



Developing market models to support future telecoms infrastructure deployment



DCMS submission Annex | January 2018



Executive summary – Market Models for UK telecoms infrastructure

- Developing world-class next generation technologies for both fixed and mobile connectivity is **critical to maintaining a digitally advantaged UK post-Brexit**, and offers the potential to generate up to £39bn of economic output (and associated benefits) through additional capacity as well as new use cases for businesses and consumers
- However, achieving at-scale deployments of **these technologies will require large investments** (estimated at £30bn for fixed fibre, £8bn for 5G)
- Both fixed and mobile **technologies face high barriers to investments**, stemming from uncertainty around three axes: (i) consumer demand and willingness to pay, (ii) ability of investors to recover costs and (iii) regulatory and policy frameworks
- We have developed **5 distinct market models which combine regulatory and policy levers** in different ways, namely the “*regulated infrastructure competition*,” “*nominated provider with regulatory pricing*” “*market-driven*” “*franchising*” and “*government-led*” models. We have benchmarked these models versus telecoms markets in other countries as well as other UK sectors
- **Two models do not appear to promote desired investment outcomes in the UK:** the status quo (in fixed markets) of “*regulated infrastructure competition*” and “*franchising*” (or some other form of mandated market allocation).
- **A “market-driven” model offers the potential to incentivise at-scale deployment of both full fibre and 5G.** “*Nominated provider with regulatory pricing*” could also incentivise fixed investments and performs more strongly in delivering universality objectives. Our international case studies also suggest that “*market-driven*” models complemented, in some cases, by different forms of collaboration and risk sharing have helped commercially funded investment in particular in France, Portugal and Spain.
- The “**government-led**” model is critical to support next generation rollout in uncommercial areas, particularly for infrastructure competition models which will inevitably leave parts of the country less well served, and where the option to fund deployment in these areas through a single provider cross-subsidy model is lost; in mobile, government’s role additionally involves ‘barrier busting’ for example on planning restrictions

- **Fixed / mobile overview**

- Levers and market models
- Learnings from international case studies
- Evaluation of market models in UK

Fixed / mobile summary

- Next-generation technologies offer the potential to **increase capacity and provide new fixed and mobile use cases** to both business and consumers – for example in the autonomous vehicle, railway, healthcare, supply chain, smart utilities, and media & cloud sectors
- There are potential **synergies between full fibre and 5G** in terms of end-user proposition and network deployment
- National Infrastructure Commission (NIC) has estimated that **building out full fibre networks (including “fibre to 5G”) could add at least £39bn of economic output (and associated benefits)** in an “ambitious” scenario, driven largely by video use cases
- However, achieving at-scale deployments of **these technologies will require large investments** (estimated at £30bn for fixed fibre, £8bn for 5G), which would be the UK’s largest infrastructure project alongside HS2
- Fixed and mobile **technologies face high barriers to investments**, stemming from different sources of uncertainty:
 - *Demand uncertainty*: limited demonstrated willingness to pay by consumers for ultrafast above DSL speeds; 5G is untested with unproven willingness to pay
 - *Cost recovery uncertainty*: full fibre and 5G investments are costly, while returns are contingent on favourable market situations
 - *Regulatory and policy uncertainty*: investments pay off over long periods; governments / regulators may change the rules before investments have been recouped, but after costs have been sunk

Next generation technologies could provide significant economic benefits in the UK both today and in the future across several use cases

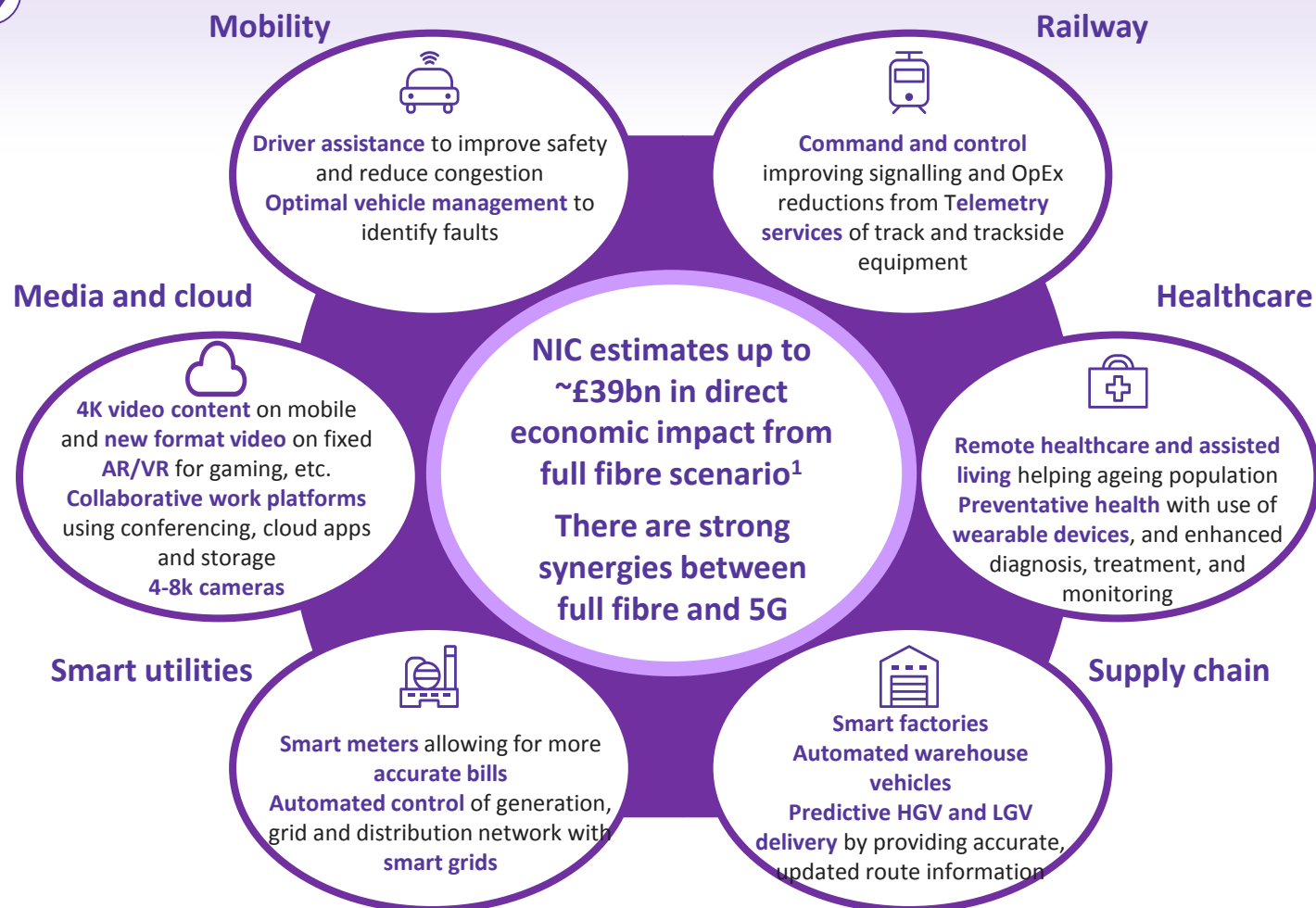
The use cases today are compelling....

... and will only become more compelling in the future



Next generation technology can produce faster, more reliable and more resilient (e.g., weather-proof) broadband services ...

... and enable better mobile coverage in less dense areas, better capacity & more consistent user experience in dense areas and better quality in all areas



¹ Estimate taken from 3 ambitious scenarios (100% FTTP with infrastructure re-use, fibre to 5G, FTTP with FWA/LRVDSL)

There are potential synergies between full fibre and 5G

Enhancing the fixed service

- Enhancing the in/near building wireless distribution with 5G to address issues where today the performance bottleneck is often the WiFi to the customer's device not the fixed connectivity

Although the experience will not be equivalent to FTTP, wireless solutions could address costly fixed areas

- in the short to medium term, enhanced 4G, could assist with “last mile” connectivity in rural areas
- in the medium to long term, 5G and mm wave, could address “last metres”, and high performance in specific semi-dense areas of demand

Enhancing the mobile / 5G service

- Deploying 5G mobile in-building solutions alongside FTTP, to enhance the “outside in” 5G in-building service

5G will require a fibre rich backhaul network, and will rely on fibre closer to the edge:

- increasing capacity demands on the macro network
- hundreds of thousands of small cells
- pushing of 5G core network functions to the edge for demanding new 5G services

Enhancing combined service

Fibre and 5G together will create a more ubiquitous platform for the development of new experiences and services – better performance for more customers in more places, inside and outside

Enhancing combined deployment

Different deployment timelines and locations for the FTTP and 5G deployments are a challenge, but operators should look at the potential for:

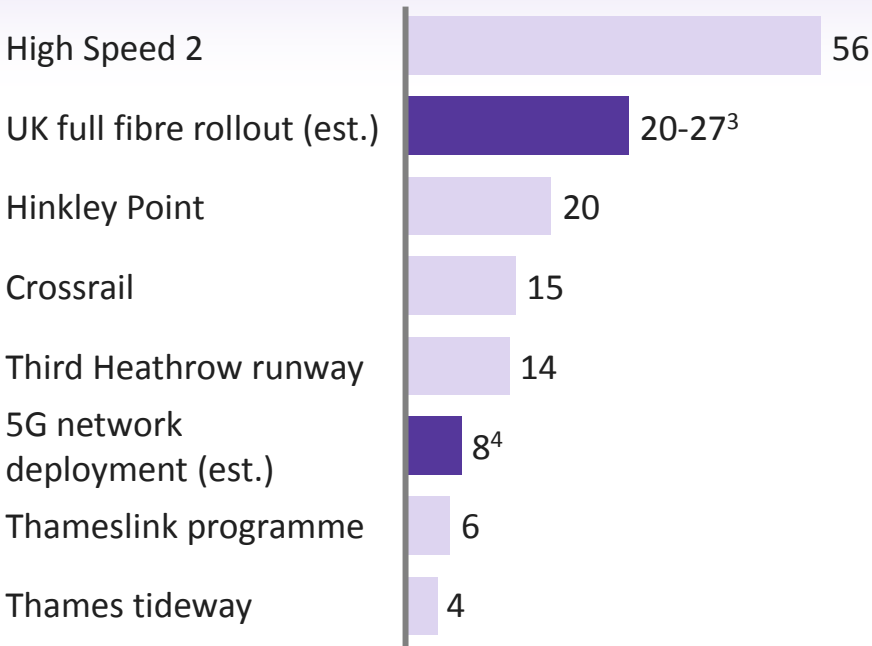
- coordinating new fibre backhaul for 5G with FTTP deployment plans
- co-deployment of fibre distribution points and 5G small cells

Achieving an at-scale rollout of FTTP and 5G wireless requires a large investment, comparable to other major UK infrastructure projects

Full fibre and 5G would be amongst the UK's biggest projects

Comparison of estimated total capex costs of major UK infrastructure projects and full fibre / 5G deployment¹

£bn, total project capex costs



Comparison of estimated total economic benefits of major UK infrastructure projects and full fibre / 5G deployment²

£bn, total economic benefit

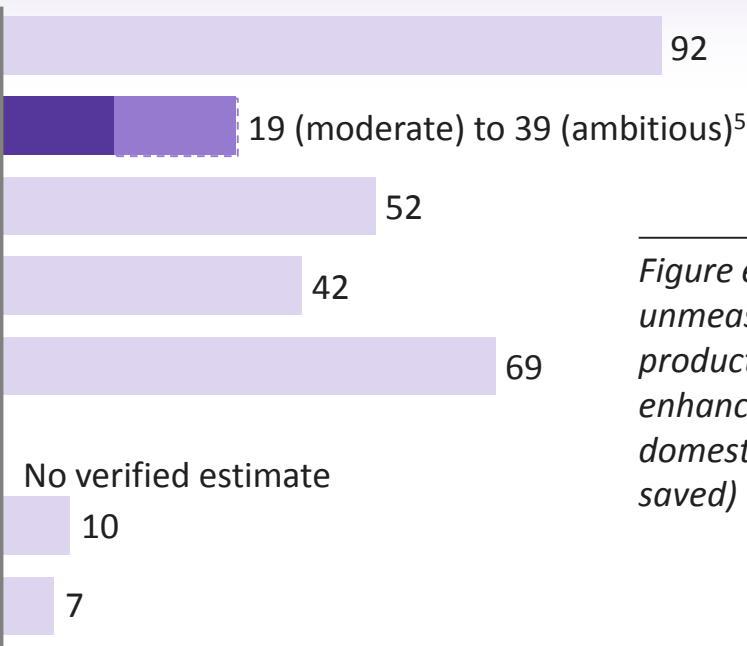


Figure excludes unmeasured tech. productivity enhancement (e.g. domestic time saved)

1 National Infrastructure and Construction Pipeline (Autumn 2017) - Total Capex cost; Davies report (Jul 15) | 2 HS2: DfT Economic case (Jul 17); UK fibre: Frontier 'Future benefits of broadband networks' (Dec 17); Hinkley: BEIS VFM Assessment (Net Social Benefits) (Oct 16); Crossrail: City of London 'Impact of Crossrail' (Apr 15); Heathrow: Davies report (Jul 15); Thameslink: NAO 'Progress in the Thameslink programme' (Jun 13); Thames tideway: DEFRA 'Cost and benefits of the Thames tideway programme' (Oct 15) | 3 Captures Capex cost range in NIC scenarios 2, 3, and 4 from NIC 'A Cost Analysis of the UK's Digital Communications Infrastructure options 2017- 2050' (December 2017). All of these include DPA and show costs of full (2) or almost full (3, 4) fibre coverage | 4 Projected costs of macro cell 5G deployment by 2025; estimate is from BT analysis of publically available data – see appendix [Site numbers [Vodafone, EE, Hexus, Arqiva], Costs [Ofcom, Senza Fili, Deloitte] | 5 Moderate scenario: (£14.9bn incremental output + £4.3bn cost savings (5G deployment and telehealth); Ambitious scenario: (£33.9bn incremental output + £5.1bn (5G deployment and telehealth). All figures are given as NPV in 2017 [NIC, 'Future Benefits of Broadband Networks' (December 2017)

New fixed and mobile technologies face many barriers to investment

Fixed

Mobile

Demand uncertainty

- Mass market willingness to pay a premium for full fibre has not been demonstrated.
- Capabilities of existing copper, FTTC and cable based services will continue to meet bandwidth demand for many people for some years

- Consumer willingness to pay for new 5G capabilities remains unclear
- There is an expectation of demand from beyond current mobile segments, such as from different industry sectors or types of services but these are still under development

High sunk cost combined with uncertainty

- Build costs per premise are high compared to expected revenues and incurred before sales.
- Investment cases are highly sensitive to build costs which are impacted by local issues and hard to estimate.
- While costs are likely to reduce over time through learning by doing, extent and timing of this is uncertain.
- For existing players, deploying new technology can lead to early write-off of valuable assets.

- Cost forecasts highly sensitive to assumptions about use cases and demand
- Cost of deployment highly sensitive to the performance of the new technology in the real geography and deployment trials are only just starting
- Costs and performance of later 5G deployments in very high frequencies (mm wave) is even more uncertain, but likely to be high due to the numbers and costs of small cells – sites, backhaul, power

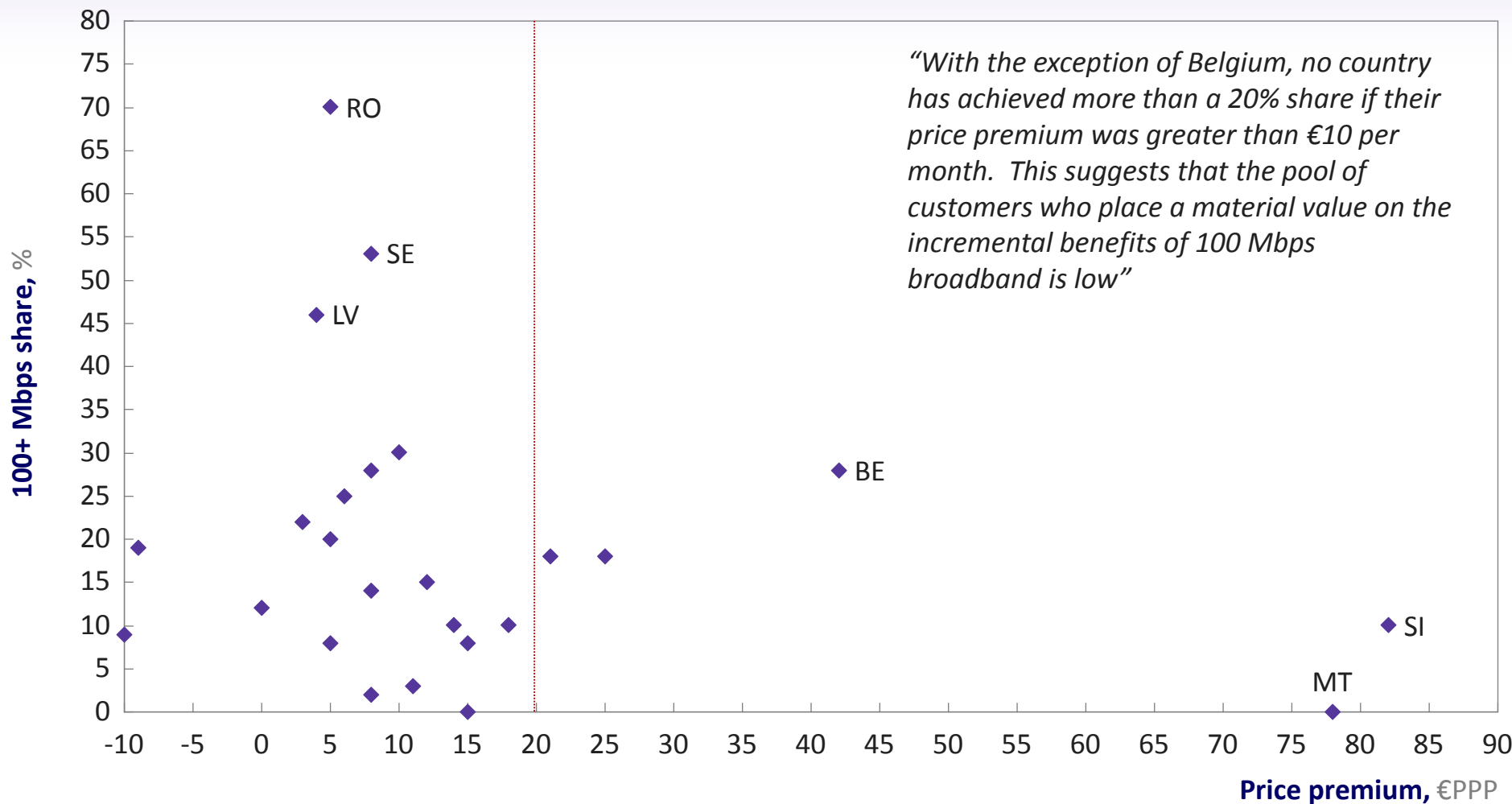
Regulatory and policy uncertainty

- Long payback investments are made more risky by possibility of regulatory / policy change
- Regulation at multiple levels of the value chain increases uncertainty as regulators have more levers to adjust

- Spectrum policy may lead to sub-optimal outcomes
- Barriers to deployment such as planning / permitting regime, availability of suitable sites including use of public assets
- Recurring threat of potential policy intervention to mandate national roaming to address partial “not spots” adversely affects incentives to extend geographic coverage and capacity

Evidence from European peers suggests consumers are unwilling to pay a significant premium for higher speed broadband

100+ Mbps share of BB in covered areas and price premium over 30-100 Mbps, 2015



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- Fixed / mobile overview
- **Levers and market models**
- Learnings from international case studies
- Evaluation of market models in UK

Levers and market models summary

- **There are a number of levers to promote investment and to stimulate competition**, including entry levers (incentivising different levels of infrastructure competition), wholesale regulatory levers (regulating wholesale access and potentially wholesale pricing), fixed migration levers (enabling demand for full fibre), commercial enablement levers (permitted rather than implemented by the government), and mobile specific levers
- We have developed **5 distinct market models which combine regulatory and policy levers to address investment incentives** in different ways:
 1. *Regulated infrastructure competition*: incumbent subject to multiple layers of regulation with multiple objectives (incl. promoting greater infrastructure competition and promoting downstream competition through access regulation)
 2. *Nominated provider with regulatory pricing*: aims to provide a regulated risk-adjusted return for a single player to promote widespread, efficient investment and create long term incentives (e.g. RAB model) with less emphasis on infrastructure competition
 3. *Market-driven*: regulation is removed or amended (where there is evidence of competitive pressure) allowing greater commercial flexibility to promote switchover and investment at scale. Under this model there are risk sharing opportunities and commercial collaboration may emerge over time
 4. *Franchising*: covers a variety of government-mandated models to allocate exclusive network build and operating rights to specific geographies, potentially including a no-overbuild rule
 5. *Government-led*: covers a variety of models through which government may actively support investment in areas that would otherwise be uncommercial and remove barriers
- **Choice of market model may vary by geotype**, as costs of investment increase outside of dense, urban areas and the market may not support multiple infrastructure operators

A mix of levers exist to promote investment in full fibre/5G, as well as the government's pro-competition goals

		Description
Entry levers	DPA	Mandate passive access to ducts and poles of incumbent
	Geographic price restrictions	Restrict incumbent from varying price by geography
	Price floor	Restrict incumbent from legacy technology price cuts below a price floor
	Franchise auctions	Auction exclusive fibre build out rights on a temporary, regulated basis for designated geographic units
	No overbuild rule	Mandate no overbuild in specific geographies for a period of time, ensuring only one infrastructure player invests
Wholesale regulatory levers	Active access	Mandate wholesale access to fibre network of an infrastructure provider found to have market power
	Charge control / RAB+	Implement a wholesale price regulation regime across significant proportion of offerings with the aim of providing investors with a risk-adjusted return on investment, including RAB or similar
	Safeguard caps or 'retail minus' charge control	Cap on permitted increase from current price; retail minus (efficient component pricing rule)
	Ex-post dispute resolution	Do not apply any ex-ante price regulation, but rely on ex post dispute resolution procedures or general competition law
Fixed migration levers	Legacy product pricing	Promote migration through pricing of legacy products (includes wedge pricing)
	Anchor	Ex ante price control is applied to the legacy network service
Commercial enablement levers	Commercial risk sharing	Share risks (and gains) between network operator and CPs via contracts
	Commercial infrastructure sharing	Collaboration to minimise asset duplication (eg, implemented ex ante in fixed through DPA access; network sharing between vertically integrated operators in mobile)
	Switchover	Commercially-led switchover to fibre is supported
Mobile specific levers	Spectrum policy	Use of spectrum policy levers to promote competition; and/or coverage and build out requirements
	Planning restriction relief	Provide regulatory relief to quickly approve planning for new towers and other infrastructure
	Site access	Regulatory solutions for site access (e.g. for small cell deployment)

We have identified 5 market models for full fibre / 5G investment in the UK

	1	2	3	4	5
	Regulated infrastructure competition	Nominated provider with regulatory pricing	Market-driven	Franchising / Market allocation	Government-led
Description	<ul style="list-style-type: none"> There is infrastructure competition: actual and/or prospective There is regulation to support entry/expansion by network rivals There is regulation to support service-based, downstream competition; “wholesale access” Regulation is not geographically differentiated Regulatory review periods are short (3 years) No clear application for mobile 	<ul style="list-style-type: none"> Infrastructure competition is limited A provider of infrastructure is designated There is regulation of prices and services to support service-based, downstream competition (e.g. RAB model) Regulatory review periods are longer (5 years) Could be regionally designated providers (to allow yardstick competition) No clear application for mobile 	<ul style="list-style-type: none"> Regulation to support service-based, downstream competition is removed or changed to encourage long term investment There is infrastructure competition: actual and/or prospective There is regulation to support entry/expansion by network rivals (but focused on reducing rivals’ costs not constraining incumbent) Geographically differentiated (differing competitive conditions) Commercial collaboration could evolve over time between existing infrastructure providers to minimise asset duplication (e.g. network sharing in mobile; in fixed, asset sharing currently mandated through regulation) Applies to UK Mobile sector 	<ul style="list-style-type: none"> May take a variety of forms: <ul style="list-style-type: none"> a) Government might auction right to build and operate full fibre in specific geographic areas with a long term contract (e.g. 25-30 year concession) b) Could include (temporary) no overbuild rule to achieve a market “carve up” Might require similar regulatory model as in Model 2, on a regional basis where local market power found Not relevant for mobile except e.g. large public sector customers; connectivity for public transport or similar 	<ul style="list-style-type: none"> Direct central or local government funding Long-term gainshare contracts with government Funds awarded by competitive tender and/or reverse auction Most likely to be in uncommercial areas (via subsidy), but also includes nation-wide “barrier busting” on planning and permitting restrictions Mobile: very rural areas only
Examples	<ul style="list-style-type: none"> UK fixed markets 	<ul style="list-style-type: none"> Singapore (explicitly nominated provider) NZ Japan (incumbents) Energy transmission Heathrow airport 	<ul style="list-style-type: none"> UK wireless including MBNL, CTIL Portugal (denser areas) France (denser areas) Spain (geographies with prospective competition) US Royal Mail 	<ul style="list-style-type: none"> Cable in UK UK train operators 	<ul style="list-style-type: none"> Australia Sweden (municipalities) BDUK

Each model employs different levers to incentivise investment

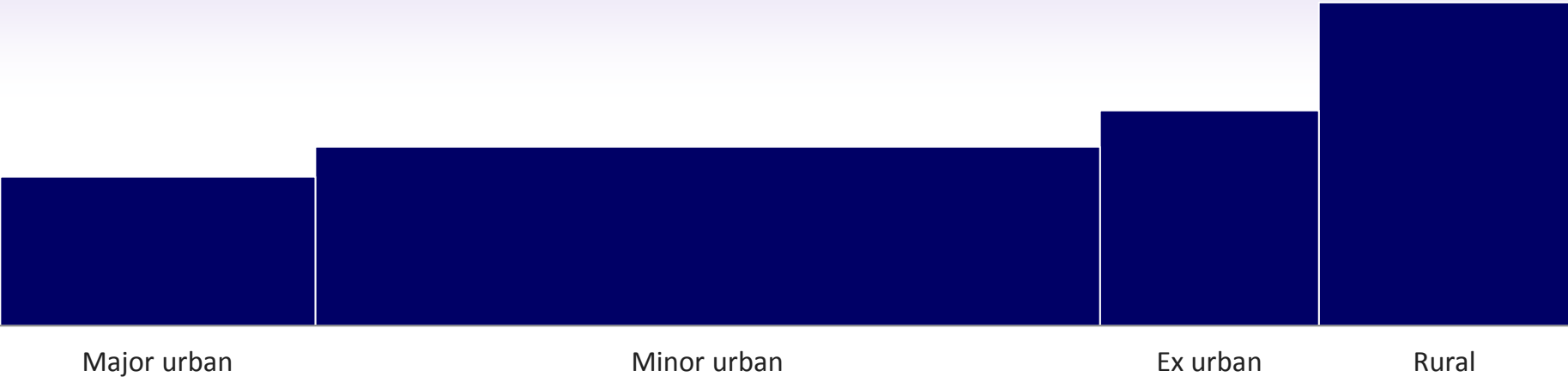
Regulatory levers		1	2	3	4	5
		Regulated infrastructure competition	Nominated provider with regulatory pricing	Market-driven	Franchising/ Market allocation	Government-led
Entry levers	DPA	✓	✗	✓	✗	
	Geographic price restrictions	✓ ¹	✗	✗	✗	
	Price floor	✗	✗	✗	✗	
	Franchise auctions	✗	✗	✗	✓	
Wholesale regulatory levers	Wholesale active access	✓	✓	✗	✓	
	Charge control / RAB+	✓	✓	✗	✓	
	Safeguard caps / retail minus charge control	✗	✗	?	✗	
	Ex-post dispute resolution	✗	✗	✓	✗	n/a (varies by country)
Fixed migration levers	Legacy product pricing	?	?	✓	?	
	Anchor	✓	?	?	?	
Commercial enablement levers	Commercial risk sharing	?	✗	✓	?	
	Commercial infrastructure sharing	✗	✗	?	?	
	Switchover	?	?	✓	?	
Wireless specific levers ²	Spectrum policy	NA	NA	?	NA	
	Planning restriction relief	NA	NA	✓	NA	
	Site access	NA	NA	?	NA	

1 Proposed

2 Models 1, 2 and 4 have no clear application in mobile

Market models by geotype

Geotypes ordered by average capex cost per home passed



1 Regulated infrastructure competition

2 Nominated provider with regulatory pricing

3 Market-driven

4 Franchising

5 Government-led

No model will provide complete rural coverage

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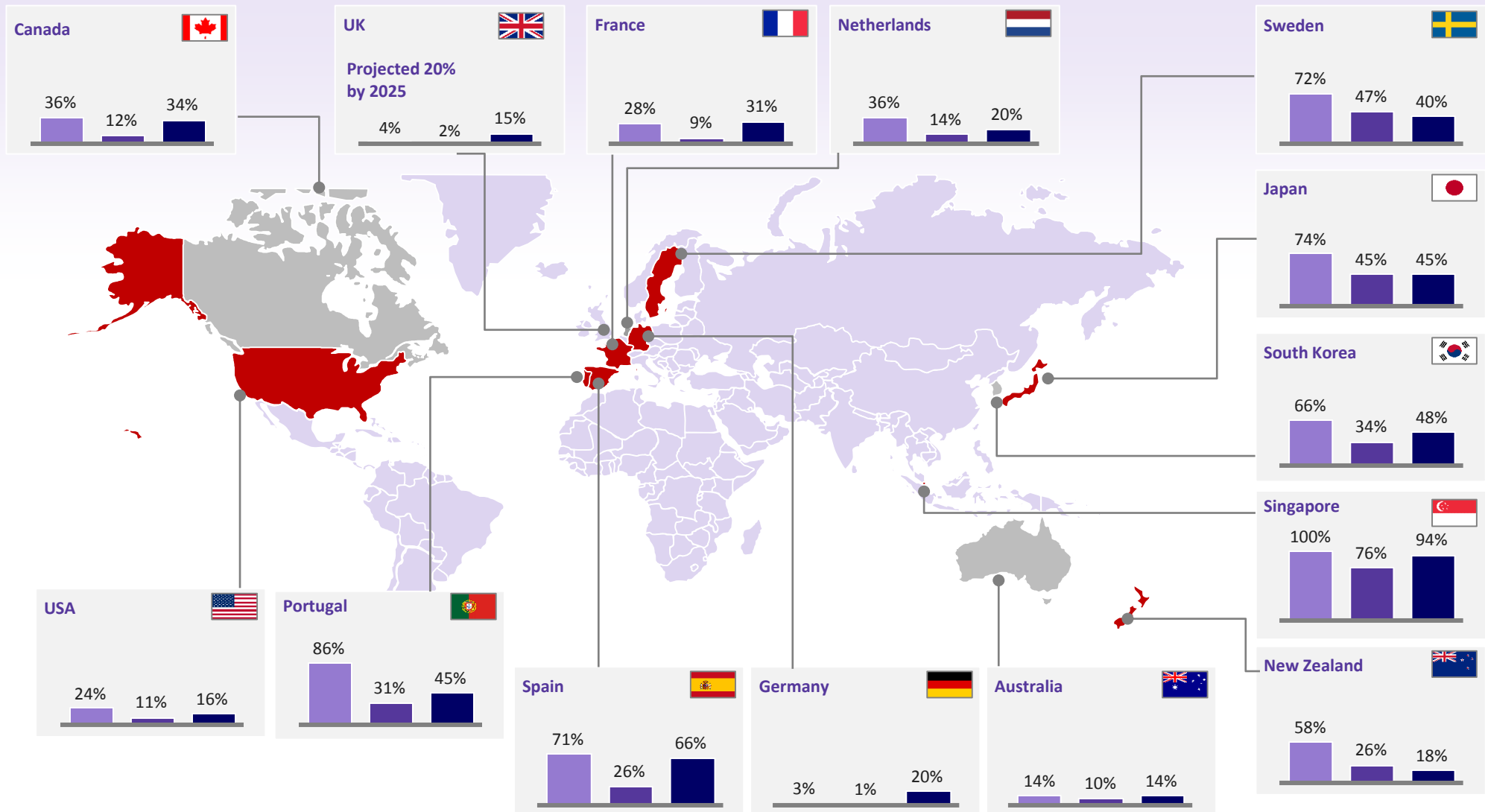
- Fixed / mobile overview
- Levers and market models
- **Learnings from international case studies**
- Evaluation of market models in UK

International case studies summary

A comparison of a representative set of developed countries reveals several clear themes to inform the goal of at-scale FTTP deployment in the UK:

1. The market models correlated with **the highest levels of FTTP coverage have typically involved either nominated providers with significant government assistance (#2, #5) or market-driven** model often on a geography-specific basis (#3), ...complemented, in some cases, by commercial infrastructure collaboration
2. There are no **clear examples of countries adopting either franchising (#4) or regulated infrastructure competition (#1)** while also **achieving high FTTP coverage**
3. **Many countries have not imposed wholesale access obligations (except for duct access), even on anchor products, to incentivise FTTP deployment** by allowing more predictable returns from new build infrastructure. In some cases, a light touch form of regulation (symmetric, ex post and dispute-based) in prospectively competitive areas has been imposed to give sufficient comfort that consumer choice is maintained as the markets become more competitive
4. Countries with high levels of FTTP coverage have typically adopted **geographically differentiated regulation** to reflect different competitive conditions and also provide sufficient incentives to invest in FTTP deployment (France, Spain, Portugal) – geographic markets were identified prospectively on the basis of existing and prospective levels of fibre competition and dwelling density and were refined during rollout
5. Especially in countries with nominated provider models (Singapore, Australia) there has been **significant demand side stimulus in the form of direct public subsidy which has aided coverage rollout**
6. Countries with **market-driven models do not appear more concentrated at retail level than the UK** (France, Spain, Portugal)
7. **National FTTP coverage rarely means universal FTTP coverage** - even in countries with high levels of national FTTP coverage, extending FTTP to rural areas has been limited (Spain, Sweden)

We have compared a representative group of developed countries to determine applicable lessons for at-scale FTTP deployment for the UK



1 Percentage of households with FTTP connection 2 Premises using FTTP as a proportion of total premises

SOURCE: European Commission, 'Study on Broadband 2016' (21 September 2017); Eurostat and relevant national statistical agencies [MDU share]; CRTC (Canada); NBNCo (Australia); Ofcom (Korea, Japan); MBIE (NZ); Netlink Trust (Singapore); Fiber Broadband Association (USA); Analysys Mason (take-up statistics); Analysys Mason, 'FTTx roll-out and capex worldwide: forecasts and analysis 2017–2022'. The number of households for Spain in this graph includes 7m businesses, holiday properties and empty villas (excluding them would bring coverage to about 90%). Please note the disclaimer in the Annex.

Overview of key Fixed/FTTP metrics

Countries	Household density	Infrastructure		Internet quality, cost and coverage			
	MDU share of households, % of h/holds	Dominant transmission conduit, aerial vs underground	High duct quality and ease of access ²	Avg. broadband download speed mbps	High speed (25mbps+) internet cost ¹ % of OECD avg	FTTP coverage, % of h/holds	FTTP take-up, % of h/holds, 2017
France	32	Aerial	✓ (Local utilities)	11	40	28	9
Germany	57	Underground	✗	15	99	3	1
Netherlands	20	Underground	✗	17	72	36	14
Portugal	45	Aerial	✓	13	127	86	31
Spain	66	Aerial	✓	13	121	71	26
Sweden	40	Underground	✓ (Local utilities)	23	73	72	47
Canada	34	Aerial	✓	16	194	36	12
USA	16	Aerial	✓	19	123	24	11
Australia	14	Aerial		11	140	14	10
New Zealand	18	Aerial	✓	15	110	58	26
South Korea	48	Aerial	✓	29	21	66	34
Japan	44	Aerial	✓	20	60	74	45
Singapore	94	Underground	✓	20	n/a	100	76
UK	15	Underground	✗ (Access available but lower quality)	17	44	4 Projected 20% by 2025	1

1 Total cost per month of benchmark plan/estimated download speed

2 Empty ticks reflect reduced need for high quality ducts due to presence of aerial cabling

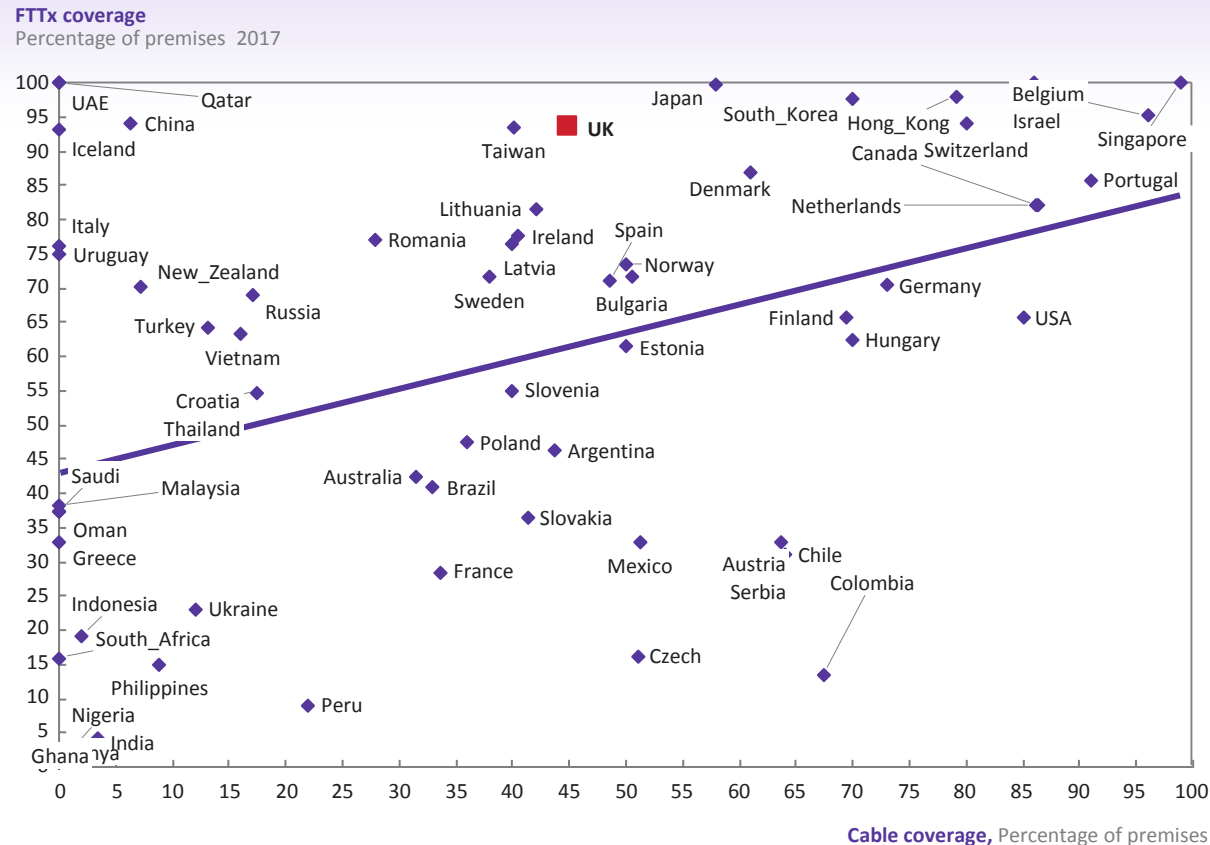
3 HFC/D3.0 covers cable operators coaxial-based networks where either optical fibre has been deployed to a node outside building and/or the D3.0 standard has been implemented in central node (ldate)

SOURCE: Akamai State of the Internet Report, OECD Broadband Portal, European Commission, 'Study on Broadband 2016' (21 September 2017); Eurostat and relevant national statistical agencies[MDU share]; Analysys Mason (FTTP coverage and take-up, '. The number or households for Spain in this graph includes 7m businesses, holiday properties and empty villas (excluding them would bring coverage to about 90%)., see disclaimer in the Annex.

The presence of cable as a competitive threat stimulates investment from fixed providers, but whether FTTP or FTTC depends on country characteristics

Comparison of FTTx (incl. FTTP and FTTC) coverage rates with cable penetration rates

Observations






- The presence of cable stimulates investment in FTTx but this can take the form of FTTP or FTTC
- Countries with higher levels of FTTP coverage have often embraced FTTP due to the presence of other 'nudge' factors:
 - high levels of MDUs,
 - high quality duct
 - regulatory policy favourable to investment (see next section on levers and market models)
 - significant government aid to accelerate the deployment of FTTP nationally
- Countries with lower levels of FTTP coverage but higher levels of FTTx coverage (Germany, Netherlands, Belgium) have focussed on non-FTTP technologies and share similar structural characteristics to the UK (lower MDU share, lower quality ducting, underground cabling, higher labour costs)
- The UK has high levels of FTTC coverage which lifts overall FTTx coverage to 93% of premises (91% - FTTC + 2% - FTTP)

SOURCE: Analysys Mason, 'FTTx roll-out and capex worldwide: forecasts and analysis 2017–2022'. The number of households for Spain in this graph excludes 7m holiday properties and empty villas (including them would increase coverage to about 90%). Please note the disclaimer in the Annex.

There are some clear lessons for each market model when considering the case studies of at-scale fibre deployment

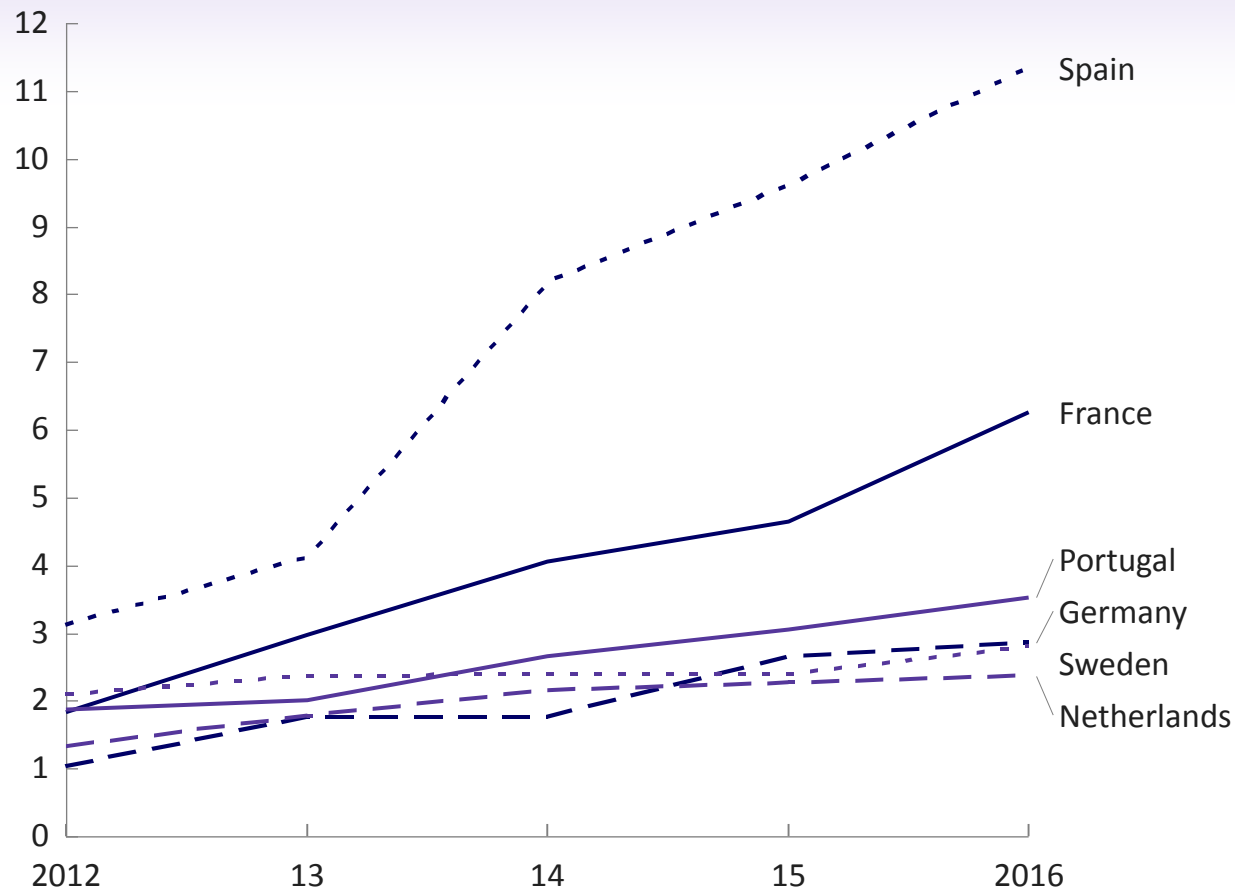
1	2	3	4	5
Regulated infrastructure competition	Nominated provider with regulatory pricing	Market-driven	Franchising	Government-led
<p>A. There are no notable examples of the regulated infrastructure competition model at a national level resulting in at-scale full fibre rollout</p>	<p>A. Countries that have opted for nominated provider models who have achieved coverage gains have also made steep public investments to assist the nominated providers (NZ, Singapore)</p> <p>B. Temporary deregulation of pricing has been an additional spur to invest (NZ)</p> <p>C. Some countries who have adopted the nominated provider model have failed to achieve desired coverage gains on time (Australia)</p> <p>D. Sometimes, nominated providers have been de facto, still with positive consumer outcomes (NTT in Japan)</p>	<p>A. There are multiple examples of countries successfully employing market-driven models in prospectively competitive areas to incentivise high levels of fibre rollout (France, Spain, Portugal)</p> <p>B. Infrastructure competition often regulated on a region-specific basis (France, Spain, Portugal)</p> <p>C. Countries often provide temporary forbearance on wholesale access requirements (especially active access) (France, Spain, Portugal) with adjustments in implementation of the regulatory approach as markets evolve</p> <p>D. Commercial arrangements for supporting investment include risk sharing through two-part tariffs/volume discounts between the incumbent and access seekers (Germany) and collaboration to minimise asset duplication (France, Spain); asset sharing achieved in the UK through duct and pole access</p> <p>E. Countries with the market-driven model do not appear less competitive at retail level</p>	<p>A. There are no notable examples of successful deployment of franchising to incentivise at-scale FTTP deployment (or equivalent NGA technology) in developed countries</p> <p>B. We have not come across examples internationally where local franchising has been used as an approach, except in circumstances of retail supply to e.g. public sector tenants which could be considered a form of franchising.</p>	<p>A. Demand-side government stimulus has been a powerful driver of rollout in countries with high FTTP coverage whether direct (government-owned wholesalers as in Sweden) or indirect (government-subsidised wholesalers as in New Zealand)</p> <p>B. Government subsidies are especially required for commercially unviable rural areas (France)</p>

Some regulators have adjusted implementation over time to ensure applicable regulation continued to reflect market developments

	Description	Subsequent adjustments
 Spain	<ul style="list-style-type: none"> During initial investments, the regulator refrained from mandating wholesale access to incumbent's (Telefonica) network at speeds above 30Mbit/s in 2009 Commercial infrastructure sharing facilitated by adjustments to regulatory framework. This facilitated in-building wiring JVs between Orange and Vodafone as well as regional reciprocal access arrangements 	<ul style="list-style-type: none"> Introduction of VULA on all speeds in 2016 in non-competitive areas to facilitate retail competition; deregulation in nine cities maintained In non-competitive areas incumbent allowed a risk premium above WACC to allow for a higher price for VULA at speeds >30Mbps; for speeds <30Mbit/s a risk premium allowed when delivered using full fibre
 New Zealand	<ul style="list-style-type: none"> Contracted FTTP providers were given a ten-year regulatory 'holiday' from price and access regulations by the NZ Commerce Commission in 2011 Only requirements to re-sell access were via government's contracts with local fibre providers 	<ul style="list-style-type: none"> Fibre will become a regulated service and will be regulated on a 'utilities basis' with price and access obligations imposed on operators by Commerce Commission (currently under legislative review) Copper services to be de-regulated
 France	<ul style="list-style-type: none"> 2009 ARCEP (French telecoms regulator) regulatory framework consciously did not apply wholesale access requirements to fibre networks in order to stimulate investment and rollout in very dense and dense areas; Commercial infrastructure sharing facilitated by adjustments to regulatory framework 	<ul style="list-style-type: none"> In 2014, ARCEP removed a wholesale access requirement in dense areas for building operators to provide an additional dedicated fibre to third-party operators (multifibre concentration point) – this was identified as a potentially onerous requirement that was slowing FTTP deployment

In Europe, only Spain (1.6m homes/year) has managed to deploy fibre to more than 1m homes/year – this indicates the difficulty of rapid, at-scale deployment

FTTP coverage by EU country, 2012-16, homes passed (m)



FTTP homes passed per year,
000s of homes, 2012-16


	Spain	1,644
	France	883
	Portugal	330
	Germany	366
	Sweden	140
	Netherlands	208

SOURCE: European Commission, 'Study on Broadband Coverage in Europe, 2016' (September, 2017)

In countries with at-scale FTTP deployment, there has been significant demand side stimulus in the form of direct public subsidy

Commercial operators can struggle to justify FTTP capex

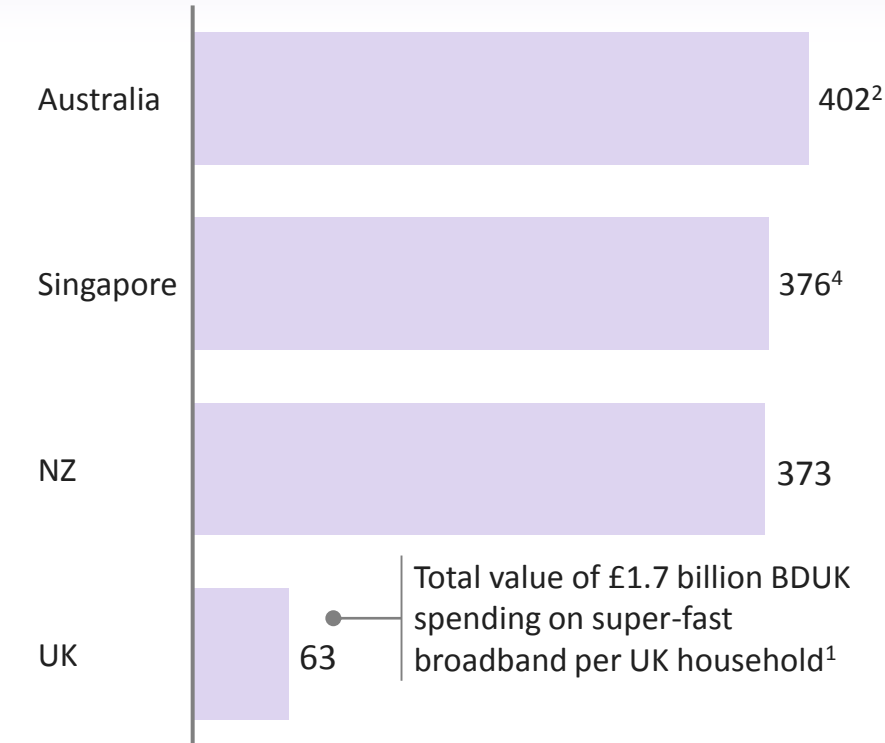
“ Altice-SFR ready to deploy very high speed throughout the territory, without public money
LesEchos 11 July 2017 ”

“ Altice abandons effort to lay its own fibre technology across France
 **REUTERS** 13 December 2017 ”

“ Why Google Fiber is no longer rolling out to new cities
The Washington Post 16 October 2016 ”

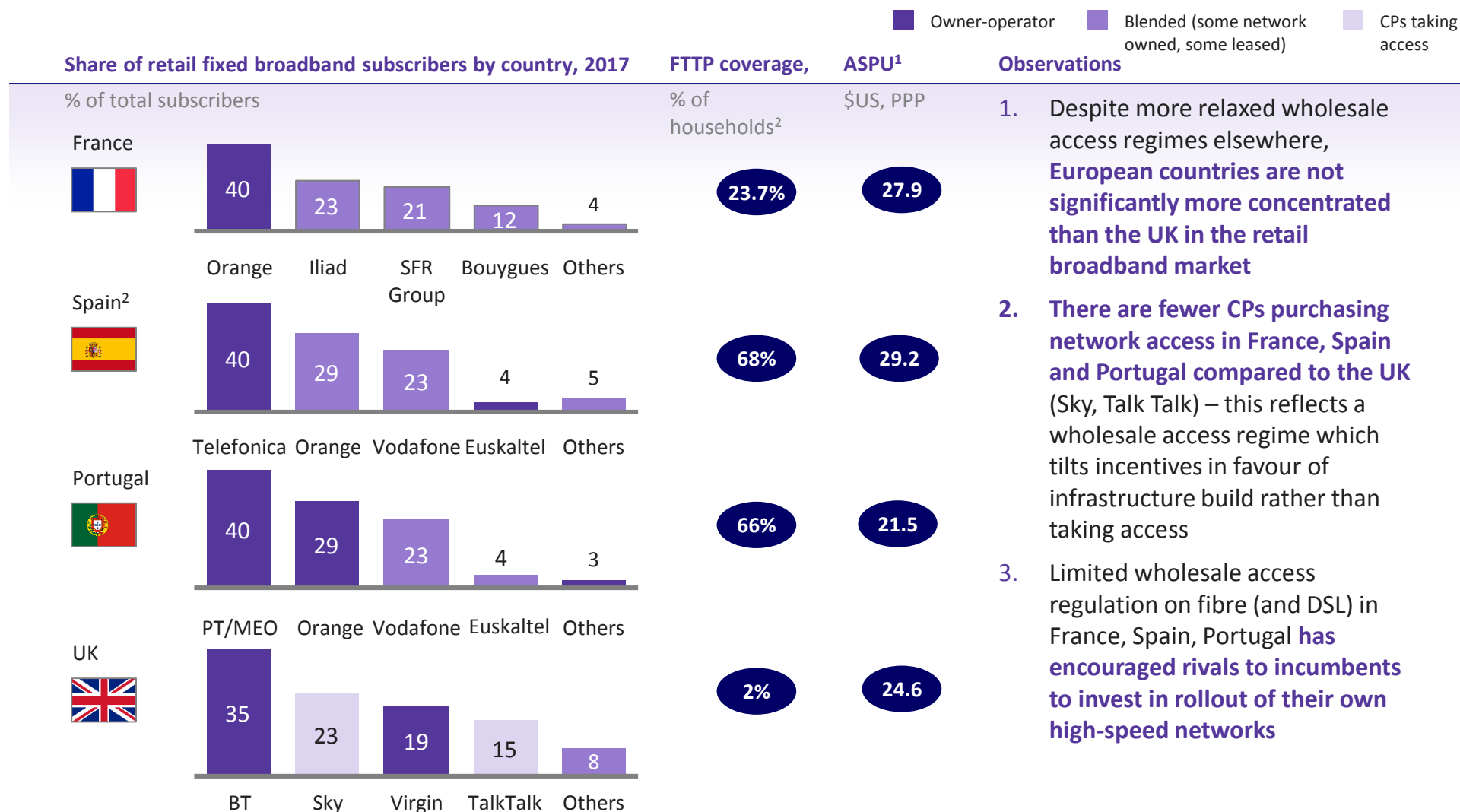
The sums invested by Government-led national provider models represent a steep premium to existing UK spending

Average level of public subsidy for fibre broadband per household, £GBP



1 House of Commons, ‘Superfast Broadband in the UK’ (March, 2017) | 2 Estimated by WikConsult at 560 euros in 2015 (exchange rate to GBP of 0.8 - £402) | 3 Estimated total public subsidy of £475m divided by 1,263m households in Singapore [Ofcom, International Case Studies (July 2015), p. 166] | 4 Estimated total public subsidy of £690m divided by 1.85m households [Ofcom, International Case Studies (July 2015), p. 44]
SOURCE: Analysys Mason (for Ofcom) ‘International Case Studies’ (July 2015) [NZ and Singapore figure]; Wik Consult, ‘Competition and Investment’ (July 2015) [Australia figure]; National statistical authorities (household figures)

Countries with market-driven infrastructure competition models are broadly as competitive as the UK



¹ Average spend per user per month, industry-wide for broadband services 2017

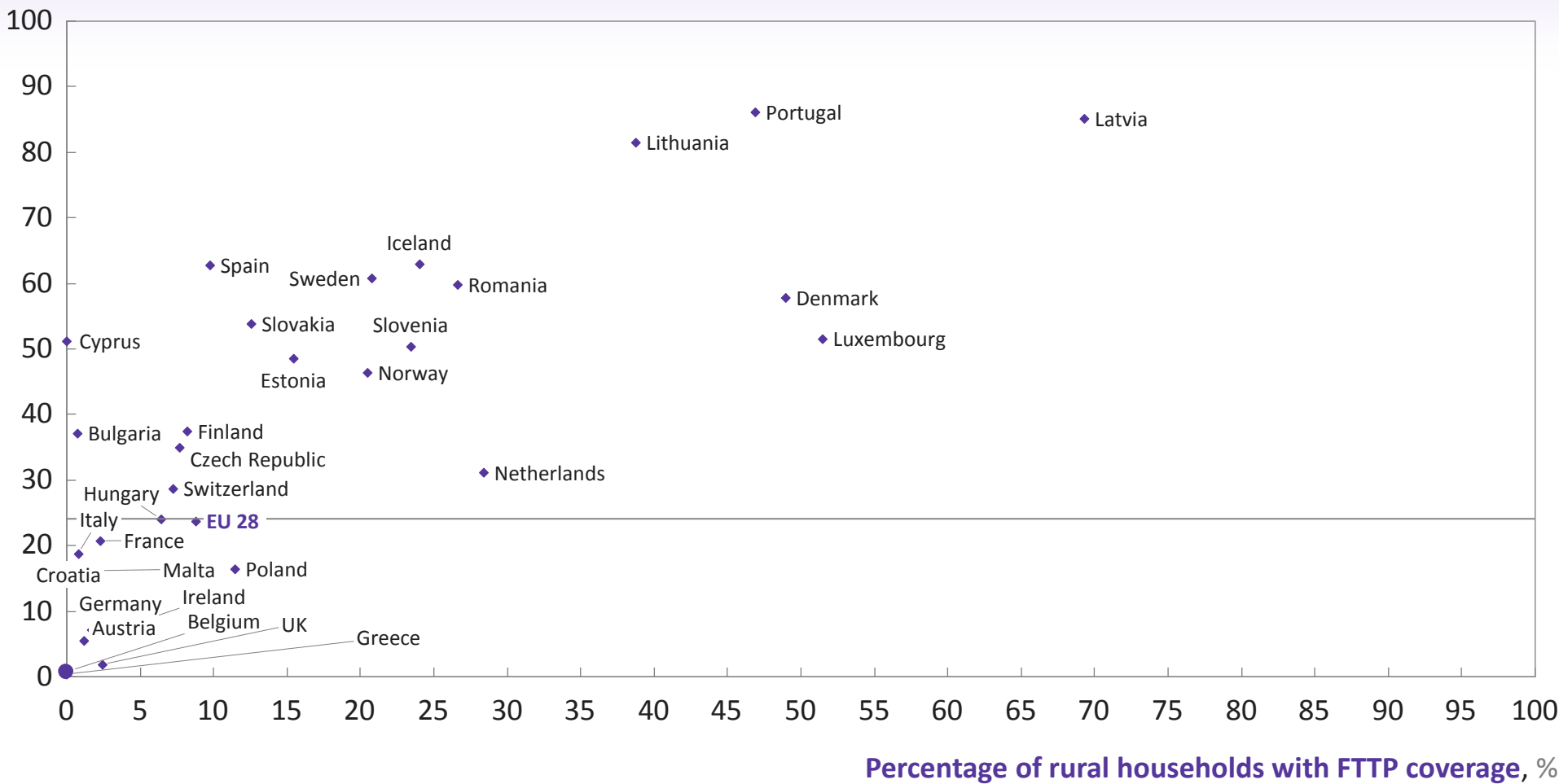
² 2016 figures (as for 2017 only estimates available at this time); coverage for Spain includes holiday villas and empty properties. Excluding them would bring coverage to 90%.

SOURCE: Analysys Mason; : European Commission, 'Study on Broadband 2016' (21 September 2017); please note the data disclaimer in the Annex.

Even countries with high levels of national FTTP coverage struggle to extend FTTP to rural areas

FTTP coverage by EU country

Percentage of national households with FTTP coverage, %



SOURCE: European Commission, 'Study on Broadband Coverage in Europe, 2016' (September, 2017)

Contents

- Fixed / mobile overview
- Levers and market models
- Learnings from international case studies
- **Evaluation of market models in UK**

Market model evaluation summary

- **Market models were evaluated in terms of social impact (investment, efficiency, prices) and impact on the industry**
- **Full fibre investments are best supported by two of the market models** (*Market-driven, and nominated provider with regulated pricing*) while two of the models (*regulated infrastructure competition, franchising/market allocation*) are less likely to incentivise rapid and cost-effective investment; the Government-led model is required in all cases:
 - *Market-driven* can drive at-scale deployment by providing greater flexibility for network rivals (including incumbents) to develop products, pricing, switchover models and risk-sharing deals to mitigate investment risk
 - *Nominated provider* (RAB model) also offers the potential to incentivise at-scale investments and can deploy cross-subsidy to fund a wide deployment
 - *Government-led* support is required in non-commercial areas for all models (although any subsidy requirement is likely to be more limited for the nominated provider model)
 - *Regulated infrastructure competition* and *franchising* models incentivise less and slower investment
- **5G investments are best supported by Market-driven models** supported by collaborative arrangements (e.g. network sharing), with Government-led being critical to address a range of barriers:
 - *Market-driven* potentially supported by commercial infrastructure collaboration promotes investment incentives and a “race to 5G”
 - *Government-led models* (including barrier busting) are required to reduce the cost of deployment
 - *Regulated infrastructure competition, nominated provider, and franchising* models do not have obvious applications in the UK mobile sector
- Overall there is a **powerful alignment in that the market-driven model has the potential to drive at-scale investment across both full fibre and 5G**, supported by government-led models for non-commercial areas and barrier-busting

Evaluation criteria for market models address relevant stakeholder priorities

Priority area





















Criteria for evaluating market models

Societal evaluation	Attract capital for fast roll-out	<ul style="list-style-type: none"> ▪ Ability of market model to incentivise investment in deployment of full fibre/5G ▪ Speed of full fibre/5G deployment ▪ Geographic extent of deployment
	Efficient delivery and quality of service	<ul style="list-style-type: none"> ▪ Total cost (to industry/consumers) of full fibre/5G deployment ▪ Incentives to provide a high quality service
	Fair and affordable prices	<ul style="list-style-type: none"> ▪ Protecting consumers from excessive prices ▪ Customer migration
Industry evaluation	Impact on BT	<ul style="list-style-type: none"> ▪ Protecting and enhancing long-term shareholder value through long-term, competitive returns ▪ Customer service and customer perceptions
	Impact on competitor (VM)	<ul style="list-style-type: none"> ▪ Protecting and enhancing long-term shareholder value through long-term, competitive returns ▪ Extent of expansion of cable footprint
	Impact on new entrants	<ul style="list-style-type: none"> ▪ Protecting and enhancing long-term shareholder value through long-term, competitive returns ▪ Ease of entry into high-speed broadband market

Full fibre: Overview of five market models against key societal criteria

	Illustrative possible market Structures (many possibilities)	Illustrative wholesale/retail price dynamic by geotype	Attract Capital for Fast Roll-Out	Fair & Affordable Prices	Efficient Delivery & Quality Service	Feasibility of creating the model
				<div><div></div></div> Dark shade ~ full marks	<div><div></div></div> Regulated wholesale price	<div><div></div></div> Likely competitor wholesale price
1	Regulated infrastructure competition <div><div><div>National Wholesaler</div><div>AltNets</div><div>Cable operator</div></div><div><div>CP1</div><div>CP2</div><div>CPn</div></div></div>	<div><div></div><div></div><div></div><div></div></div> <div>Costs</div>	<div><div></div></div> Capital deterred by uncertain investment environment and regulatory regime	<div><div></div></div> Low prices in AltNet areas, and incumbent delivers common national prices (which rise as it loses share in low cost areas)	<div><div></div></div> Competition drives efficiency and service but benefits attenuated by incumbent constraints	<div><div></div></div> Current path
2	Nominated provider with regulatory pricing <div><div><div>National Wholesaler</div><div>Cable operator</div></div><div><div>CP1</div><div>CP2</div><div>CP3</div><div>CPn</div></div></div>	<div><div></div><div></div><div></div><div></div></div> <div>Costs</div>	<div><div></div></div> Visible regulated return on RAB subject to competition from cable (e.g., VM)	<div><div></div></div> Uniform national prices at levels which will support investment	<div><div></div></div> Relies upon regulatory incentives & penalties	<div><div></div></div> Not clear how provider is designated
3	Market-driven <div><div><div>National Wholesaler</div><div>AltNets</div><div>Cable operator</div></div><div><div>CP1</div><div>CP2</div><div>CP3</div><div>CPn</div></div></div>	<div><div></div><div></div><div></div><div></div></div> <div>Costs</div>	<div><div></div></div> Investment environment more certain as regulation encourages investment and network rivals compete on level playing field	<div><div></div></div> Differentiated geo pricing, albeit at competition-driven levels	<div><div></div></div> Competition drives efficiency and quality of service; commercial flexibility to promote migration, reduce cost and share risk	<div><div></div></div> Achievable with amendments to existing regime
4	Franchising <div><div><div>W/saler – Area 1</div><div>W/saler – Area 2</div><div>W/saler – Area 3</div><div>W/saler – Area n</div><div>Cable operator</div></div><div><div>CP1</div><div>CP2</div><div>CPn</div></div></div>	<div><div></div><div></div><div></div><div></div></div> <div>Costs</div>	<div><div></div></div> Difficult to create uncontested revenue stream (assuming VM and legacy BT network are present)	<div><div></div></div> Tough to secure common national prices (without subsidies)	<div><div></div></div> Relies upon regulation but loss of economies of scale	<div><div></div></div> Complex franchising design for build and operate
5	Government-led <div><div><div>National Wholesaler</div><div>AltNet 1</div><div>AltNet 2</div></div><div><div>CP1</div><div>CPn</div></div></div> <div>Rural geotype only - Complements all Models</div>	<div><div></div><div></div><div></div><div></div></div> <div>Government subsidy will aim to bring wholesale price close to that charged in commercial areas</div>	<div><div></div></div> Critical for rural areas	<div><div></div></div> Can use competitive processes to minimise subsidy and deliver fair prices	<div><div></div></div> Service delivery specified as condition of subsidy (indirect measure)	<div><div></div></div> Extends proven BDUK model

Fixed market models evaluation: societal impacts

	1 Regulated infrastructure competition	2 Nominated provider with regulatory pricing	3 Market-driven	4 Franchising	5 Government-led
Attract Capital for Fast Roll-Out	 <ul style="list-style-type: none"> + Spur for competitors to invest in areas with favourable economics ● Incentives to enter/expand are lower elsewhere ● Multiple layers of regulation and uncertain regime discourages FFTP investments ● Access preferred over investment/supporting investment 	 <ul style="list-style-type: none"> + Spur to invest because of regulated return + Likely to attract capital reflecting stable, predictable regime 	 <ul style="list-style-type: none"> + Investment environment more certain as regulation encourages investment and incumbent competes on level playing field + Rapid development of commercial areas 	 <ul style="list-style-type: none"> ● Complex franchising model (i.e. build and operate) not likely to be bankable ● Difficult to create revenue stream to underpin a franchise given existing competition ● Complexity and implementation time leads to delayed rollout ● Market allocation (e.g. no overbuild) not consistent with infrastructure competition 	 <ul style="list-style-type: none"> + Only model to specifically address and incentivise uncommercial areas ● State aid questions to be addressed
Efficient Delivery & Quality Service	 <ul style="list-style-type: none"> + Competition helps drive down costs and improves quality ● Risk of inefficient asset duplication 	 <ul style="list-style-type: none"> + Minimum duplicated infrastructure ● Service quality relies on regulatory incentives and penalties and less on competitive pressure 	 <ul style="list-style-type: none"> + Competition helps drive down costs and improves quality + Commercial flexibility to promote migration, reduce cost and share risk 	 <ul style="list-style-type: none"> + Yardstick competition can mitigate inefficiency ● Loss of scale benefits ● Inconsistent systems and operating models 	 <ul style="list-style-type: none"> + Only effective solution to develop network in uncommercial areas
Fair & Affordable Prices	 <ul style="list-style-type: none"> ● Geographic variation in prices ● Incumbent delivers common national price (which needs to rise as it loses share in low cost areas) 	 <ul style="list-style-type: none"> + Attempts to mimic pricing of market-driven model through regulation + If implemented well, regulated returns/ pricing can keep prices low 	 <ul style="list-style-type: none"> + Commercial flexibility to promote migration, reduce cost and share risk ● Geographic variation in prices 	 <ul style="list-style-type: none"> ● Geographic variation in prices ● Reduction in scale makes franchised networks less efficient (higher prices) 	 <ul style="list-style-type: none"> + Consumer prices kept low and affordable by subsidies
Implementation feasibility	 <ul style="list-style-type: none"> ▪ Current status quo regulatory model 	 <ul style="list-style-type: none"> ▪ Not clear how provider is designated 	 <ul style="list-style-type: none"> ▪ Effective DPA regulation more important in model with greater emphasis on entry levers 	 <ul style="list-style-type: none"> ▪ Requires effective regional regulation and complex franchising arrangements 	 <ul style="list-style-type: none"> ▪ Extends proven BDUK model

Applies primarily in uncommercial areas

Fixed market models evaluation: industry impacts

Applies primarily in uncommercial areas

	1 Regulated infrastructure competition	2 Nominated provider with regulatory pricing	3 Market-driven	4 Franchising	5 Government-led
Impact on BT	<p>✗✗</p> <ul style="list-style-type: none"> Competitors 'cream skim' BT limited in capturing full end-to-end margin Geo pricing restriction limits options for responding to competition; cross-subsidies unwind 	<p>✓✓</p> <ul style="list-style-type: none"> OR is a natural choice for national nominated infra provider 	<p>✓</p> <ul style="list-style-type: none"> BT competes on a level playing field Competition means infrastructure operators may take away from BTs market share 	<p>✗✗</p> <ul style="list-style-type: none"> BT could bid BT loses commercial flexibility to deploy at scale 	<p>✓✓</p> <ul style="list-style-type: none"> BT incentivised to invest more than it otherwise would have, rolling out more fibre to more customers
Impact on competitor (VM)	<p>✓</p> <ul style="list-style-type: none"> VM may increase market share as a result of restrictions on BT to meet competition Low anchor price and regulation of BT at all levels of the supply chain reduce possible returns to investment 	<p>?</p> <ul style="list-style-type: none"> VM would continue to compete with BT as today 	<p>✓✓</p> <ul style="list-style-type: none"> Improved investment incentives as regime more favourable to infrastructure investors 	<p>✗✗</p> <ul style="list-style-type: none"> VM could bid VM's would lose market share 	<p>✓✓</p> <ul style="list-style-type: none"> VM incentivised to invest more than they otherwise would have, rolling out more fibre to more customers
Impact on new entrants	<p>✓</p> <ul style="list-style-type: none"> Entrants would aggressively invest in fibre in dense areas where they have a competitive advantage vs BT or where regulation facilitates it 	<p>✗</p> <ul style="list-style-type: none"> Entry assisted through regulation less likely 	<p>✓✓</p> <ul style="list-style-type: none"> Entrants can compete with BT and VM on a level playing field 	<p>✓</p> <ul style="list-style-type: none"> Entrants could bid 	<p>✓✓</p> <ul style="list-style-type: none"> Entrants incentivised to invest more than they otherwise would have, rolling out more fibre to more customers

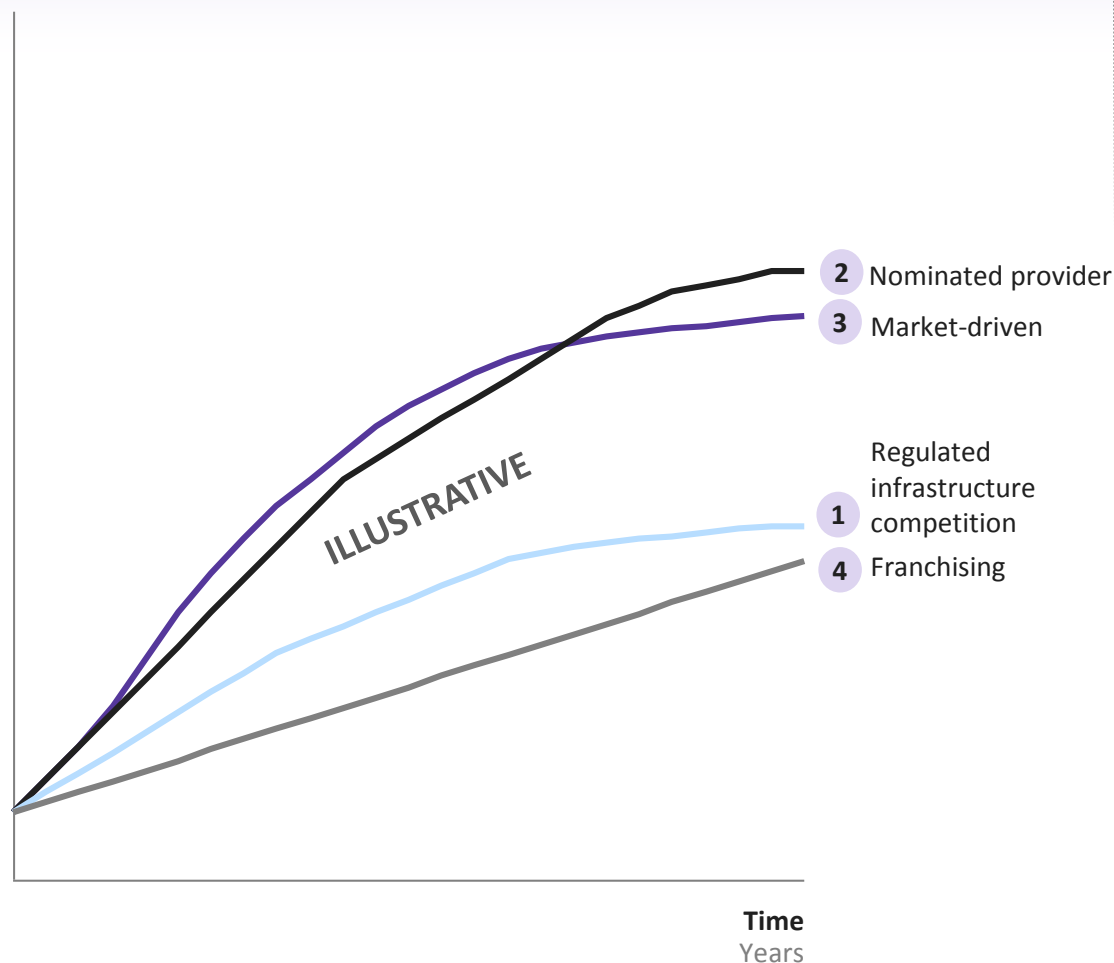
Some models are expected to drive more rapid and extensive fibre deployment than others

Diffusion of FTTP over time under different commercial market models

Explanation

FTTP deployment

% of premises passed with fibre



- 2 A **nominated provider** benefits from economies of scope and a stable and predictable regulatory regime and can rapidly invest in new areas
- 3 The **market-driven model** is likely to provide an investment boost in the lowest cost/highest value areas. Commercial flexibility to promote migration, reduce costs and share risks, together with a predictable and enduring regulatory regime which encourages investment may help the geographic scope of deployment go further
- 1 **Regulated infrastructure competition** results in quick initial deployment but wide deployment beyond the core areas is limited by lack of commercial flexibility and a regulatory regime which is unpredictable and encourages access over investment (or supporting investment)
- 4 **Franchising** may provide an initial boost, but due to smaller scale and lower commercial viability of many regions, this may not take off

Mobile market models evaluation: societal impacts

Models with positive outcomes in both fixed and mobile

	1 Regulated infrastructure competition	2 Nominated provider with regulatory pricing	3 Market-driven (with collaboration)	4 Franchising	5 Government-led
Attract Capital for Fast Roll-Out	No clear application in UK mobile market	No clear application in UK mobile market	✓✓ + Competition drives investment in coverage and capacity + Co-investment and asset sharing can promote significant savings e.g. In mobile 15% with mast-sharing, 30% with RAN –sharing, backhaul sharing; can also speed up deployment	No clear application in UK mobile market	✓ + Can address very high cost geographies not covered by spectrum license conditions ● Nation-wide “barrier busting” needed (e.g. site access, planning)
Efficient Delivery & Quality Service			✓✓ + Co-investment and asset sharing in conjunction with competition delivers high efficiency		✓✓ + Only necessary for very high cost geographies + May broaden scope for investment in commercial areas
Fair & Affordable Prices			✓✓ + Infrastructure competition leads to competitive prices in differentiated services market + Commercial co-investment can reduce cost duplication mitigating the need for price rises		✓✓ + Consumer prices kept low and affordable by subsidies, but not in a way that distorts the competitive dynamic
Implementation feasibility			✓ + Limited policy adjustments to status quo + Well established infra sharing in wireless (e.g. towers)		✓✓

Integrated market model evaluation for a joint deployment of full fibre and 5G

Models with positive outcomes in both fixed and mobile

1 Regulated infrastructure competition	2 Nominated provider with regulatory pricing	3 Market-driven	4 Franchising	5 Government-led
<ul style="list-style-type: none"> Makes large investments difficult without a clearer pro-competitive framework and level playing field Not popular globally in either fixed or mobile contexts where investment is a priority 	<ul style="list-style-type: none"> This model can work well for fixed broadband, but no clear application in mobile Potential role in fixed to accelerate full fibre investments with a wide coverage and national pricing 	<ul style="list-style-type: none"> Chosen by many countries for fixed technology investments because it allows commercial flexibility where there is actual and/or prospective competition, in turn incentivising faster and more widespread rollout Central model for 5G investments, as investors face a reasonable risk/reward tradeoff Can be complemented by commercial co-investment or infrastructure sharing (particularly in mobile) 	<ul style="list-style-type: none"> Not a popular model for international comparators for either fixed or mobile investment In fixed, franchising could lead to a lack of efficient scale and poor outcomes for customers Specific, clearly scoped franchises may work for deploying mobile technologies to some public service customers quickly 	<ul style="list-style-type: none"> For both fixed and mobile, full coverage would require some sort of government support Government support could take different forms in fixed and mobile contexts Most peer countries provide support for uncommercial investments

Appendix: Assumptions underpinning high level estimate of 5G investment

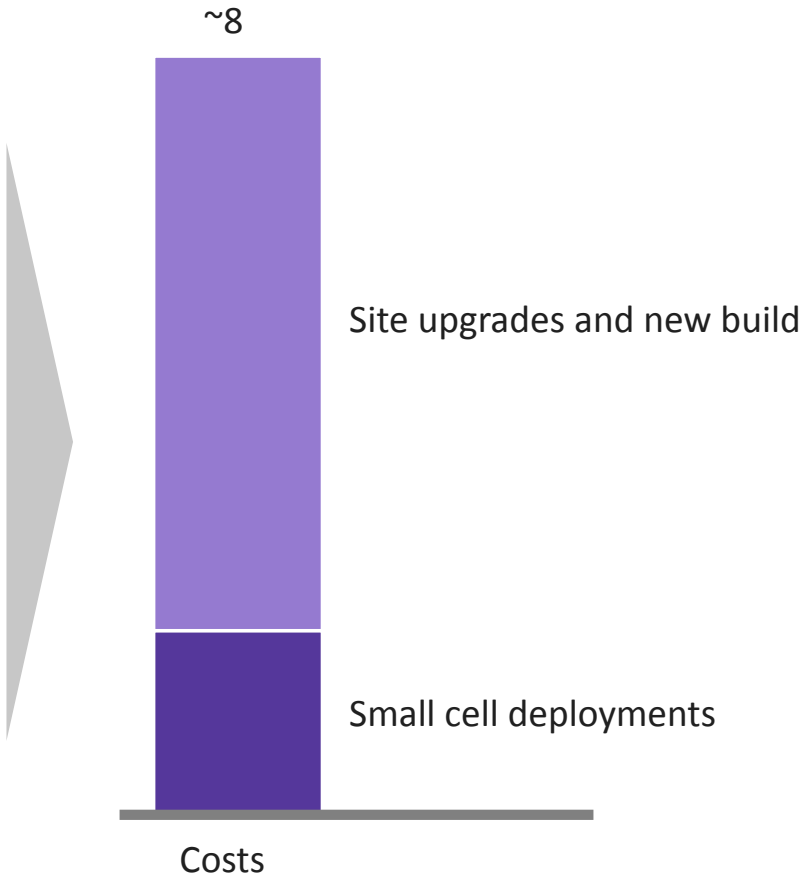
5G investment costs through 2025 could total £8bn

CALCULATIONS ARE HIGHLY PRELIMINARY AND PURELY ILLUSTRATIVE

Assumptions

- BT expects there will be 5G technology deployment through 2025 across 4 major existing carriers
- Rollout could comprise the following investments
 - ~90,000 site upgrades and new build¹
 - 200,000 small cells at est. £6k each²
- High frequency mm wave technology deployment would require a separate set of (potentially costly) investments

5G deployment cost calculations, £bn



1 includes some mobile site infrastructure upgrades good to new 5g equipment
2 Estimated 50,000 small cells per operator
SOURCES: publicly sourced: site numbers: Vodafone, EE, Hexus, Arqiva; costs: Ofcom, Senza Fili, Deloitte. Includes some BT internal estimates.

INDUSTRY AND MARKET DATA

Slides 8 and 25 above contains statistics, data and other information from Analysis Mason relating to markets, market sizes, market shares, market positions and other industry data pertaining to our business and markets. Market data and statistics are inherently predictive and subject to uncertainty and not necessarily reflective of actual market conditions. Such statistics are based on market research, which itself is based on sampling and subjective judgments by both the researchers and the respondents, including judgments about what types of products and transactions should be included in the relevant market.

We have generally obtained the market and competitive position data in this document from industry publications and from surveys or studies conducted by third party sources that we believe to be reliable. While we accept responsibility for the accurate extraction and summarization of such information, we cannot assure you of the accuracy and completeness of such information, and we have not independently verified such market and position data.

In many cases, there is no readily available external information (whether from trade associations, government bodies or other organizations) to validate market-related analyses and estimates, requiring us to rely on our own internally developed estimates regarding our industry, our position in the industry, our market share and the market shares of the various industry participants based on our experience, our own investigation of market conditions and our review of industry publications, including information made available to the public by our competitors. We and the Initial Purchasers cannot assure you of the accuracy and completeness of, and take no responsibility for, such data. Similarly, while we believe our internal estimates to be reasonable, these estimates have not been verified by any independent sources and neither we nor the Initial Purchasers can assure you as to their accuracy or the accuracy of the underlying assumptions used to estimate such data. Our estimates involve risks and uncertainties and are subject to change based on various factors.