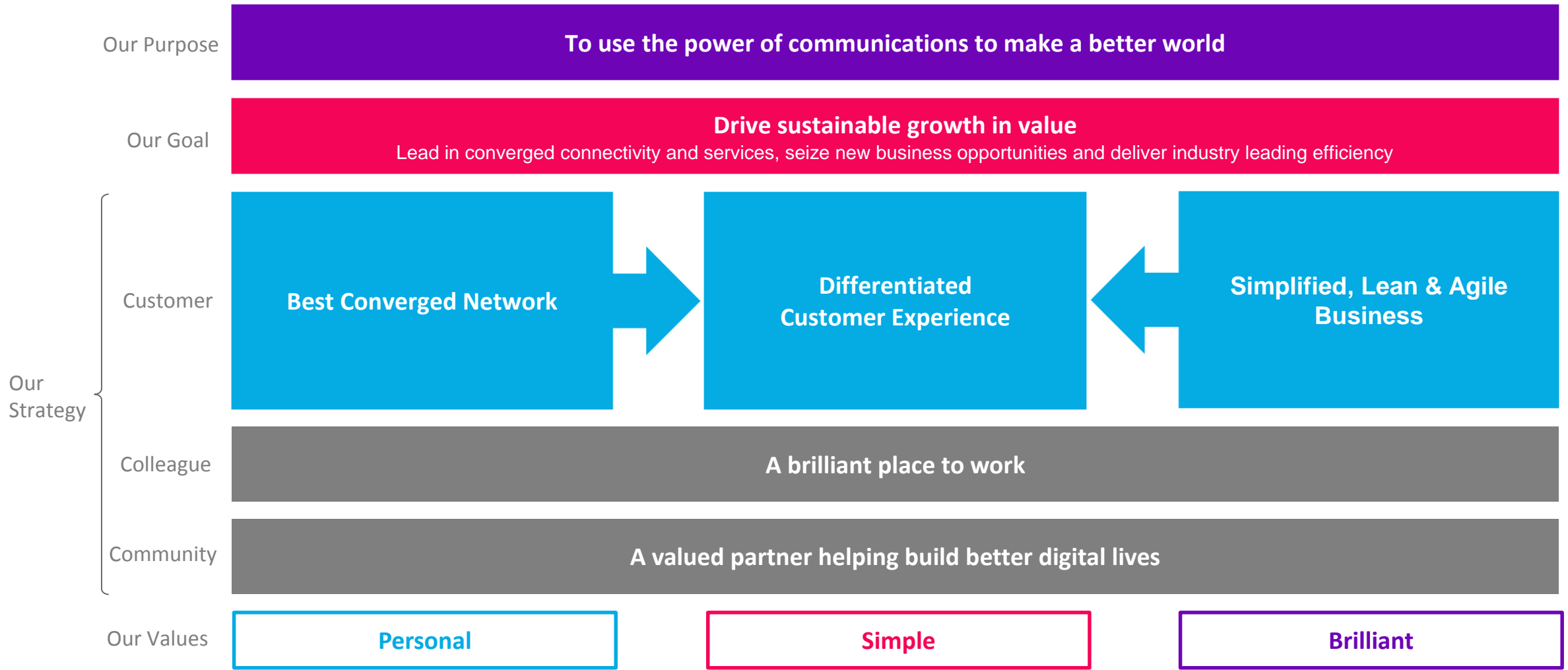
Our unique opportunity to build the future

Technology is at the heart of BT



¹ 2018/19

We are a key enabler of BT's strategy



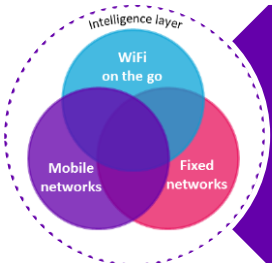
We are building a better BT for the future



Our markets are rapidly changing as our customers connect more devices and use exponentially more data



We have a unique set of core and access networks, and a proven track record of delivery



Our plans for one smart network and IT transformation will enable continued differentiation

Technology's ten year vision: value beyond connectivity



Connectivity as a Service



Trust as a Service



Actionable insight as a Service



Productivity as a Service

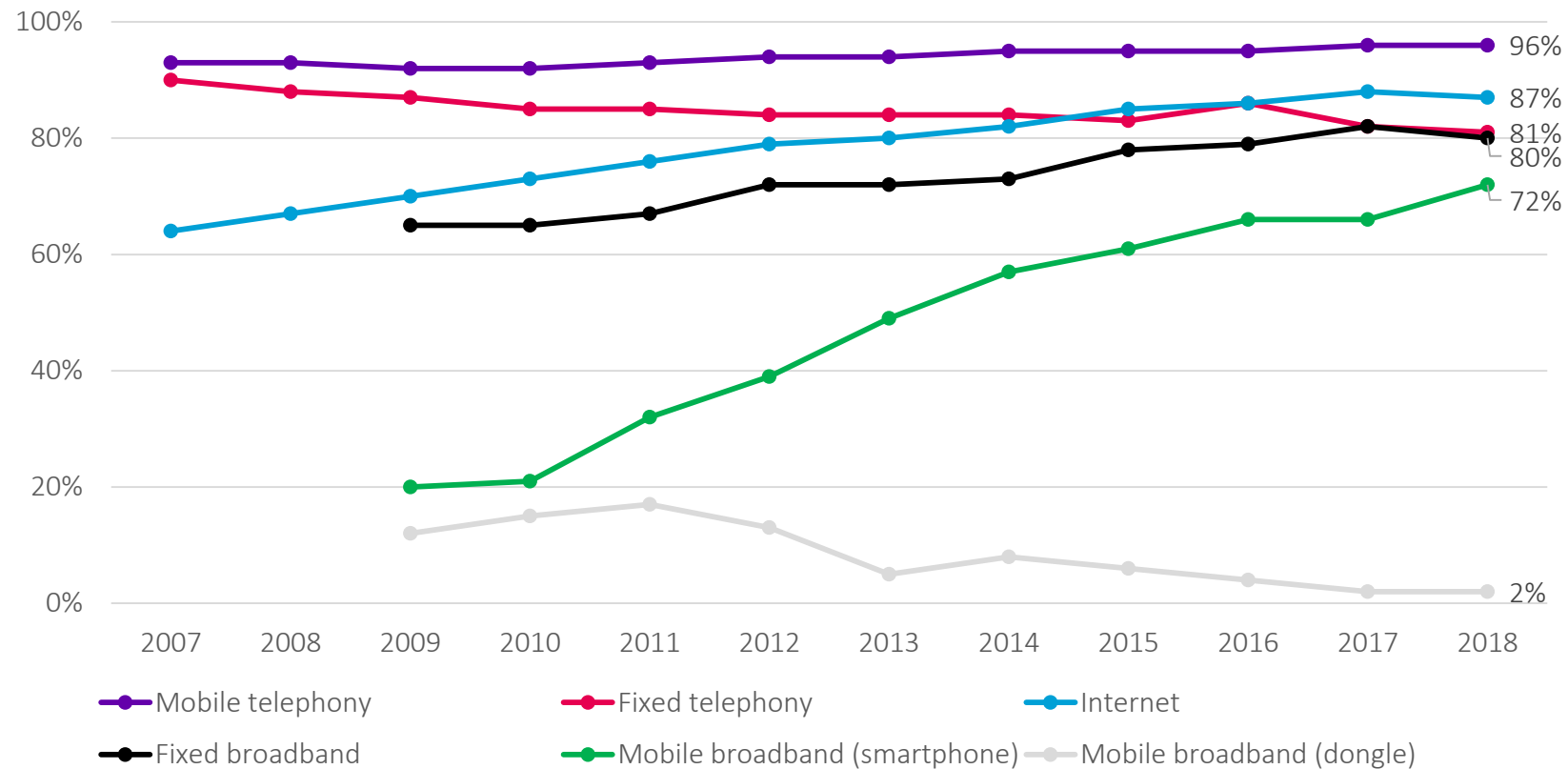


Market context

Howard Watson

We're reaching saturation in both fixed and mobile markets

UK take-up of communications services¹

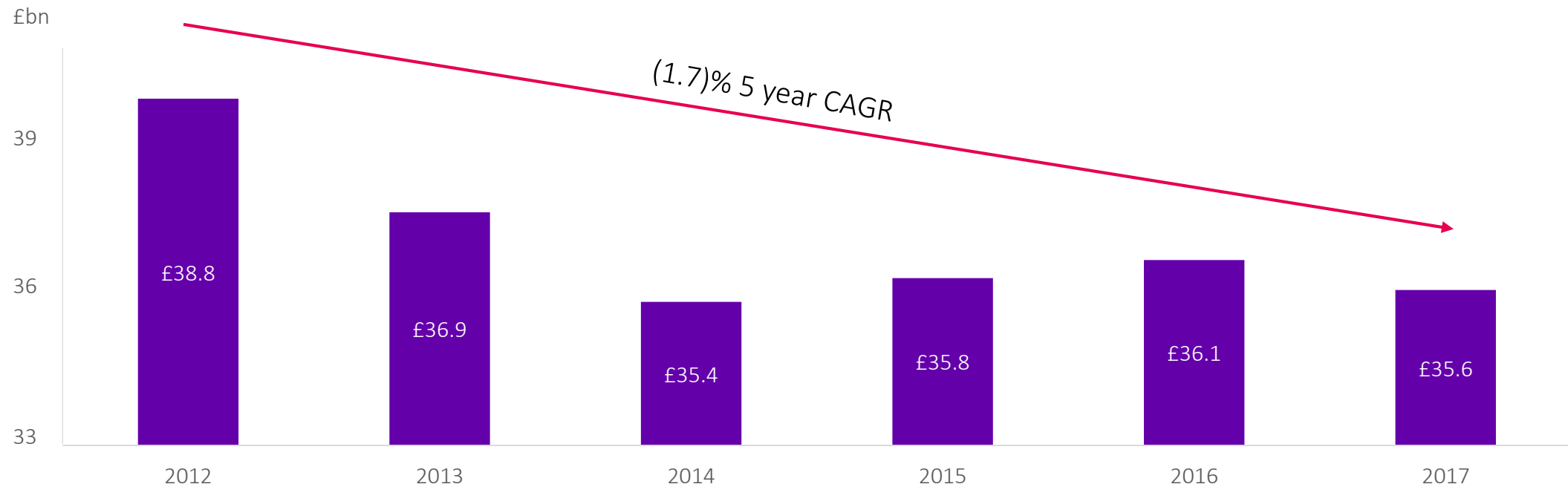


¹Use of internet on mobile is personal take-up measure, whereas the other data relates to household take-up

Source: Ofcom Communications Market Report 2 August 2018

UK Telecoms revenue has declined and returns disappointing

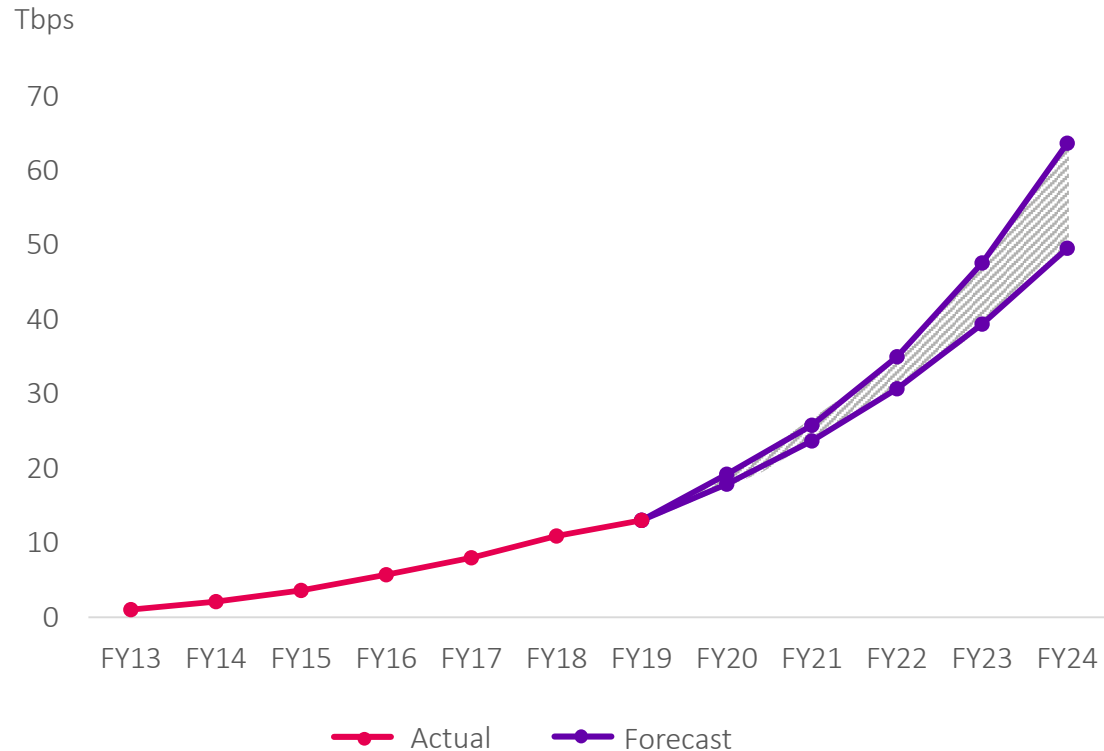
UK telecoms industry revenue



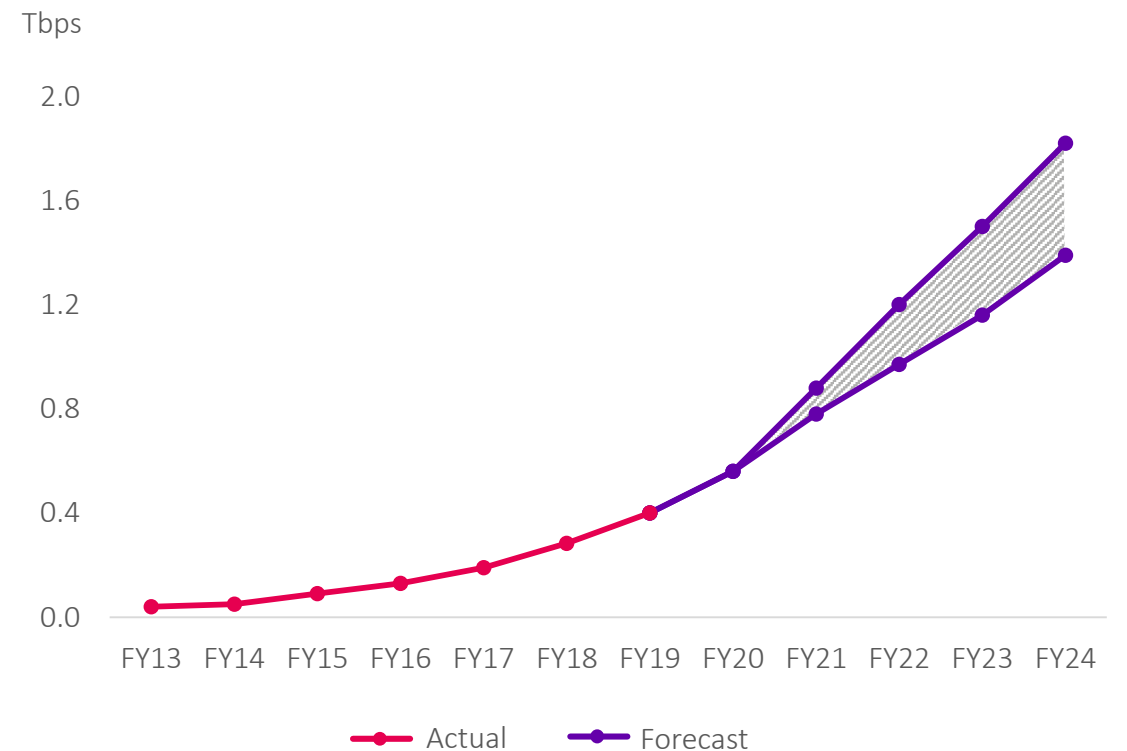
Source: Ofcom / operators

Data consumption in both fixed and mobile markets is growing exponentially

Peak fixed broadband demand (Tbps)



Peak mobile demand (Tbps)



Source: BT's actual and forecasted growth on BT's network



A woman with long brown hair, wearing a white lab coat and a small hoop earring, is focused on working with a dense array of grey network cables in a server rack. She is holding a cable with both hands, appearing to be in the process of plugging it into a port. The server rack is filled with multiple rows of network equipment, and the cables are bundled and organized. The background shows the interior of the server cabinet with various colored cables (yellow, blue, red) visible through a glass door.

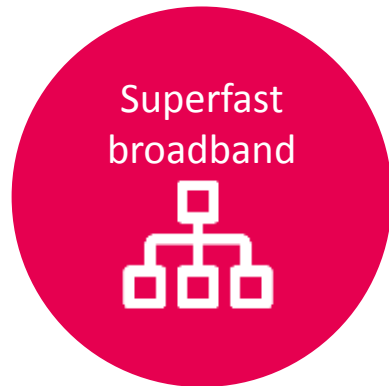
Best converged technology

Howard Watson

We're bringing our unique assets together as the UK's leading smart network

Today:

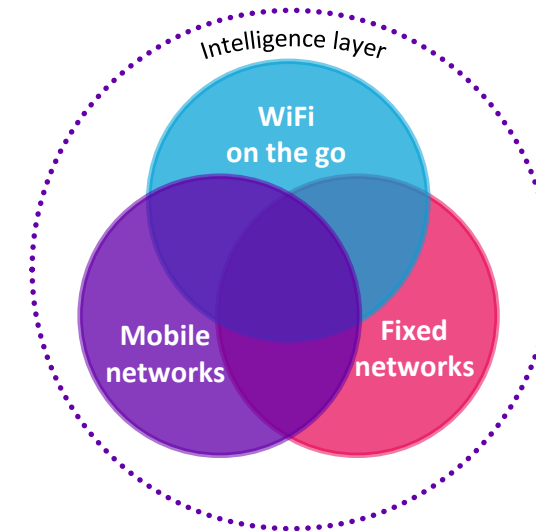
Three different networks



- ✗ Complex to switch between networks
- ✗ Costly capacity upgrades
- ✗ Limited flexibility

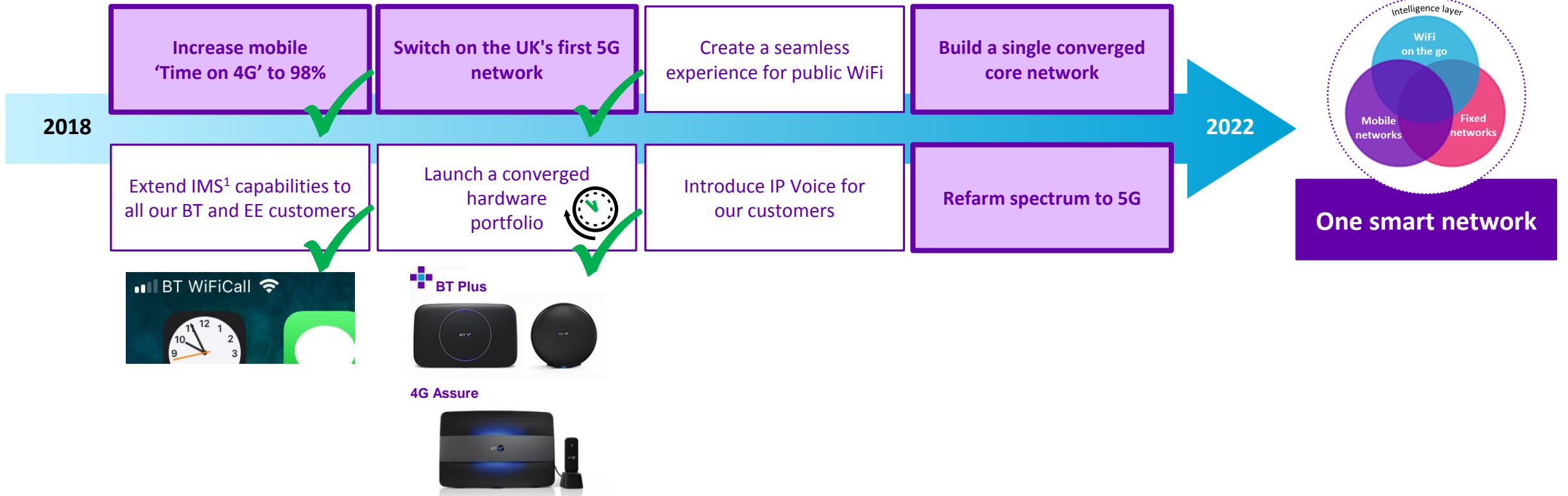
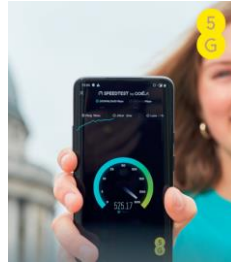
Tomorrow:

One smart network



- ✓ Seamless, consistent connectivity
- ✓ Significantly lower upgrade costs
- ✓ Flexibility through virtualisation

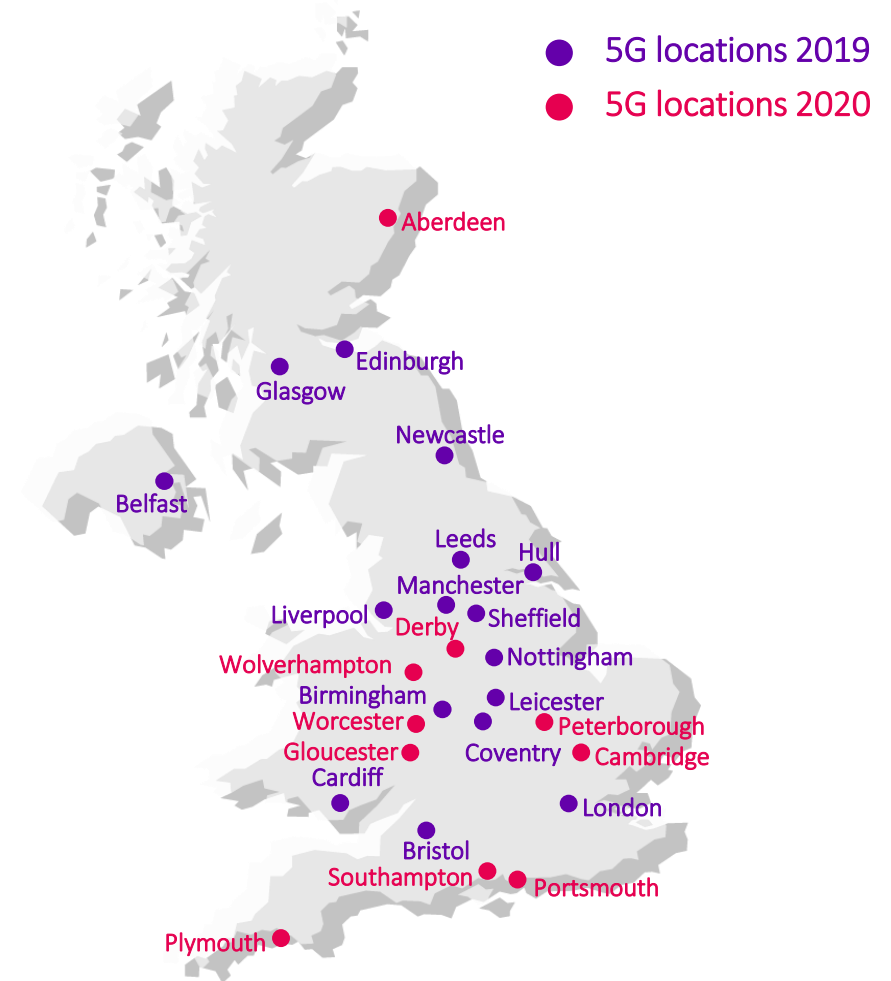
The journey towards one smart network



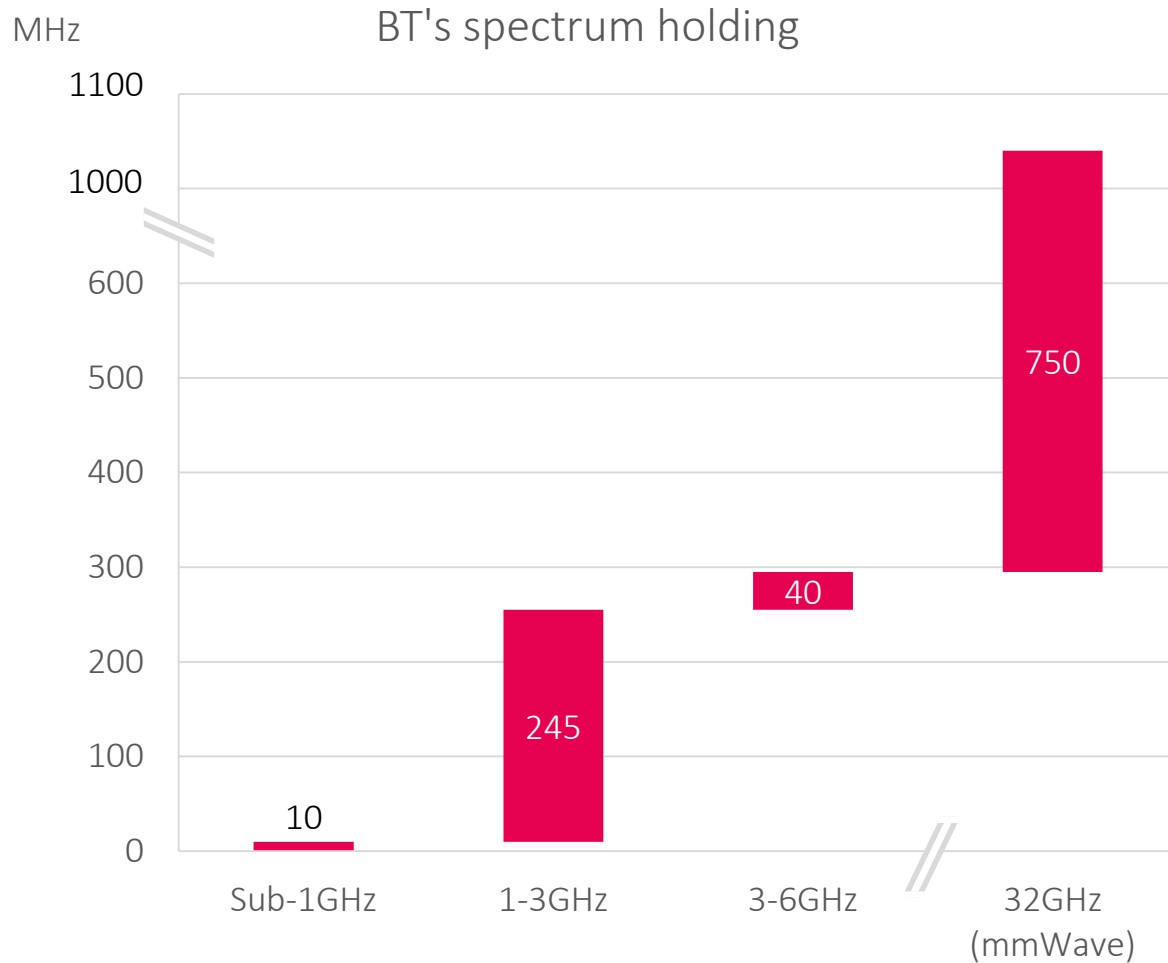
¹ Internet protocol multimedia subsystem

We've launched the first 5G network in the UK

- Launched with four handsets, with coverage in six cities
- Offering a speed uplift of around 100-150Mbps from 30Mbps average today on 4G
- All 5G sites being connected via 10Gbps backhaul to our evolved mobile core
- Existing 4G sites being upgraded to at least three carrier aggregation as part of 5G rollout



We have a great spectrum asset, for now and for the future



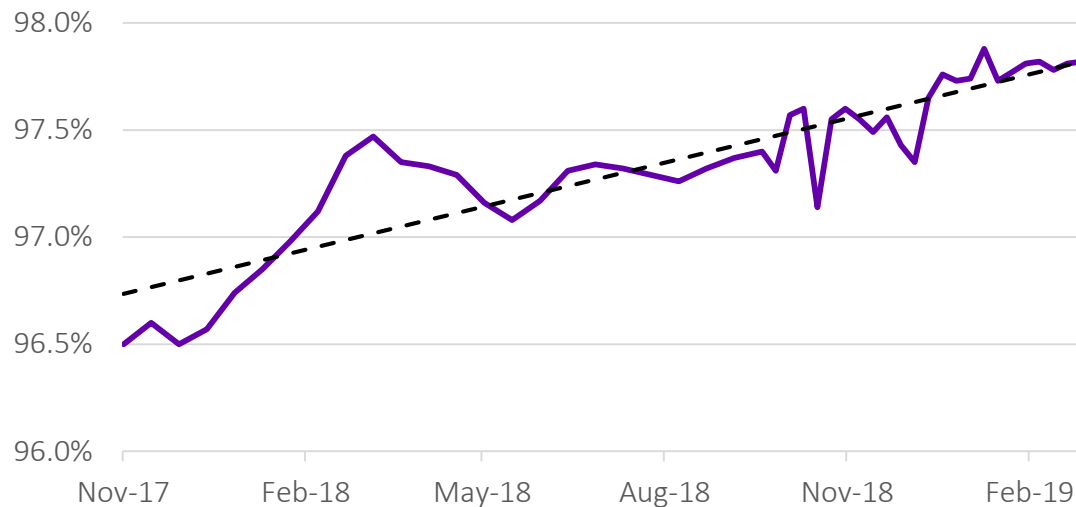
Band	Today	Re-farm	Future
32GHz (mmWave)	Fixed links	→	5G
3.4GHz	5G		5G
2.6GHz unpaired	-		5G
2.6GHz paired	4G		4G/5G
2.1GHz	3G/4G	→	4G/5G
1.8GHz	2G/4G		2G/4G
800MHz	4G		4G

- Upcoming auction: 700MHz and 3.6-3.8GHz

Best 4G network for five years running

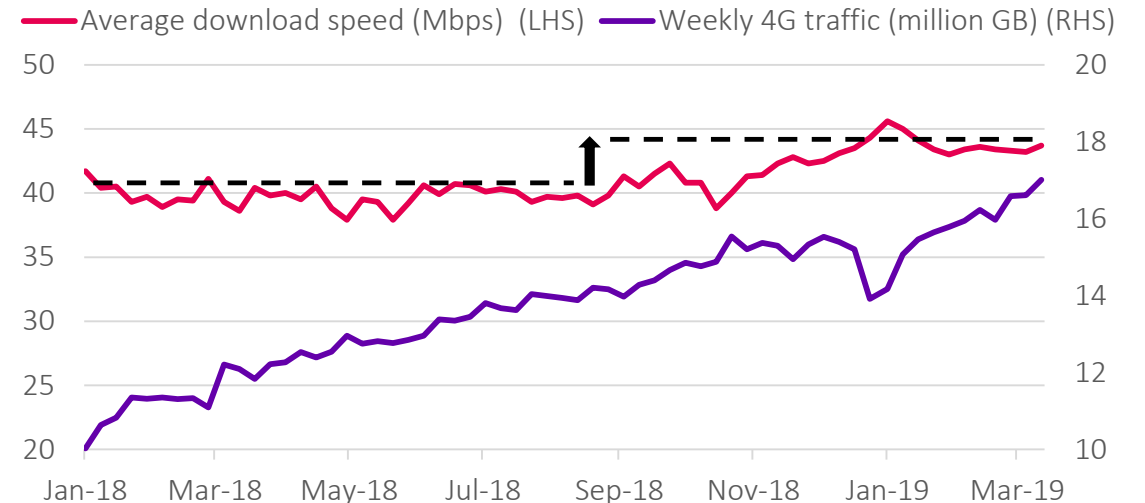
Increasing the time on 4G improves customer experience on voice and data

Time on 4G



Spectrum re-farming has allowed us to improve average download speeds despite increasing demand for data

4G network speeds and capacity



With opportunities for further improvements with 5G

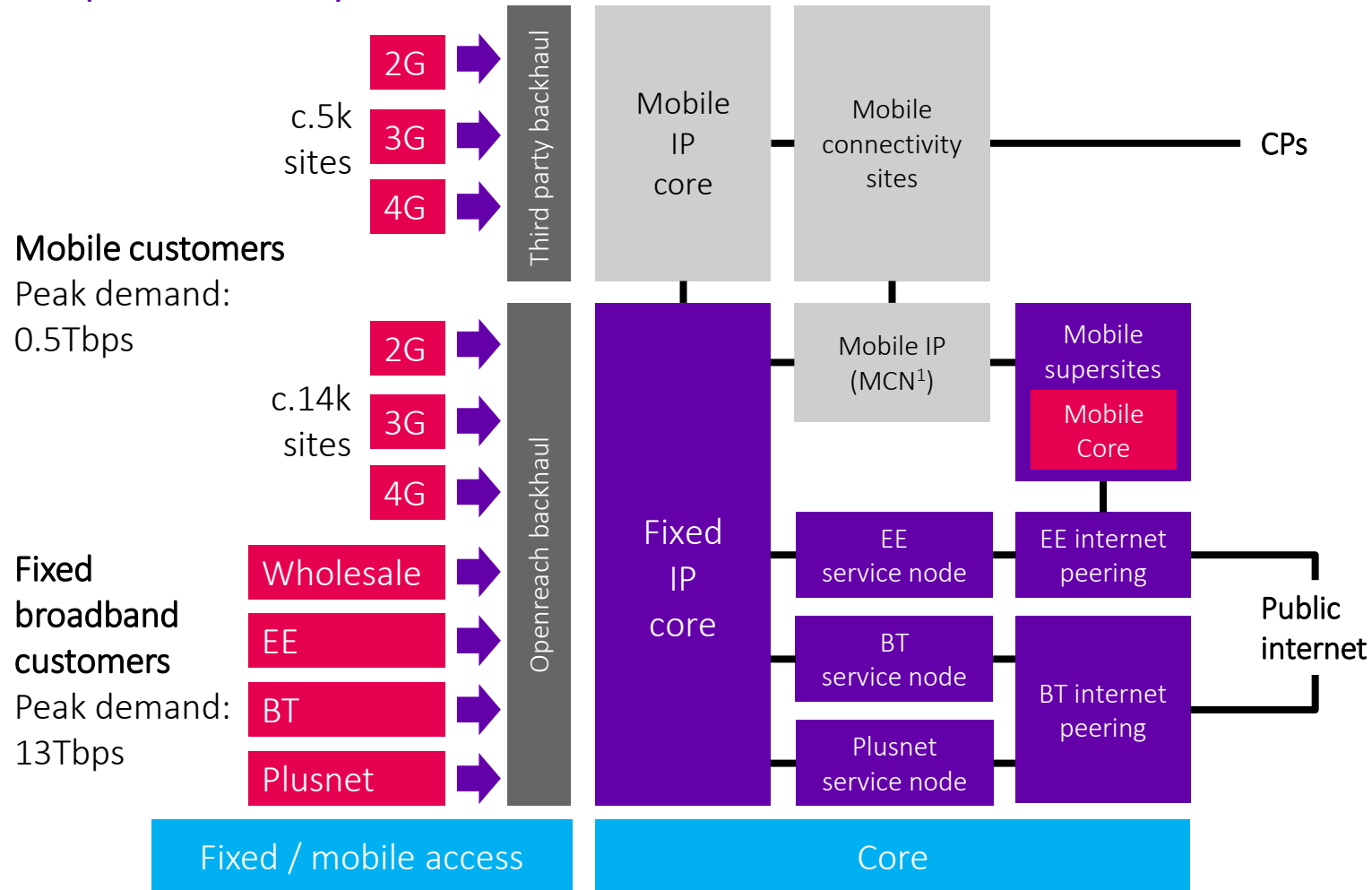
- 5G is c.4x more efficient at delivering data than 4G
- M-MIMO¹, use of mmWave frequencies and selective densification will enable significant increases in capacity and speed
- Our superior major and minor road coverage offers a competitive advantage for future IoT devices

Source of 'Best 4G network' claim: EE has been named the UK's best mobile network by independent testing experts RootMetrics for five years in a row to 2018

¹ Massive multiple input multiple output

Our current core handles fixed and mobile traffic separately

Multiple cores today



- Significant premium to add mobile network capacity versus fixed network
- Many third party dependencies for services
- Switching between networks generally requires user intervention
- Disparate equipment supplier base

¹ Mobile cloud network

Our future core improves customer experience and lowers costs for growth

Future converged core

Mobile customers

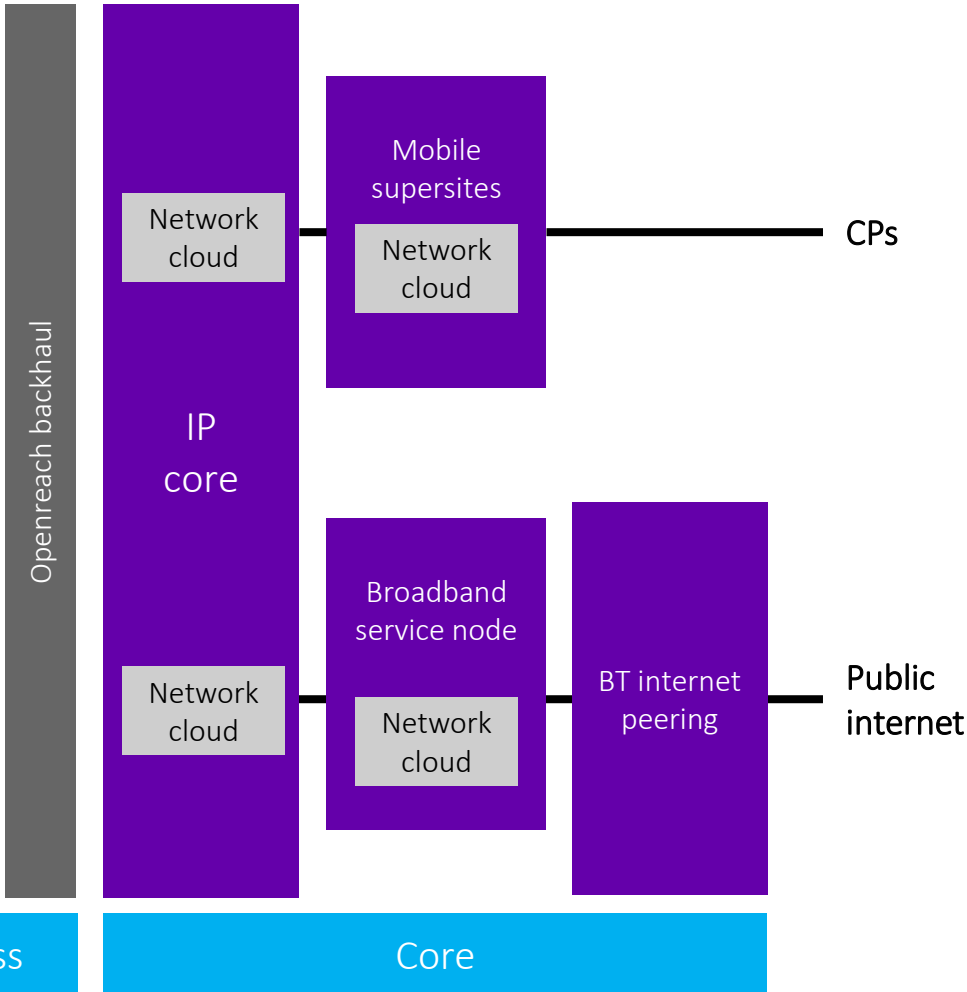
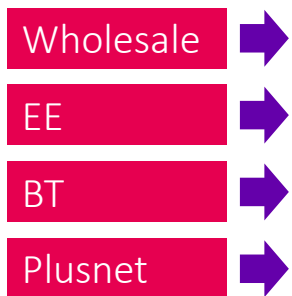
Peak demand:
c.1.5Tbps¹

c.19k
sites



Fixed broadband customers

Peak demand:
c.50Tbps¹

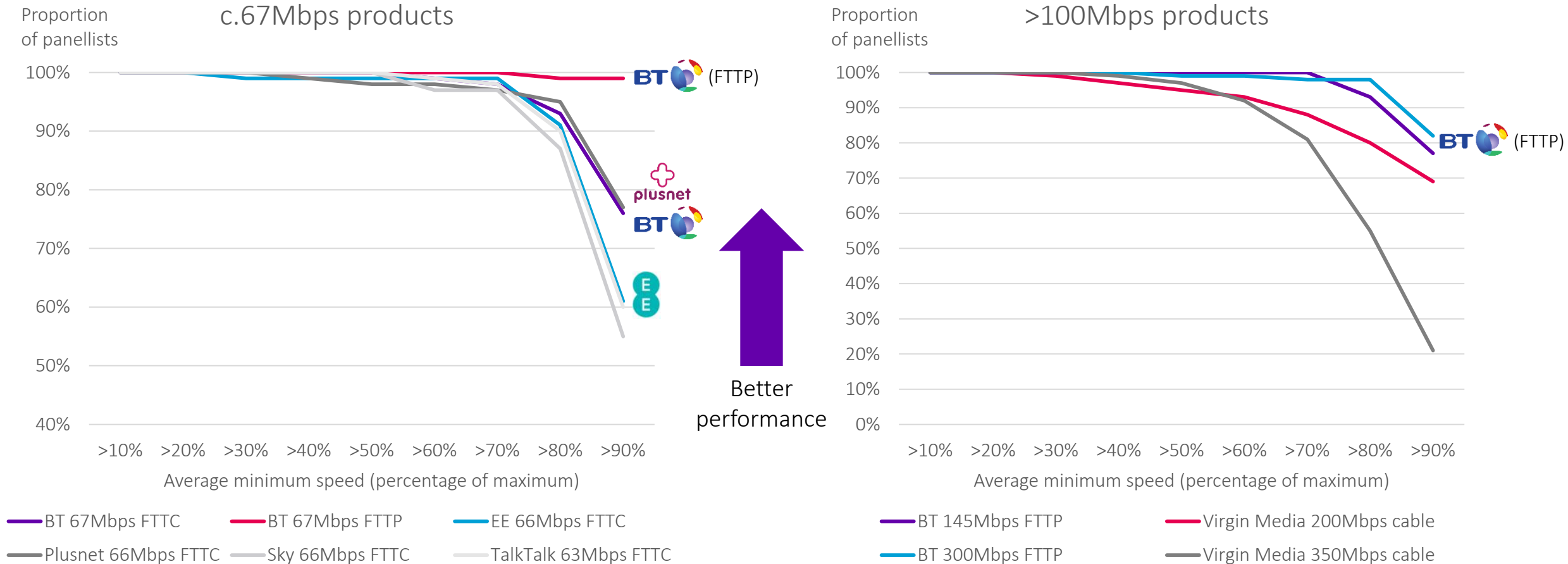


- Significant reduction in cost of adding incremental capacity
- Limited third party dependencies
- Seamless switching between networks
- Consolidated supplier base
- Network cloud allows faster, more agile deployment of applications and functionality

¹BT forecast

Our converged core will build on our fixed network leadership

Distribution of average minimum speed as a proportion of maximum speed for 30Mbps and above (2018)

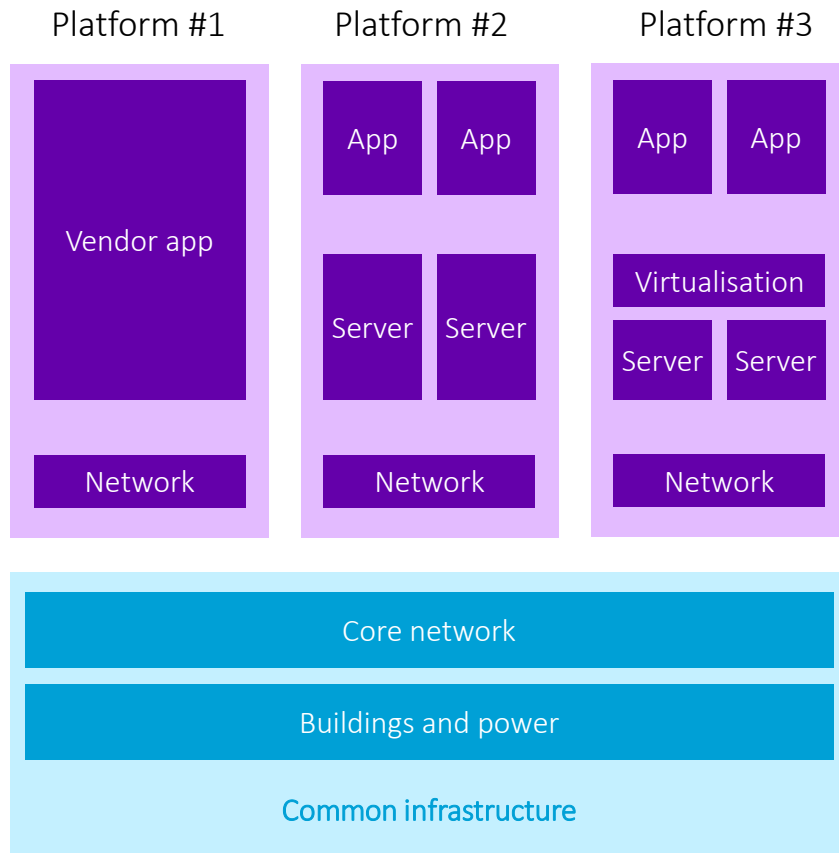


Source: Ofcom UK Home Broadband Performance Nov 2018

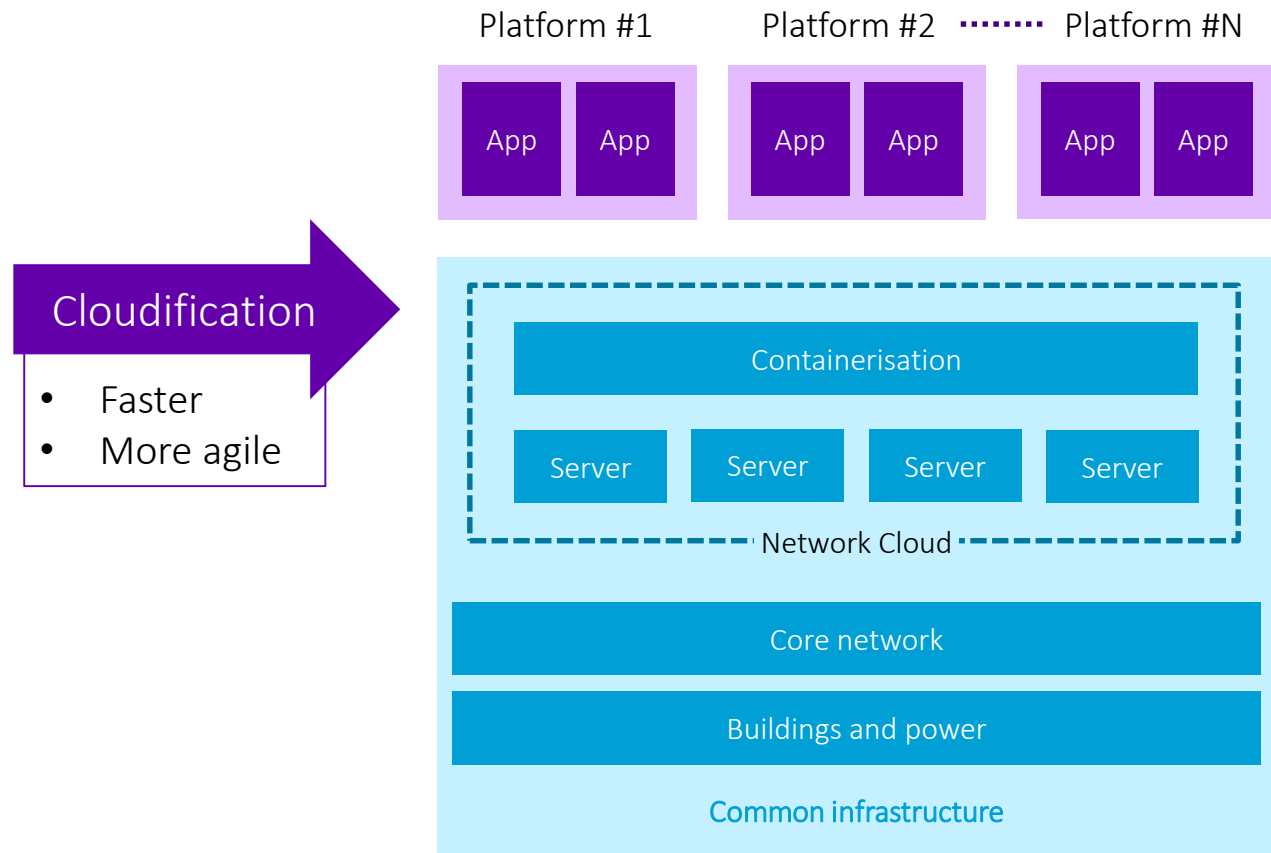


Network cloud is a key element of our future converged core

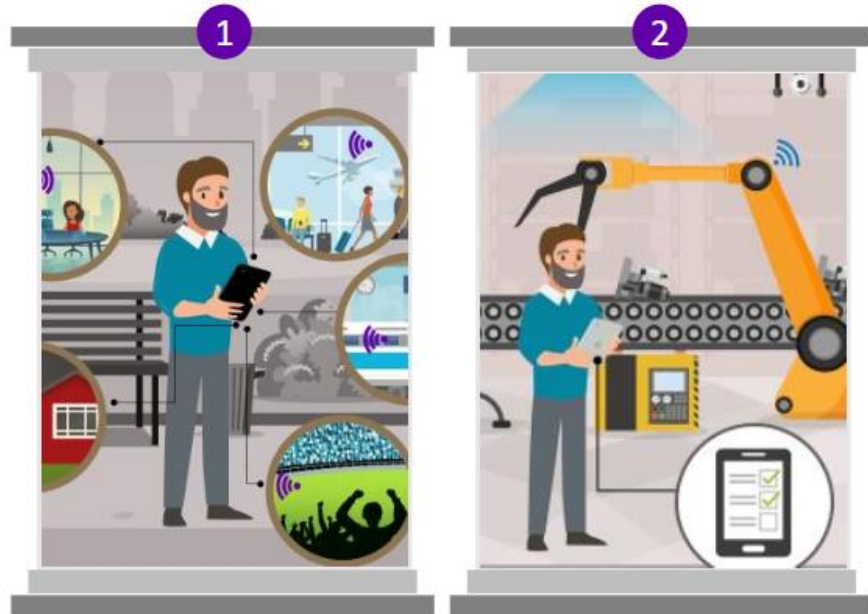
Network functionality today



Future functionality with network cloud

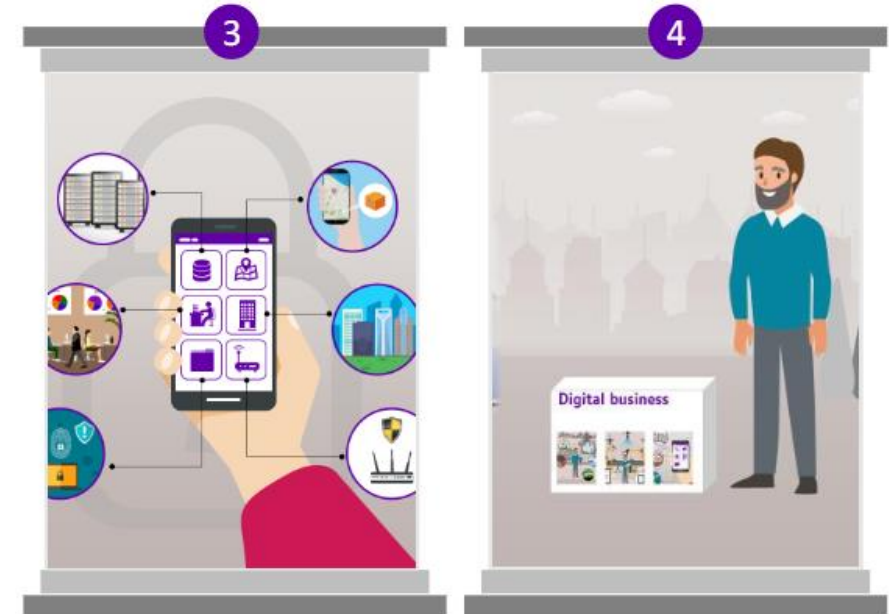
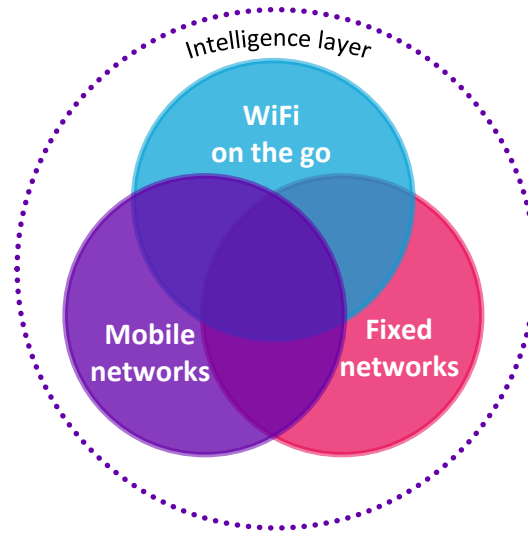


Our smart network will provide a seamless, consistent customer experience



Consistent experience everywhere

Everything works seamlessly



Everyone and everything protected

Buying experiences easily



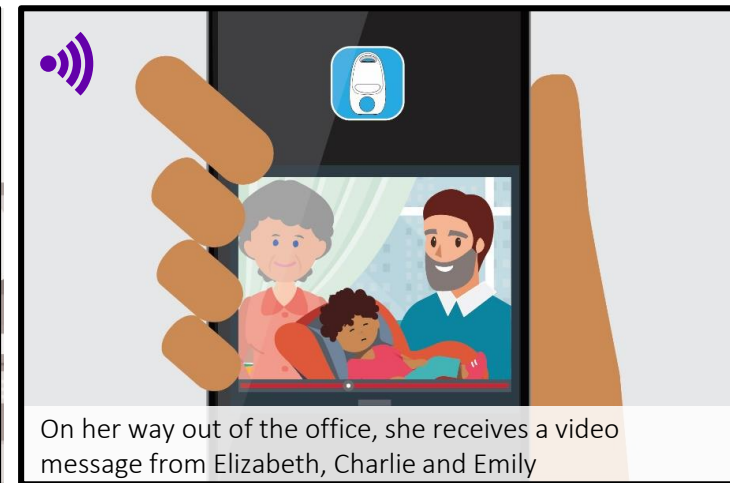
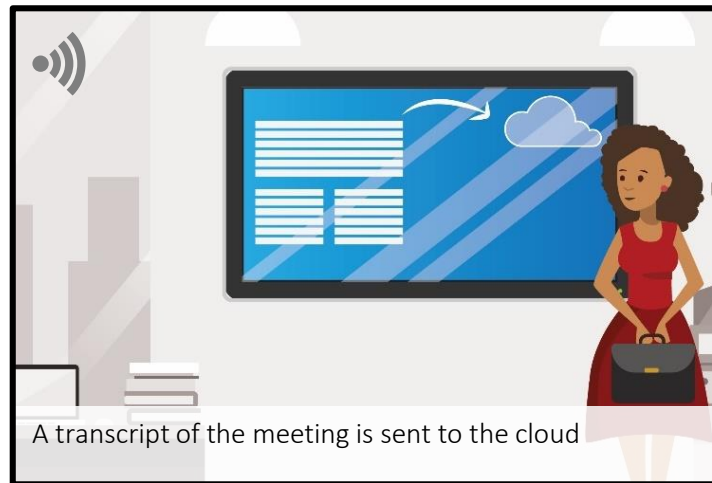
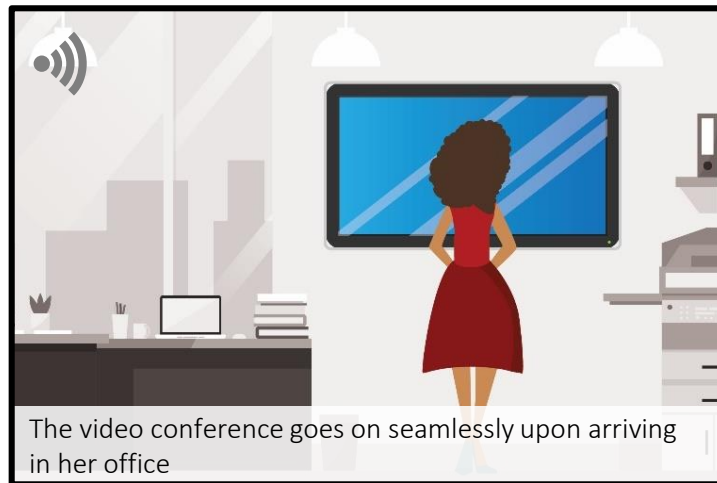
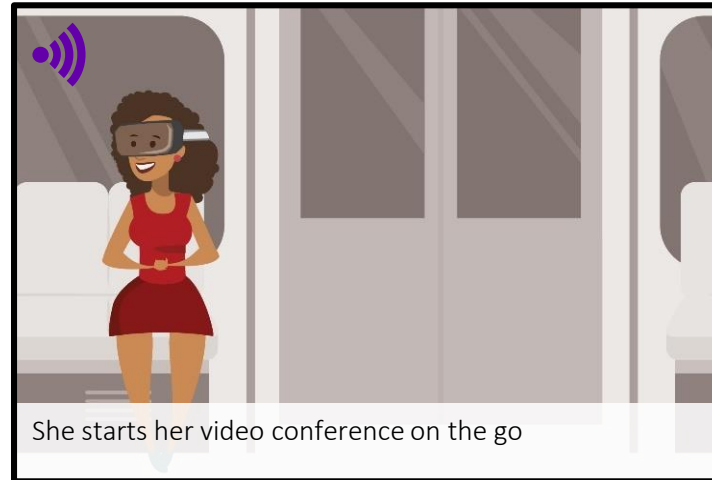
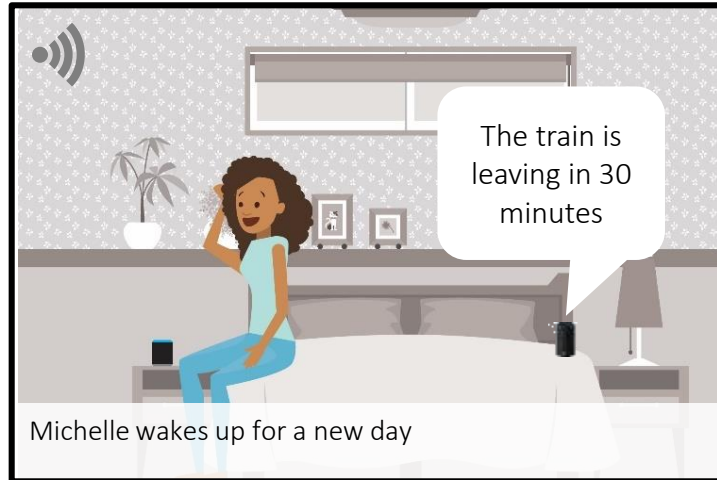
Differentiated customer experience

Greg McCall, Managing Director of Converged Service Platforms

[Placeholder for converged world video]

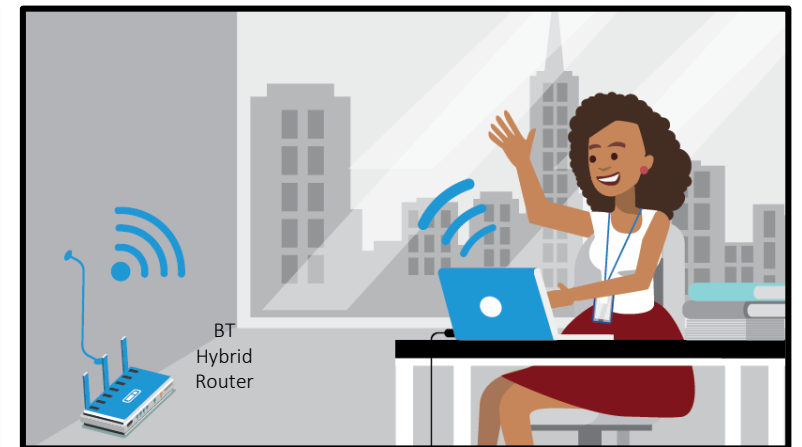
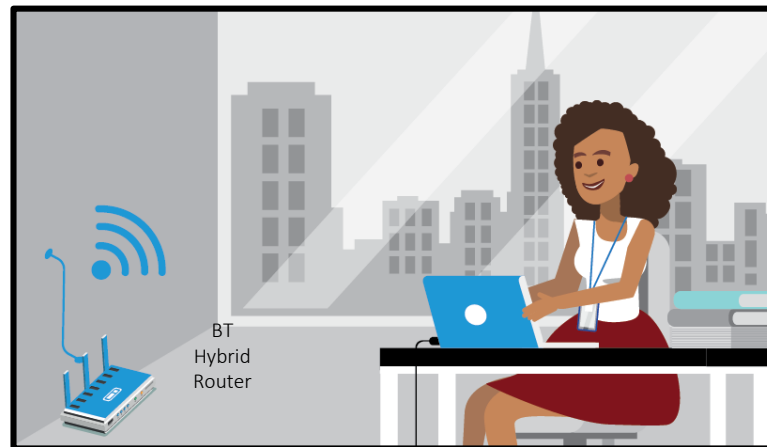
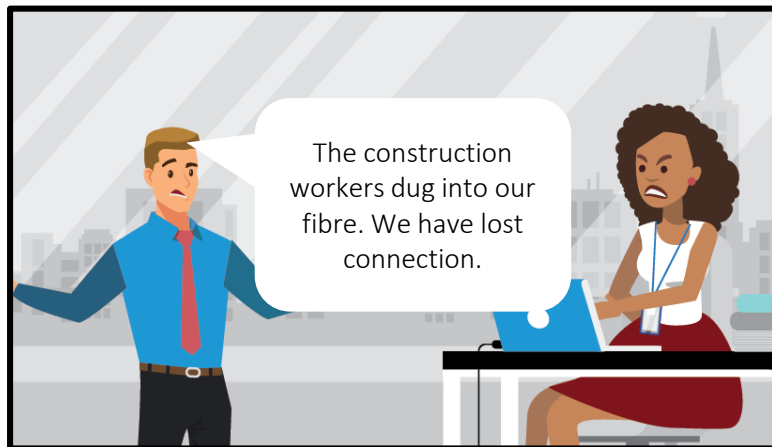
Convergence for consumers

Michelle gets fast, seamless service on the go to make her business efficient and stress-free



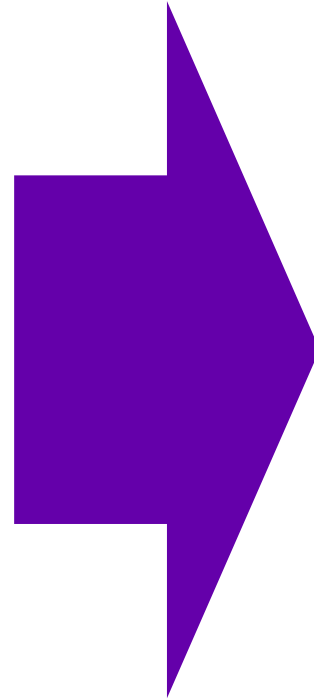
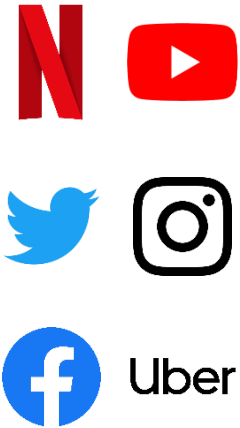
Convergence for businesses

Michelle's ad firm's fixed connection breaks down, but hybrid resilience saves the day



We expect 5G to enable a wave of new business models

4G



5G



Not just for the future – customers today benefit from our network leadership

AR¹ and VR² gaming



- Next generation gaming relies on the best connectivity
- Exclusive partnerships ensure that our customers have new experiences on our networks first

Private networks for campuses and factories



- Our private networks in hospitals deliver:
 - better patient experience and outcomes
 - reduced demand on emergency departments
 - faster flow through the hospital

Best network in crowds



- Our Wembley network is a demonstration of our capability to deliver best connectivity in crowded environments
- AR¹ facilitates new ways of viewing sport and concerts

¹ Augmented reality

² Virtual reality

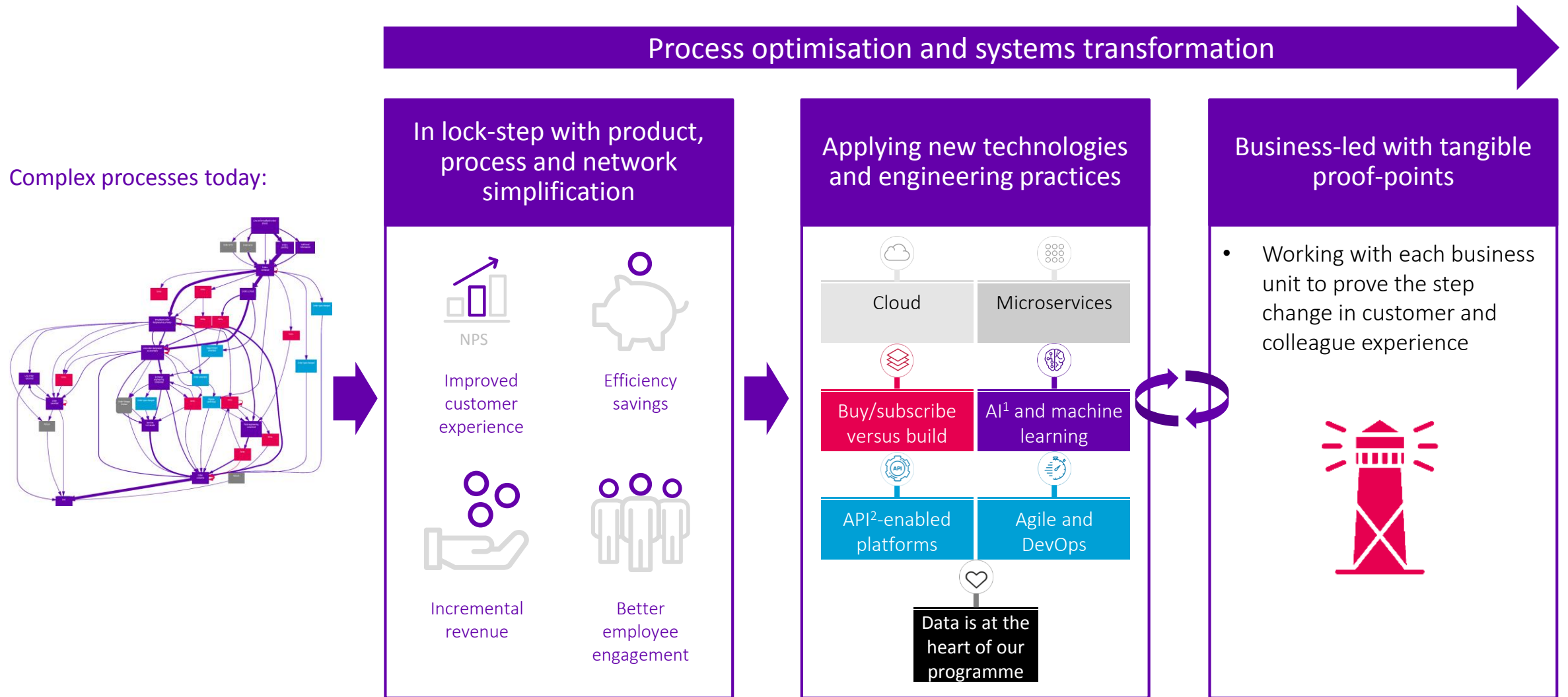
[Placeholder for EE Wembley Stadium video]



Our IT transformation journey

Rachel Higham – Managing Director, IT

We're simplifying and optimising processes as we apply the latest technology



¹Artificial intelligence

²Application programming interface

New technologies and practices are enabling our transformation

Cloud

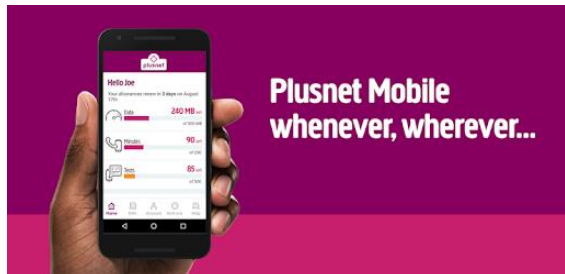


Setting up new environments and tooling:
16 weeks → 2 minutes

Microservices and API¹-enabled Platforms



Design Thinking, Agile and DevOps



¹ Application programming interface

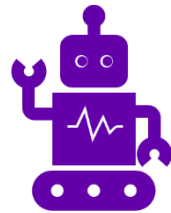


New technologies and practices are enabling our transformation

Build/subscribe
versus build

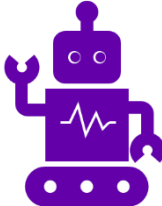


Design-led
automation



x 168 = 180,000 hours manual work

Artificial intelligence
and machine
learning

openreach +  = 30-40% automation

Data and insights

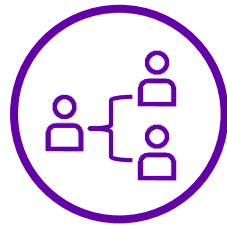


faults
2.5%

And to support these ways of working we're changing our organisation



Leadership,
culture and
mindset



Organisation
and operating
model

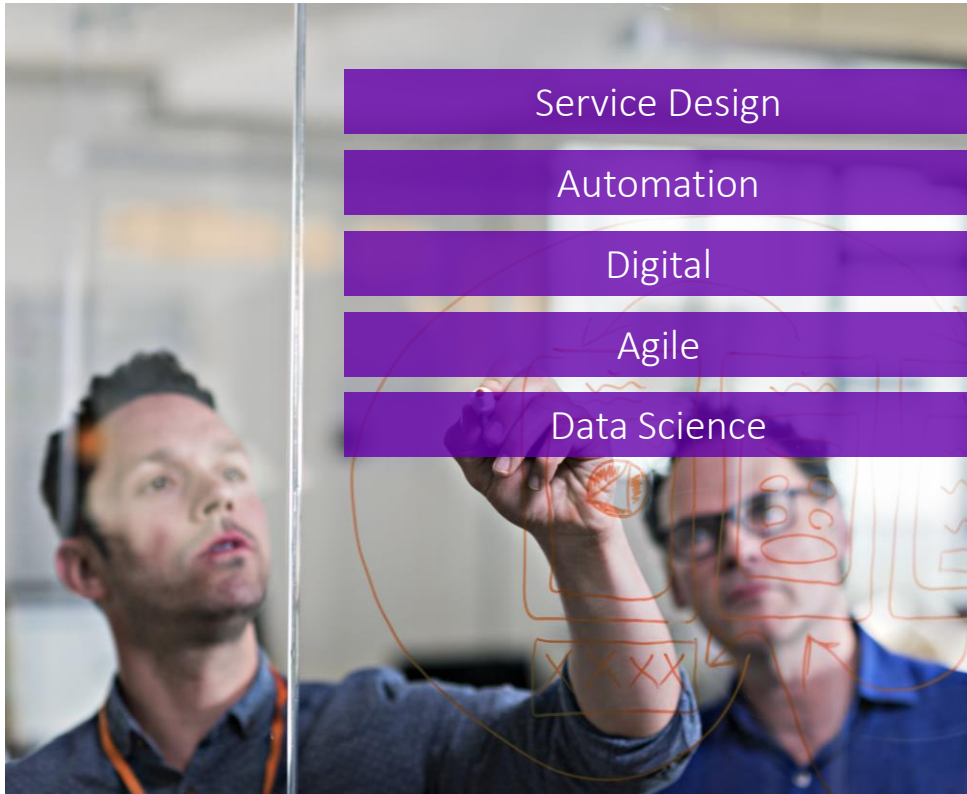


Reimagining IT
touchpoints



Strong
partnerships

We're reskilling the business to support this transformation



Our goals

- 1 Giving our people opportunities to learn and grow new skills (...in a fun, interactive, experiential way)
- 2 Building an external brand/presence in the market to help us attract talent in new domains
- 3 Strengthening capability through strategic/disruptive hires

Our approach

<p>Learning</p>	<p>Pan-org events / 'Show and Share'</p>	<p>Communities of Practice</p>
<p>Focus on building out CoEs¹ (service design, engineering excellence etc.)</p> <p>Commissioned work through research agency/linked in channels</p>		

¹ Centres of Excellence





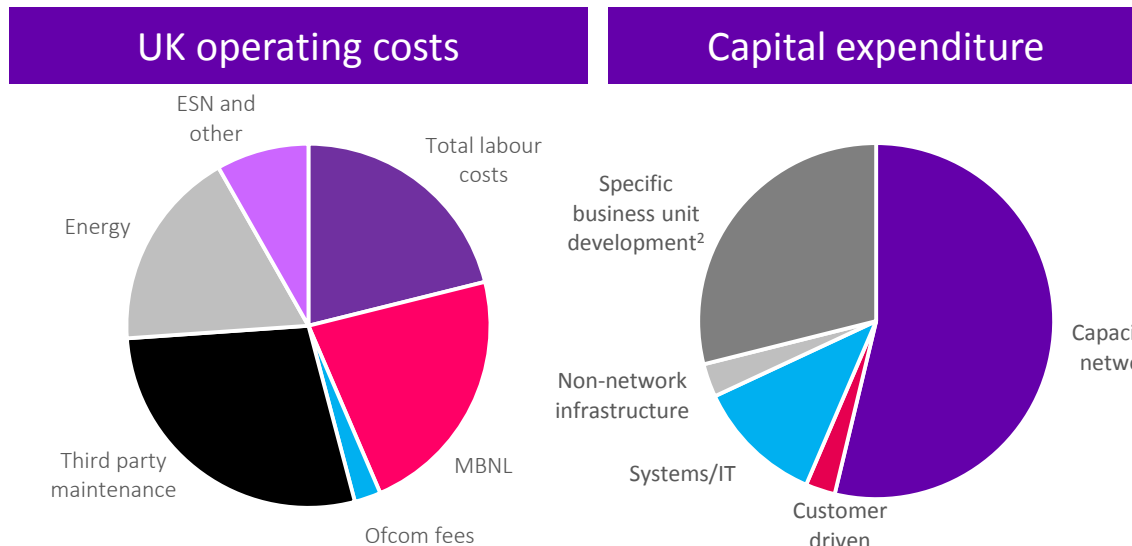
Finance and transformation

John Beswick, CFO Technology

We are responsible for 40% of the Group's capex

Technology ¹	2017/18	2018/19	Change
UK operating costs	£1,624m	£1,601m	(1)%
Capital expenditure ²	£1,532m	£1,535m	0%
Overseas operating costs	£234m	£208m	(11)%
Total managed costs	£3,390m	£3,343m	(1)%

- UK operating costs down 1%, driven by:
 - reduction in spectrum annual license fees and strategic sourcing
 - offset by higher energy costs, and increasing mobile coverage and capacity driving higher operating costs
- Capital expenditure flat, driven by:
 - network capacity expansion
 - offset by strategic sourcing, transformation of network build costs and reduction in EE integration spend
- Overseas operating costs (cost of running Global's networks) down 11%, driven by:
 - strategic sourcing and network optimisation

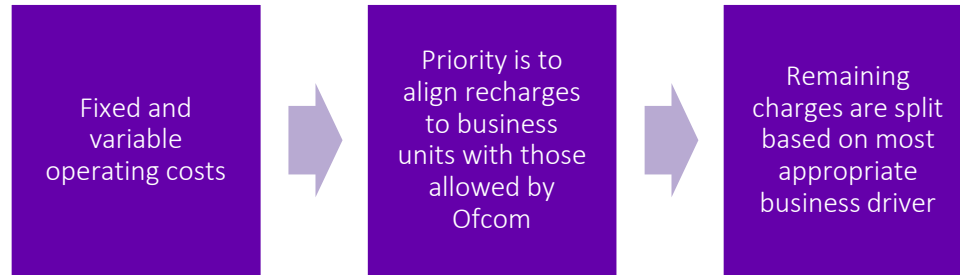


¹ Financials adjusted to reflect 2018/19 organisational moves

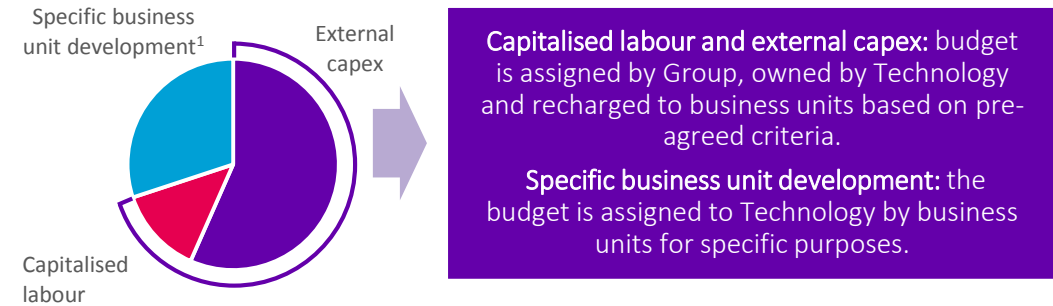
² For presentation purposes we have reflected the 'specific business unit development' spend as capital expenditure. Each business unit determines whether to capitalise these costs, but today c.90% is capitalised.

We allocate our costs across the Group's business units

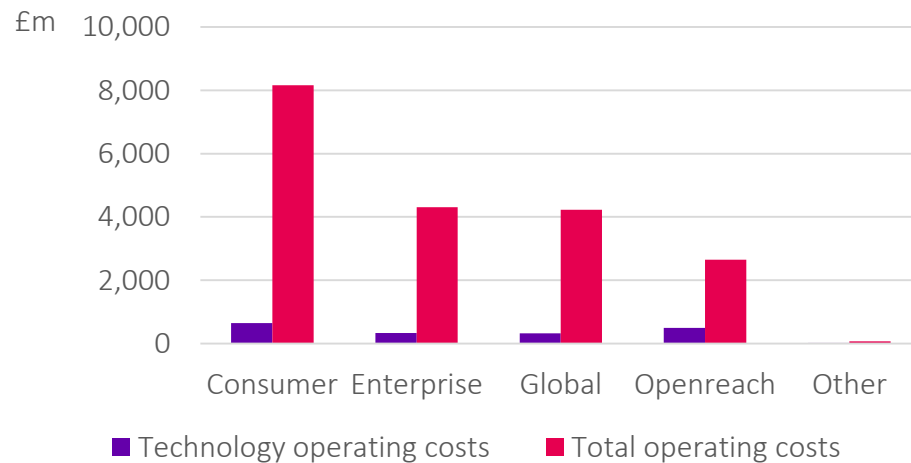
Technology's operating cost allocation



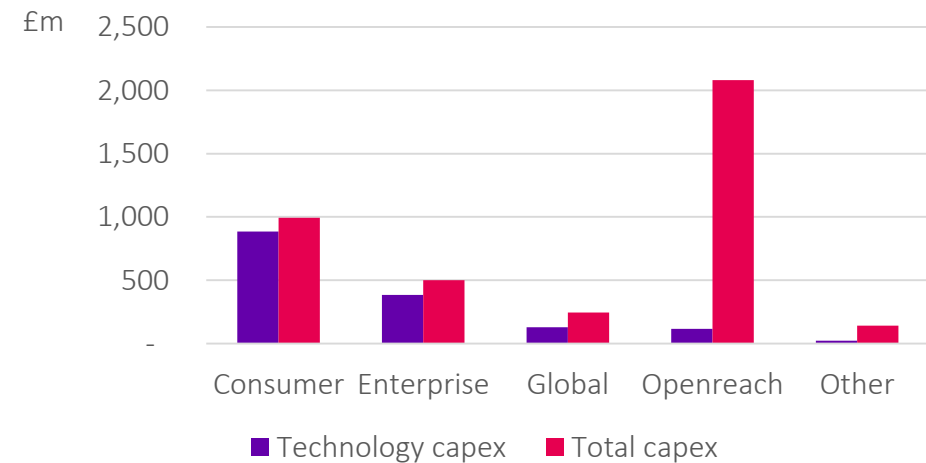
Technology's capital expenditure allocation



2018/19 operating costs by business unit



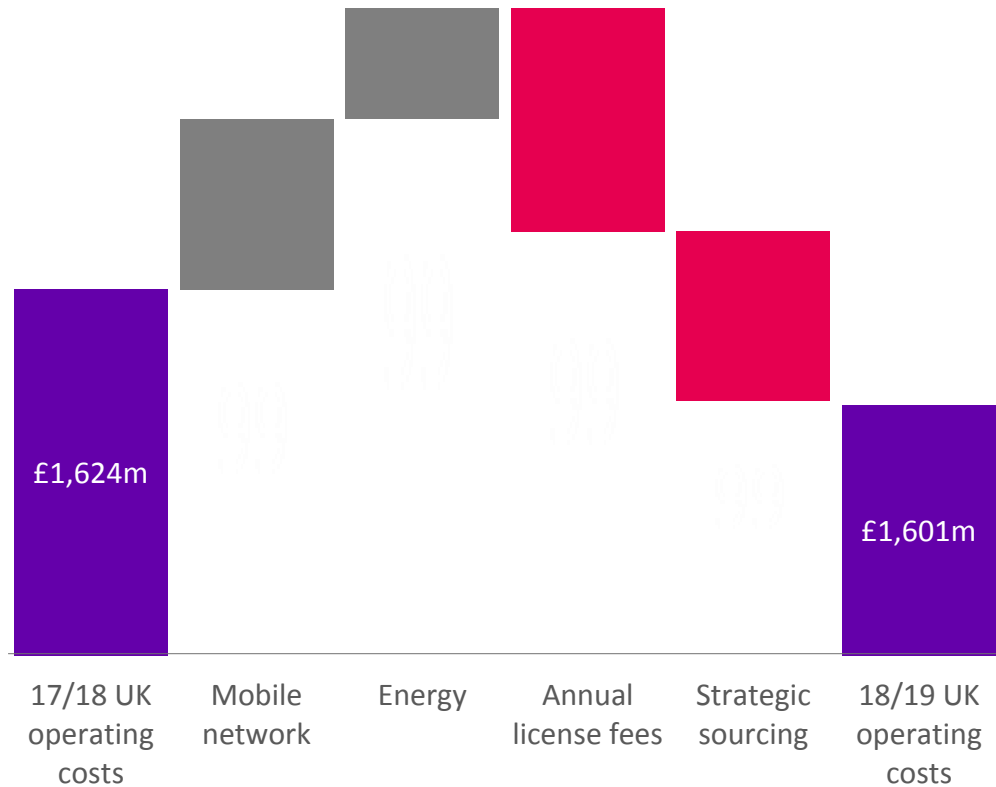
2018/19 capex by business unit



¹ For presentation purposes we have reflected the 'specific business unit development' spend as capital expenditure. Each business unit determines whether to capitalise these costs, but today c.90% is capitalised.

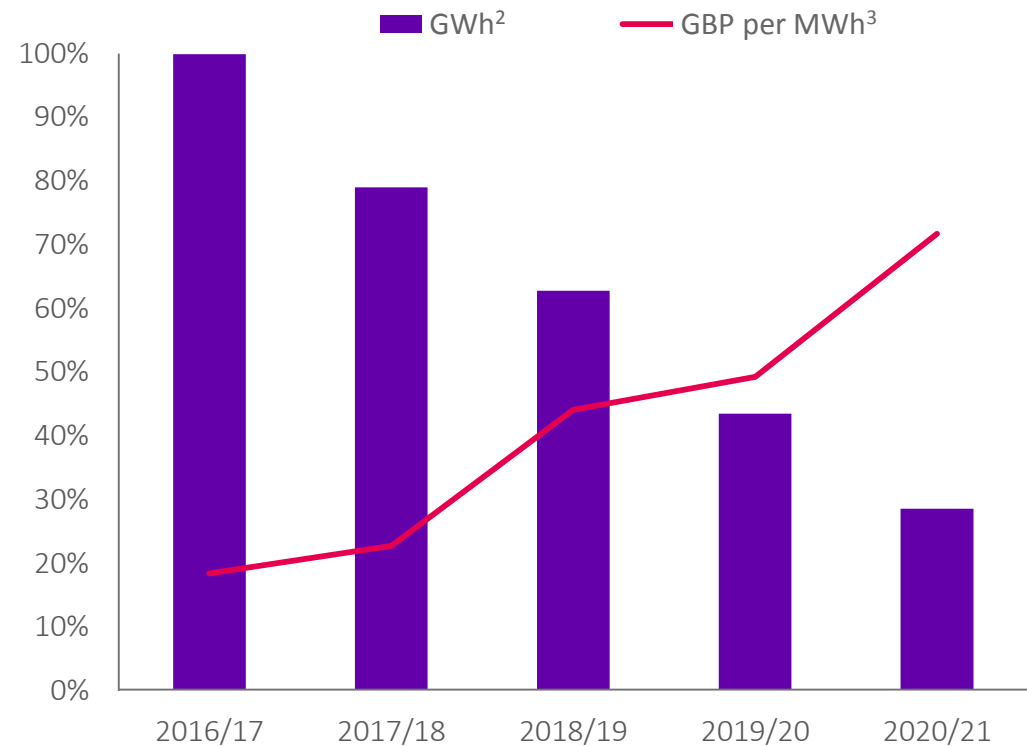
Inflationary pressures are offset by transformation

Operating costs reducing despite headwinds



We will continue to drive our efficiency programmes to offset cost inflation and increasing data consumption

Electricity volumes versus unit prices¹



¹Source: BT forecast

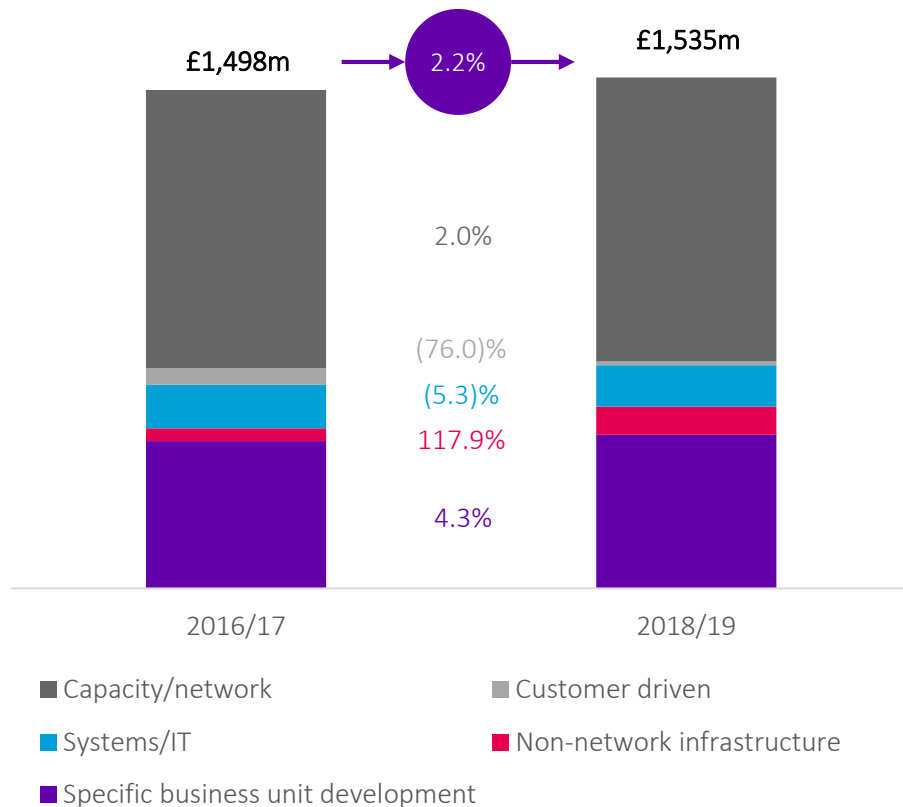
²Gigawatt hour

³Megawatt hour

We're managing growth in data consumption by reducing unit core costs

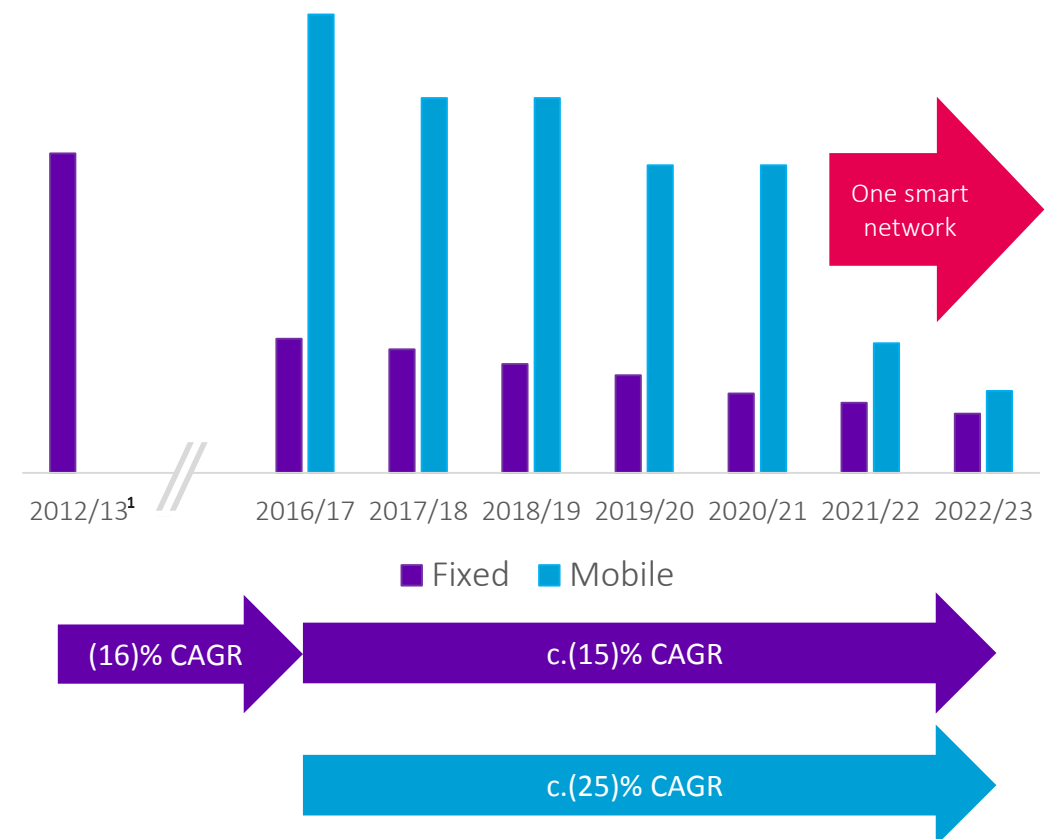
An increasing proportion of capex is invested in the network

Technology's capex from 2016/17 to 2018/19



Exponential growth in data consumption is offset by transforming the cost of incremental core network capacity

Core network deployment costs (cost per Gbps)



¹ No equivalent mobile core cost data available for 2012/13

Multiple initiatives underpin our transformation programme



A single, converged core: reducing the cost of adding network capacity as data consumption increases



Transforming energy consumption through adiabatic cooling and rectifier replacement



New operating model implemented



Third Party transformation: further strategic sourcing with key suppliers



Process simplification and automation



Removal of legacy systems and platforms



Spectrum license fees: continued focus on annual license fees, recently securing restitution payment



Our unique opportunity to build the future

Howard Watson

We have an exciting programme of near-term research

Cloud native network



Network virtualisation is enabling a radical re-architecture of network infrastructure enabling automation, optimisation and the ability to rapidly create new services.

Opportunity: Using AI¹ to deliver a zero touch self-optimising network.

Quantum key distribution



Quantum key distribution enables the secure distribution of encryption keys and detection of eavesdropping on fibre networks.

Opportunity: Highly secure networking using quantum key distribution on financial, life sciences and critical infrastructure.

Immersive content



AR², VR³ and 360 degree content brings you closer to the action. Object Based Broadcasting will enable users to personalise their viewing experiences.

Opportunity: Immersive formats will augment BT Sport content.

Future cyber operations centres



Advanced human-centred threat detection and response capabilities for future cyber security operation centres.

Opportunity: Early threat identification and correlation to assist and differentiate our security services and protect our networks and services.

AI¹ and machine learning



AI¹ encompasses a range of powerful technologies including machine learning, which is the ability of a system to learn from and improve with experience without being explicitly programmed.

Opportunity: Automation of routine tasks, from diagnostics to customer support. We are also extending BT's AI¹ readiness so we can rapidly adopt new AI¹ technologies.

¹ Artificial intelligence ³ Virtual reality

² Augmented reality

We continue to invest in the longer term to keep the UK ahead

Ultra MIMO¹



Ultra MIMO¹ enables the same spectrum to be reused from the same base station in order to provide major capacity increases on wireless networks.

Opportunity: Mobile spectrum is limited and expensive. Our goal is to develop technology to deliver a further step change in capacity based on MIMO¹ technology.

Fundamental physics



All communications systems are underpinned by fundamental physics of the underlying transmitters and receivers and the medium between them.

Opportunity: Applying physics, mathematics and material science has the potential to unlock an order of magnitude improvement of capacity in our networks.

Breakthrough civils



By using new sensing techniques we will be able to determine exactly what's under the streets and then use emerging technologies such as robotics to reduce the effort required to deploy.

Opportunity: Breakthroughs in computer vision and sensors to create digital twins combined with robotics will help Openreach reach more of the UK with full fibre.

Instrumented world



IoT's ability to provide actionable insight from sensors and other connected devices will have a transformational impact across a broad range of sectors including: manufacturing, healthcare, and transport.

Opportunity: Connectivity and security services have vital roles in IoT – use cases are continuously evolving.

Self healing security



AI and data science will underpin an “artificial immune” system for networks and services to allow adaptive defences and automated rapid response to attacks.

Opportunity: Leadership in cyber-security technology and solutions is necessary both in our security portfolios and in protecting our infrastructure from threats and attacks.

¹Multiple input multiple output

[Placeholder for Global's security video]

Our ten year vision positions us to win beyond connectivity



Connectivity as a Service

In the UK, a single converged network that can scale to meet demands, providing agility, resilience and differentiation.

Globally, a collection of federated networks with advanced capabilities such as QKD¹.

Opportunities

- Telemetry and autonomous control
- 5G control of mission critical applications
- Hollow core fibre
- QKDconnect



Trust as a Service

Our service offerings will be trusted and secure.

We will respect customer data and privacy, treating it as an extension of our own.

Our security tools will automate the analysis of huge volumes of data.

Opportunities

- QKD¹ for NFV²
- Visual analytics: Nexus
- Blockchain
- Cyber Security expertise



Actionable Insight as a Service

An information layer will support our own services and those from other providers. We'll collect, store and curate data from a vast array of sensors connected to our network.

Data will be available through our own applications or via APIs³.

Opportunities

- Health and monitoring
- Datahub
- Cyber analytics
- IoT



Productivity as a Service

We'll rapidly assemble new applications and services.

These components will enable new business models.

From actionable insight our services will enable increased productivity and efficiency.

Opportunities

- Fraud analysis
- Aggregated home
- Field analytics and optimisation

¹ Quantum key distribution

² Network function virtualisation

³ Application programming interface

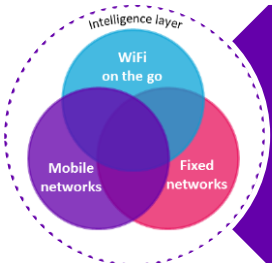
We are building a better BT for the future



Our markets are rapidly changing as our customers connect more devices and use exponentially more data



We have a unique set of core and access networks, and a proven track record of delivery



Our plans for one smart network and IT transformation will enable continued differentiation

Technology's ten year vision: value beyond connectivity



Connectivity as a Service



Trust as a Service



Actionable insight as a Service



Productivity as a Service



Glossary

ADSL: Asymmetric digital subscriber line. A digital technology that allows the use of a standard telephone line to provide high speed data communications.

Backhaul: The links by which data is transmitted from a local telephone exchange back to the operator's core network.

Broadband speed: The speed at which data is transmitted over a broadband connection, usually measured in megabits per second (Mbps).

Core network: Provides the routing between the access or backhaul network, and the internet.

CP: Communications provider. A company that provides access to the internet.

Ethernet: Point-to-point data connectivity network between sites. Typically high speed over fibre, and can be used to connect a site to the internet.

Exchange: The local telephone exchange is the building where all consumers' copper telephone lines are connected to enable telephone calls to be switched, and where network equipment is installed which enables consumers' data traffic to be routed via an operator's core network to its destination.

Fixed access network: Connects end customers (homes and businesses) to access nodes (typically in exchanges).

FTTC: Fibre-to-the-cabinet. An access network technology consisting of optical fibre extending from the access node to the street cabinet. The remaining segment of the access network from the cabinet to the customer is usually a copper pair, but another technology such as wireless could be used.

FTTP: Fibre-to-the-premises. An access network technology which connects end customers to an access node using exclusively fibre. Offers better performance, higher speeds and fewer drop-outs than FTTC.

Gbps: Gigabits per second. A unit measuring the bitrate. 1Gbps is the equivalent of 1,000Mbps.

IP voice: Internet protocol voice. A group of technologies for the delivery of voice communications and multimedia sessions over Internet Protocol (IP) networks, such as the Internet.

IMS: Internet protocol multimedia subsystem. A concept for an integrated communication provider's network that facilitates the use of IP (Internet Protocol) for packet communications (e.g. voice) in all known forms over mobile or broadband.

Latency: The delay between a user of a network making a request to their mobile or fixed network for information and the network providing this information to their device.

MBNL: Mobile Broadband Network Limited. A joint venture between BT and mobile network operator Three, whereby both operators share parts of their mobile networks infrastructure.

Mbps: Megabits per second. A unit measuring the bitrate. 1Mbps is the equivalent of 1,000kbps.

MCN: Mobile cloud network. Mobile cloud networking uses cloud computing to deliver applications to mobile devices. These mobile apps can be deployed remotely.

MIMO: Multiple input multiple output. A method for multiplying the capacity of a radio link using multiple transmission and receiving antennas to send and receive more than one data signal simultaneously over the same radio channel.

PoP: Point of presence. An artificial demarcation point or interface point between communicating entities where the entities build a connection with each other.

RAN: Radio access network. Electronics and backhaul network connecting mobile users to the core network.

Spectrum re-farming: The process governing the repurposing of frequency bands that have historically been allocated for 2G or 3G mobile services for new generation of mobile technologies.

Tbps: Terabits per second. A unit measuring the bitrate. 1Tbps is the equivalent of 1,000Gbps.

Upload speed: Also uplink or upstream speed. Rate of data transmission from a customer's connection to a network operator's access node, typically measured in megabits per second (Mbps).

Virtualisation: The process of creating a simulated, or virtual, computing environment as opposed to a physical environment. Virtualisation often includes computer-generated versions of hardware, operating systems, storage devices and more.

Notes

Notes
