This connect'd Isle: building on success in digital communications

A report for BT

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Executive Summary

Ofcom announced a strategic review of the digital communications market in April 2015 and published a discussion document in July 2015. The European Commission also announced a review of the telecommunications framework in May 2015. As an initial contribution to these reviews this paper assesses outcomes, future market developments and the current and prospective policy approach in the UK, with a primary focus on the fixed broadband access market.

The previous Ofcom strategic review of telecommunications, which concluded in 2005, focussed on ensuring non-discrimination and sustaining competition. The outcome was a set of undertakings by BT which implemented functional separation via the creation of Openreach and a regime centred on Equivalence of Inputs (EoI). Ofcom concluded in 2009 that the undertakings had been an effective mechanism for addressing competition concerns.

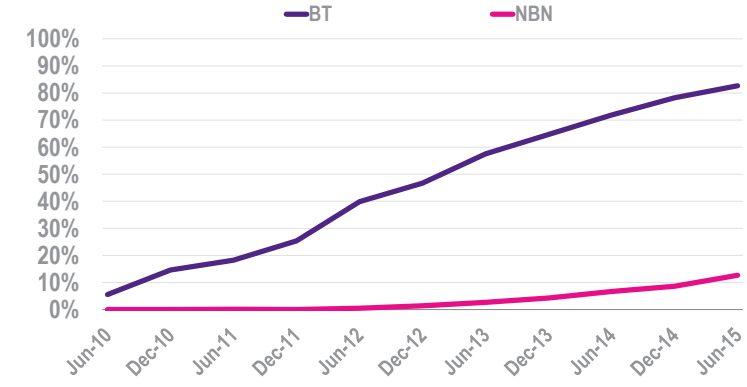
At the time of the 2005 review, Ofcom stated that it would be conducting a review of regulation for next generation access. Completion of this further review in 2009 led to a policy of pricing freedom for fibre alongside the EoI obligation established previously. In effect, Openreach could choose prices and develop its portfolio in a commercial manner, but this portfolio had to be provided on a non-discriminatory basis.

As a consequence of these policies the UK enjoys excellent outcomes in terms of broadband adoption and speeds, and intensity of internet use is world class. Fibre investment has proceeded alongside both infrastructure and service competition. Network-independent over-the top-applications now represent an important new layer of innovation and additional competition independent of access regulation.

These developments contrast with the achievements of 'more ambitious' fibre investment plans, in particular in Australia and New Zealand which both involved government direction and state subsidies. The following Figure shows the extent of the fibre deployment in Australia compared with the UK.

Fibre deployment in the UK and Australia

Premises servicable, % of total premises



Source: Plum Consulting, BT, NBN

Australia has now reviewed its choice of a national fibre to the home (FTTH) strategy, moving to a mixed technology approach including cable and fibre to the cabinet to improve the pace of delivery and to lower implementation costs.

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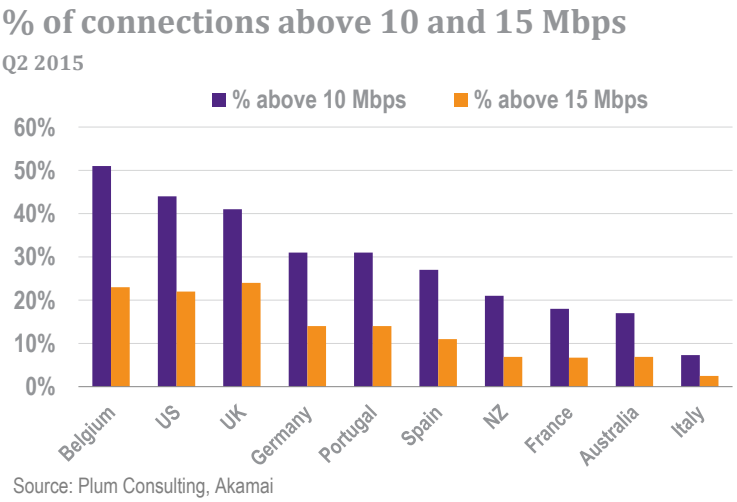
New Zealand has also pursued a national FTTH strategy and separated its incumbent's access business from downstream retail activities. Fibre deployment in New Zealand has proceeded more rapidly than in Australia, but a lack of coordination between copper and fibre price regulation has hampered fibre adoption and has undermined the fibre investment case.

The following figure shows achieved speeds above 10 Mbps and 15 Mbps where the UK leads amongst the five largest EU economies and trumps Australia and New Zealand.



The UK government plans to extend fibre access to 95% of households; and BT plans to deliver higher speeds using G.Fast technology from 2016/17. Virgin Media have announced plans to extend their cable footprint by another 4 million homes. We conclude from this that that commercial incentives, supported where appropriate by government, are working and that the UK policy approach is delivering.

Looking ahead, substantial network traffic growth can be anticipated. However, traffic growth *per se* requires additional core network capacity and not necessarily higher access speeds. In relation to access speeds, the evidence is that willingness to pay for speed diminishes sharply in the range 10 to 100 Mbps at present.

Some developments, including 4K video, will increase demand in future. However, we conclude that while demand for speeds in the low hundreds of Mbps range is plausible, this can be met via timely copper-fibre hybrid upgrades (VDSL, vectoring, G.Fast and cable DOCSIS 3.1) alongside some selective deployment of fibre to the premise where demand justifies the cost.

Against the backdrop of excellent outcomes in relation to the digital economy, calls for structural separation would involve a Pyrrhic victory, being likely to slow the pace of delivery of ultrafast broadband even if (as in Australia and New Zealand) supported by a large public subsidy.

In conclusion, a renewed commitment to fibre pricing freedom and functional separation should be made. Further, remaining policy challenges including network retirement, deregulation of services subject to over the top competition and achieving near universal broadband availability and internet use should be addressed.

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1 Introduction and context

Ofcom announced a Strategic Review of Digital Communications in March 2015[1] and published a discussion document in July 2015[2], ten years on from the 2005 Strategic Review of Telecoms. The European Commission (EC) will also this year launch a review of the European Telecommunications Framework.

The Ofcom review will examine competition, investment, innovation and the availability of products in the broadband, mobile and landline markets. Ofcom anticipates that the review will focus on three aspects in particular:

- Ensuring the right incentives for private-sector investment.
- Maintaining strong competition and tackling obstacles or bottlenecks that might be holding the sector back.
- Identifying whether there is scope for deregulation in some areas.

The EC have also raised a question over how we future proof broadband connectivity and the broadband targets that may be appropriate beyond 2020.[3]

Whilst outcomes and policy are continually under assessment, 2015 may be a key year in deciding the future direction of policy and regulation for digital communications in Europe and in the UK. We consider policy development and outcomes in the UK as a contribution to reviews by Ofcom and the European Commission.

Immediate reactions to the announcement of the strategic review tended to focus on the question of whether structural separation is justified. TalkTalk, Sky and CityFibre argue in favour of structural separation on grounds that it would promote both competition and investment. CityFibre argue that "*the UK communications market is underperforming with one of the lowest shares of fibre-connected buildings in Europe*".[4] We address the question of separation and investment incentives in the broader context of questions in relation to outcomes, future market development and policy.

This report is structured as follows:

Section 2 considers policy development to date.

Section 3 considers outcomes to date.

Section 4 assesses whether the approach is future proof.

Section 5 considers structural separation.

Section 6 provides reflections on the policy.

[1] Ofcom. March 2015. "Ofcom announces Strategic Review of Digital Communications." http://media.ofcom.org.uk/news/2015/digital-comms-review/

[2] Ofcom. July 2015. "Strategic Review of Digital Communications: Discussion document." http://stakeholders.ofcom.org.uk/consultations/dcr-discussion/

[3] Günther H. Oettinger. April 2015. "How do we future-proof Europe's broadband connectivity?" http://ec.europa.eu/commission/2014-2019/oettinger/blog/how-do-we-future-proof-europes-broadband-connectivity_en

[4] CityFibre. March 2015. "CityFibre response to Ofcom Strategic review announcement." http://www.cityfibre.com/news/2015/3/13/cityfibre-response-to-ofcom-strategic-review-announcement

2 Policy development

Before reviewing policy and outcomes on a forward looking basis we review how policy, including the 2005 Ofcom Strategic Review of Telecoms, developed, what it was intended to achieve and the findings of previous assessments.

2.1 Ofcom Strategic Review of Telecoms (2005)

The concern at the time of the 2005 strategic review was not with competition *per se*, but its sustainability. In Phase 2 of the strategic review future competition was thought to be under threat due to the transition from voice to broadband, the lack of consolidation and anticipated efficiency gains by BT (Figure 2-1).[5]

Figure 2-1: Ofcom concerns in 2005 regarding the sustainability of competition

"Each of these sources of competitive advantage is in decline. BT is becoming more efficient and enjoys greater scale economies than its competitors, competition has eroded margins and BT is now proposing to invest in a state-of-the-art new core network. Paragraph 1.12

This decline is taking place as the industry is undergoing a significant transition from voice and other narrowband services delivered via the Public Switched Telephone Network (PSTN), to broadband services delivered over new IP networks. The margins generated by these new services seem to be significantly lower than those generated historically by more established services. This transition has major consequences for all market participants including BT; but for BT's competitors, it is bringing into sharp relief the unsustainability of the current situation. Paragraph 1.13

The status quo is one in which alternative operators to BT are struggling to compete with BT in fixed markets. The Altnet sector has yet to consolidate as many have predicted. The financial challenges faced by many alternative network operators have increased as the equity, debt and bond markets have adjusted their view of the potential of those businesses. Yet just at the time when investment funds are badly needed – by Altnets to invest in new networks to remain competitive with BT, and by the nation itself to remain competitive with other countries – those funds may not be available." Paragraph 1.14

The 2005 review concluded with a new framework for competition in the market and led, via undertakings by BT, to the creation of Openreach in January 2006 - a functionally separated entity committed to non-discrimination and Equivalence of Inputs (EoI) for key products, and behavioural rules.[6]

The 2005 review did not address issues in relation to fibre investment which were evaluated over the following three years, with Ofcom noting in the Final Statement that:

> *"…upon completion of the Telecoms Review, Ofcom will be undertaking a strategic review of next generation access."* Paragraph 6.16.

[5] Ofcom. November 2004. "Strategic Review Telecommunications Phase 2 consultation document." http://stakeholders.ofcom.org.uk/consultations/telecoms_p2/

[6] Ofcom. September 2005. "Final statements on the Strategic Review of Telecommunications, and undertakings in lieu of a reference under the Enterprise Act 2002" http://stakeholders.ofcom.org.uk/consultations/statement_tsr/

2.2 Consideration of structural vs. functional separation (2005)

In 2005, Ofcom's preferred approach in relation to the question of structural or operational separation of BT (a question that had been raised at various times since the privatisation of BT in 1984) was equality of access, involving both equivalence at the product level and organisational changes by BT.

> *TSR Phase 2 Condoc: Ofcom conclusion on separation:*
>
> *"In our view, the economic arguments for and against separation are finely balanced, but there are strong practical arguments for avoiding the costs and disruption involved in a protracted break-up process if at all possible. However, for the separation issue to be finally laid to rest, it will be necessary to see real evidence of progress towards a regime which guarantees real equality of access. Only where all stakeholders see real evidence of this is it realistic to expect demands for break-up to subside. In common with the majority of respondents to our Phase 1 consultation, we would prefer a solution which delivered equality of access without the disruption and costs of BT's structural separation. However, should such an approach not deliver the results required of it, structural separation may in the long term be the only viable option." Paragraph 5.27*

Ofcom also concluded that the Undertakings were appropriate to address its competition concerns, and that it was not worth enforcing a stricter degree of separation:

> *"A more restrictive set of obligations on BT would come at a cost in terms of flexibility, practicability and efficiency. In particular, in Ofcom's view it would not be proportionate at this time to seek the structural separation of the BT group, a remedy which would in principle be available to the Competition Commission following a reference. We perceive that there are some benefits to consumers from BT's vertical integration, and the package of proposed undertakings seeks to retain these while addressing the adverse effects of vertical integration on competition."*[7] Paragraph 5.61.

2.3 Assessment of strategic review outcomes (2009)

In May 2009 Ofcom carried out an assessment of the 2005 review, concluding that:[8]

> *"Since our last review, and nearly four years on since the Undertakings were given, our annual evaluation continues to indicate that the net effect of the Undertakings to date, both for competition and consumers has been positive…It is our view that the Undertakings continue to remain an effective mechanism for addressing competition concerns."* Paragraph 1.5.
>
> *"While not the sole contributing factor to benefits experienced by consumers and businesses, we consider that the Undertakings have played a role in bringing about greater choice and take-up of services, choice of suppliers, products and packages and increased value for money. Competition has played an important factor in the take-up of fixed telecommunications services."* Paragraph 1.7.

[7] Ofcom. June 2005. "Notice under Section 155(1) of the Enterprise Act 2002." http://stakeholders.ofcom.org.uk/binaries/consultations/sec155/summary/sec155.pdf

[8] Ofcom. May 2009. "Impact of the Strategic Review of Telecoms." http://stakeholders.ofcom.org.uk/telecoms/policy/bt-undertakings/impact-strategic-review/

Ofcom (May 2009) also concluded that BT had *"shown continued commitment and focus in implementing the Undertakings."*

2.4 Adoption of fibre pricing freedom (2009/2010)

At the time of the 2005 Strategic Review it was recognised that the appropriate regulatory approach for fibre investment remained to be resolved. The concept of anchor product regulation was first proposed in 2007.[9]

In March 2009 Ofcom signalled their intent to forebear from applying price controls to fibre since both cable competition and the "anchor price" of regulated current generation access would act as a constraint on next generation access pricing.[10]

The CEO of BT Ian Livingston was reported to have responded: *"Today's announcement gives us the green light to push ahead with our £1.5bn superfast investment plans to reach at least 40% of UK households by 2012"*.[11] Ofcom formally adopted fibre-pricing freedom in 2010[12], and re-affirmed the approach in 2014.[13] BT launched the infinity fibre based broadband service in January 2010 and the extent of investment was subsequently increased.

2.5 VULA and scope for service-price differentiation

Virtual unbundled local access (VULA) was adopted given the technical and economic constraints of fibre unbundling.

An objective in relation to VULA was to maximise scope for downstream differentiation. An active wholesale product also allows tiered pricing, as Ofcom noted in the March 2009 statement on delivering superfast broadband:

> *"…allowing tiered pricing where the network operator is able to charge different prices for different quality services could have the beneficial effect of resulting in higher consumer take-up of services. In particular, a network operator, could for example, in the context of next generation services, price the highest quality next generation access products above average cost and price lower quality next generation access products below average cost. In addition to the potential to increase consumer take-up, allowing different prices to be set and higher returns to be made on the highest quality products may also create efficient incentives to invest in next generation access." Paragraph 8.29.*

[9] Brian Williamson. 2014. "Anchor product regulation – a new regulatory tool." *Info*. Volume 16(5).

[10] Ofcom. March 2009. "Delivering super-fast broadband in the UK Promoting investment and competition." http://stakeholders.ofcom.org.uk/binaries/consultations/nga_future_broadband/statement/statement.pdf

[11] http://news.bbc.co.uk/1/hi/technology/7919904.stm

[12] Ofcom. October 2010. "Review of the wholesale local access market." http://stakeholders.ofcom.org.uk/binaries/consultations/wla/statement/WLA_statement.pdf

[13] Ofcom. June 2014. "Fixed access market reviews: wholesale local access, wholesale fixed analogue exchange lines, ISDN2 and ISDN30 – Volume 1 – Statement." http://stakeholders.ofcom.org.uk/binaries/telecoms/ga/fixed-access-market-reviews-2014/statement-june-2014/volume1.pdf

2.6 Openreach boundary changes (2009)

As the market developed issues arose in relation to the boundary of functional separation. In particular, following the decision by BT to invest in fibre, Ofcom agreed to a variation of the undertakings allowing Openreach to control and operate the electronic equipment necessary to provide services using fibre to the cabinet (FTTC).[14] This illustrates the value of the flexible approach inherent in functional, as opposed to structural, separation.

2.7 EC costing & non-discrimination recommendation (2013)

The recommendation promotes copper price stability with the aim of convergence across Europe on an €8-10 range in real terms and allows for fibre pricing freedom subject to competition from competing platforms and/or a copper anchor product and non-discrimination requirements. The recommendation also notes that wholesale pricing flexibility is necessary to allow retail differentiation:[15]

> *"…pricing flexibility at wholesale level is necessary to allow both the access seeker and the SMP operator's retail business to introduce price differentiation on the retail broadband market in order to better address consumer preferences and foster penetration of very high-speed broadband services."* Paragraph 49.

The accompanying impact assessment noted that functional separation is an "exceptional" measure:

> *"As an exceptional measure, NRAs may impose functional separation – an obligation which obliges SMP operators to separate the access division controlling the communication network from the SMP operator's service branch – but only if the imposition of standard remedies has failed to achieve effective competition."* Section 1.1.

Whilst not a review of the UK approach *per se*, the conclusion of the EC review effectively endorsed the UK's broad policy approach in relation to fibre pricing flexibility, and did not advocate structural separation as a remedy.

2.8 Phase out of local loop unbundling cross subsidy (2014)

In 2014 Ofcom[16] announced the phase-out during 2014-2017 of an effective cross subsidy[17] to local loop unbundling. This indicates the maturity of competition and signals a shift in focus towards fibre.

[14] Ofcom. June 2009. "Variation to BT's Undertakings under the Enterprise Act 2002 related to Fibre-to-the-Cabinet." http://stakeholders.ofcom.org.uk/binaries/consultations/fttc/statement/statement.pdf

[15] https://ec.europa.eu/digital-agenda/en/news/commission-recommendation-consistent-non-discrimination-obligations-and-costing-methodologies

[16] Ofcom. June 2014. "LLU and WLR Charge Controls". http://stakeholders.ofcom.org.uk/binaries/telecoms/ga/fixed-access-market-reviews-2014/statement-june-2014/volume2.pdf

[17] Plum. February 2014. "Mind the gap: why the MPF vs WLR+SMPF price differential should be aligned with costs immediately". http://www.plumconsulting.co.uk/pdfs/Plum_Feb2014_mind_the_gap_MPF_vs_WLR_and_SMPF.pdf

2.9 Conclusion

The 2005 strategic review focussed on ensuring that competition would be sustained, and did not address fibre investment. In 2009/2010 Ofcom addressed fibre investment incentives by adopting anchor product regulation, leaving wholesale fibre pricing unregulated. Fibre investment followed, with one of the more rapid deployments globally.

Following review in 2009 Ofcom concluded that outcome of the 2005 strategic review had been a success; whilst in 2013 the EC recommendation on costing and non-discrimination implicitly endorsed the approach. Ofcom also reaffirmed anchor product regulation in 2014.

3 The digital economy and communications are thriving

In this section we consider connectivity and other metrics related to the use and benefits from use of digital communications.

3.1 Lies, damn lies and statistics

There are a range of metrics to measure connectivity outcomes, and some of those in use today are misleading or beside the point:

- In relation to the availability of fixed broadband, per capita adoption is sometimes reported (OECD). This is not meaningful as the household is the unit of consumption of fixed broadband and household size varies across countries. We report per household adoption.
- In relation to fibre availability, fibre to the premise alone is sometimes reported (OECD, Fibre to the Home Council). This is misleading given the step change from ADSL to hybrid technologies including VDSL and G.Fast. We report availability of a mix of technologies.
- In relation to speed, advertised speeds are sometimes reported (OECD and EC DESI index). These may differ significantly from actual speeds with the differences varying by country. Measures of actual speeds include user opt-in tests (Ookla), server side assessments (Akamai) and line speed tests using installed equipment (SamKnows). We report both SamKnows results for the UK and Akamai results for a cross country comparison.
- In relation to prices, the standalone broadband price (leaving aside line rental) is sometimes reported (EC DESI index and Ofcom ICMR). As the balance between line rental and broadband charge varies by country, and as fixed broadband rather than telephony becomes the primary reason for having a fixed line, this is misleading. We consider overall service prices.

Indicators identified as misleading continue to be utilised and may paint a biased picture. Ofcom and the government should encourage the use of appropriate metrics and discourage the use of misleading metrics.

3.2 Outcomes vs. outputs vs. inputs

Capital and other inputs are utilised to produce communications outputs such as broadband connectivity and communications services. These in turn generate outcomes including personal communications benefits in terms of productivity and income growth (in combination with other inputs including computers and investment in intangibles including knowledge and business processes).

It is helpful to keep these concepts distinct and to give appropriate weight to outcomes (benefits and proxies for benefits) versus outputs (network performance metrics). Reliance on inputs such as capital expenditure as a proxy for outputs or outcomes can be particularly misleading. If more can be obtained from less, then consumer and citizen benefits are increased. An illustration of this is the

rejuvenation of copper based broadband access via the use of more advanced coding and computing coupled with partial fibre extension.[18] We therefore do not report inputs.

3.3 A caution regarding league tables and "competitiveness"

International league tables encourage a 'higher is better' interpretation. However, for a given country the costs of reaching the top of the league table may exceed the benefits, meaning that reaching the top of the league table is a worse outcome overall.

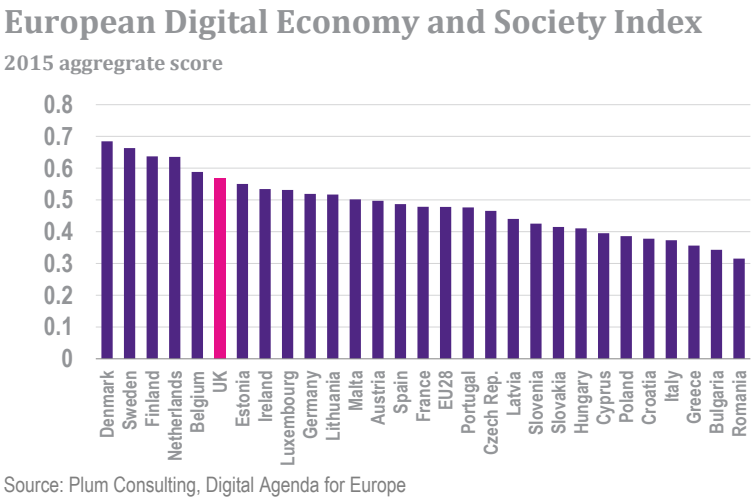
Improving connectivity outcomes also involves opportunity costs – e.g. if money is spent to improve connectivity, it cannot be used to improve, say, healthcare (or results in higher taxes and/or debt). Aiming to be top of the league table may therefore prove damaging to "competitiveness" when the costs and foregone opportunities involved are taken into account. League tables should be interpreted with caution.

3.4 Connectivity and digital economy indices

Connectivity and digital economy indices summarise a number of metrics and are widely reported. They have the virtue of summarising a range of metrics, but the disadvantage of being influenced by the choice and weights attached to individual metrics, and may combine inputs (e.g. fibre), outputs (e.g. speed) and outcomes (e.g. the impact of internet use) - thereby combining ends and means.[19]

Figure 3-1 shows the UK rank in terms of the European Commission Digital Economy Index (DESI). The UK ranks above the five largest economies in Europe and 6th overall.

Figure 3-1



Source: Plum Consulting, Digital Agenda for Europe

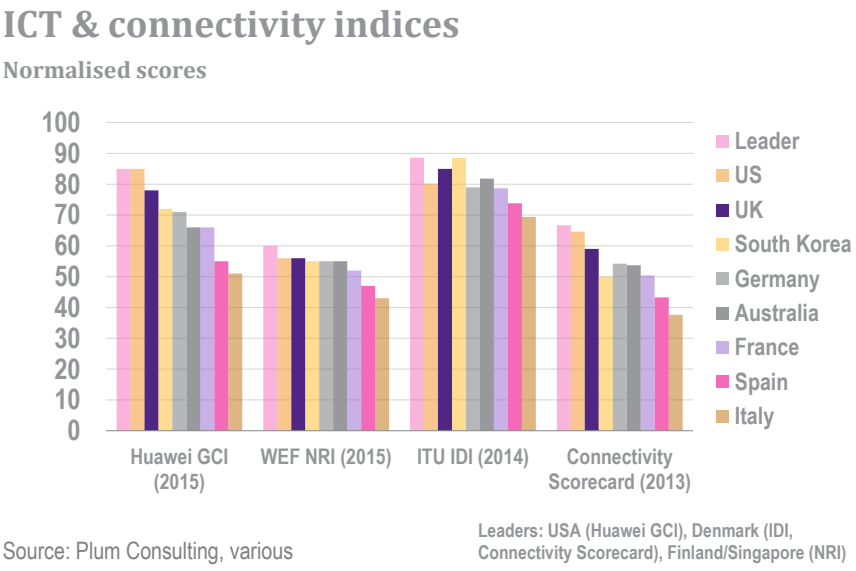
[18] The extraction of speed gains from copper utilising improved computing and coding may be symptomatic of a broader development whereby software and intelligence extend the capability of capital. Our prior notions of economically healthy levels of investment in the economy and in the telecoms sector may need to be re-examined in light of this.

[19] Plum. June 2012. "Connectivity metrics for a converged era".
http://www.plumconsulting.co.uk/pdfs/Plum_June2012_Connectivity_metrics_for_a_converged_era.pdf

However, the UK is relatively weak, but above average, in the "Integration of Digital Technology" sub-index of the DESI.[20] The UK scores third from bottom on the use of enterprise resource planning software and second from bottom on the use of RFID for business purposes.

Other indices, which also include countries outside Europe, are described in Appendix A. Figure 3-2 shows four such indices and the comparison of the UK alongside a number of countries (and the leader for each index). The UK rates highly on all of these indices.

Figure 3-2



The UK also ranks highly on an index of e-trade readiness for G20 countries developed by the Economist Intelligence Unit on behalf of eBay.[21] Further, London ranked second in the world after Stockholm on Ericsson's Networked Society City Index.[22]

3.5 Broadband adoption

The UK has high fixed broadband adoption, as shown in Figure 3-3. In addition, 10% of householders in the UK have mobile internet access and no fixed broadband at home.[23]

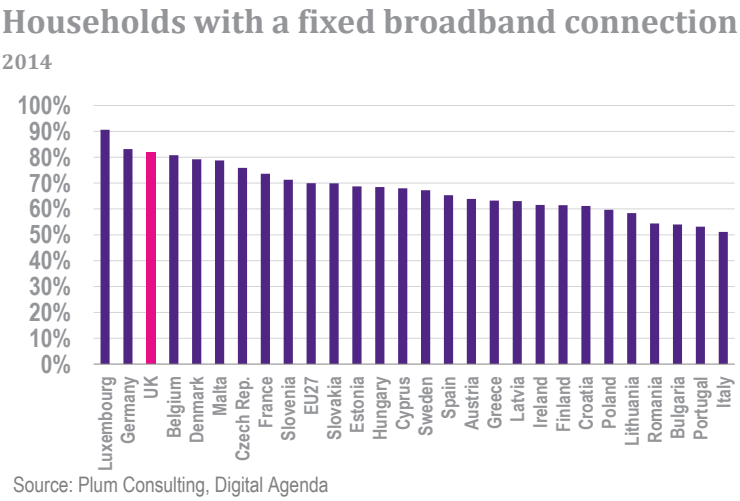
[20] http://ec.europa.eu/digital-agenda/en/digital-economy-and-society-index-desi

[21] Economist Intelligence Unit. 2014. "The G20 e-Trade Readiness Index." http://www.ebaymainstreet.com/sites/default/files/G20-etrade-Readiness-Index.PDF

[22] Ericsson. 2014. "Networked Society City Index 2014" http://www.ericsson.com/res/docs/2014/networked-society-city-index-2014.pdf

[23] https://ec.europa.eu/digital-agenda/en/news/e-communications-household-survey-and-telecom-single-market-survey-roaming-results-special

Figure 3-3

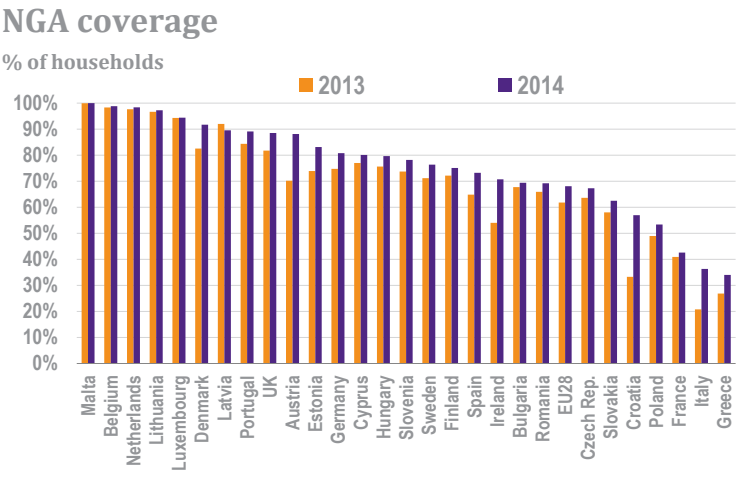


Source: Plum Consulting, Digital Agenda

3.6 Next generation access availability

Figure 3-4 shows next generation access (NGA) availability including cable, FTTH and FTTC.

Figure 3-4



Source: Plum Consulting, Digital Agenda Scoreboard

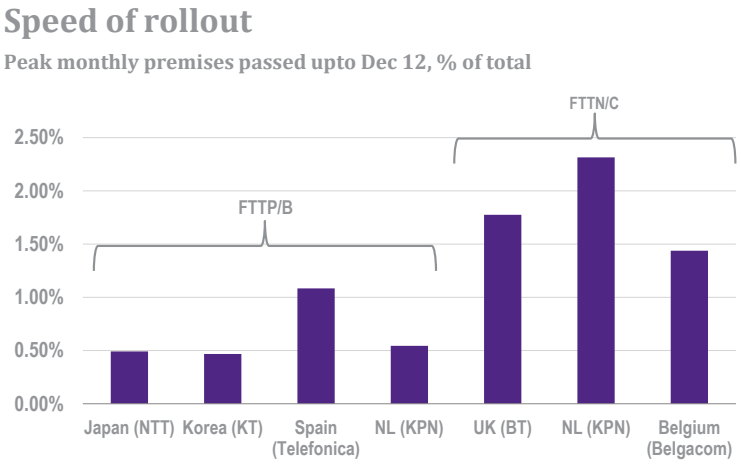
Some countries, including Malta, Belgium and the Netherlands, have cable networks that are near universal and therefore have high NGA coverage. The UK has partial cable coverage, but is extending the NGA footprint with fibre, rising from a rank of 12th in 2012 (not shown) to 9th in 2014.

With continued investment the UK is expected to move to over 95% NGA availability by 2017.[24] Virgin Media have also announced plans to extend their cable footprint to two-thirds of households.[25]

3.7 Pace of fibre deployment

Figure 3-5 shows that BT has deployed fibre rapidly, and that fibre to the cabinet can be deployed more rapidly than FTTH - a key benefit of FTTC. [26]

Figure 3-5



Source: Plum Consulting, NBNCo

Focussing on the UK (predominantly FTTC) versus Australia (FTTH) it is evident that a marked difference in the pace of deployment has been sustained over time (Figure 3-6). By January 2015 fibre deployment had reached over 75% of UK households and BT had announced plans to deploy faster G.Fast technology from 2016/17.[27] Australia, recognising the high cost and slow pace of FTTH deployment, switched to a mixed approach involving FTTH and FTTC.

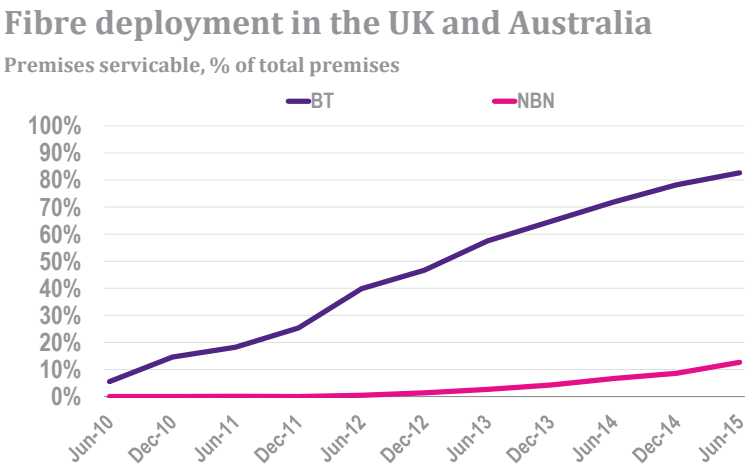
[24] https://www.gov.uk/government/publications/the-digital-communications-infrastructure-strategy/the-digital-communications-infrastructure-strategy

[25] http://about.virginmedia.com/press-release/9467/virgin-media-and-liberty-global-announce-largest-investment-in-uks-internet-infrastructure-for-more-than-a-decade

[26] Page 77: http://www.nbnco.com.au/corporate-information/media-centre/media-releases/strategic-review.html

[27] http://www.btplc.com/News/ResultsPDF/q415-release.pdf

Figure 3-6

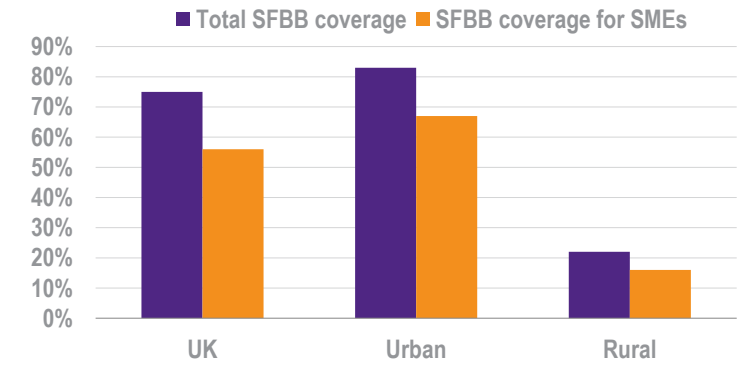


Source: Plum Consulting, BT, NBN

3.8 SME connectivity

Ofcom report that 85% of SMEs say they are well served by the communications market. As of June 2014, superfast broadband for enterprises lagged behind total superfast coverage for the UK (56% versus total coverage of 75%) – see Figure 3-7.[28] Total superfast broadband coverage for the UK is now 83%.[29]

Figure 3-7



Source: Plum Consulting, Ofcom Infrastructure Report 2014

[28] Ofcom. Infrastructure Report 2014. http://stakeholders.ofcom.org.uk/binaries/research/infrastructure/2014/infrastructure-14.pdf

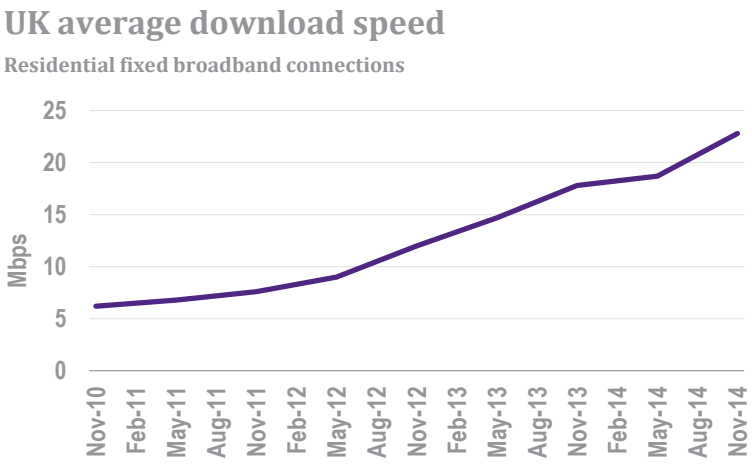
[29] Ofcom. Communications Market Review 2015. http://stakeholders.ofcom.org.uk/binaries/research/cmr/cmr15/CMR_UK_2015.pdf

Research by the Broadband Stakeholder Group indicates that one barrier to greater digital adoption by SMEs may be awareness and skills.[30] Businesses that have been in operation for more than five years are less likely to take advantage of internet services and applications.

3.9 Fixed access speeds

Improvements to ADSL and adoption of fibre and cable broadband have led to a progressive increase in the UK's average connection speed. According to SamKnows, the UK's average fixed broadband line speed has risen four-fold since 2010.

Figure 3-8:



Source: Plum Consulting, Ofcom/SamKnows

However, the choice of speed metric depends on the purpose and data availability. SamKnows measures line speed, but does not provide the cross country comparison we were seeking. We therefore utilise the Akamai measure of speed for the reasons set out in Figure 3-9.

[30] BSG. November 2014. "Broadband usage among micro businesses." http://www.broadbanduk.org/wp-content/uploads/2014/11/BSG_Micro-Businesses-Report-and-FW_17-November-2014_Final.pdf

Figure 3-9: Choice of broadband speed metrics

SamKnows rely on hardware measurement equipment installed in a representative sample of households, which tests the user's connection. According to Yoo (2014), "*The consensus is that the SamKnows methodology is superior to other commercially available measures of average download speed, and that Akamai is likely the second best source of data*".

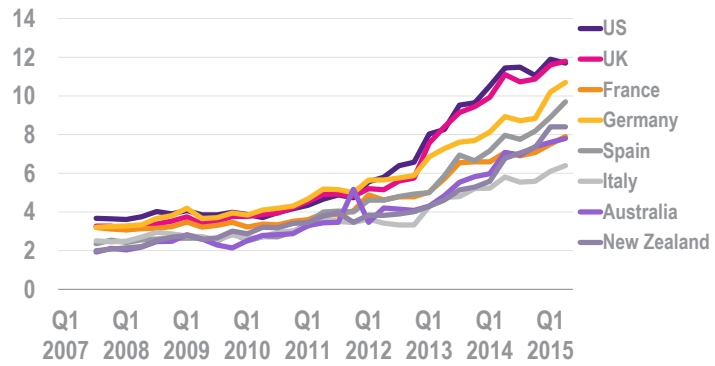
For our comparison with other countries, we nevertheless use Akamai data because the SamKnows data is for Europe provides speeds by technology, but not aggregate speeds. An end-to-end measure also has the merit of reflecting the overall user experience. The Akamai content delivery network delivers 15-30% of all internet traffic. Ookla, a commonly used source for speed data, suffers from a smaller number of servers, a smaller sample size and potential biases arising from user self-selection.

SamKnows test the line speed whereas Akamai collect data on the actual speed experienced by the end user. This is likely to be lower than the line speed for several reasons.[31] Firstly, a browser is likely to open multiple connections to Akamai for pieces of content, which compete for bandwidth but will be measured individually by Akamai. Secondly, the connections used to download smaller files may be short-lived enough that they do not reach maximum throughput rates. Third, a unique IP address may serve multiple devices behind a single Internet connection, and each device may only have a share of this connection. End user speeds will also be constrained by the capabilities of the user's Wi-Fi connection and device. For these reasons, the Akamai speeds are lower than line-based measures.

The average user speed in the UK is the highest amongst the EU-5, on a par with the US and significantly higher than speeds experienced in Australia and New Zealand.[32]

Figure 3-10

Average connection speed, Mbps



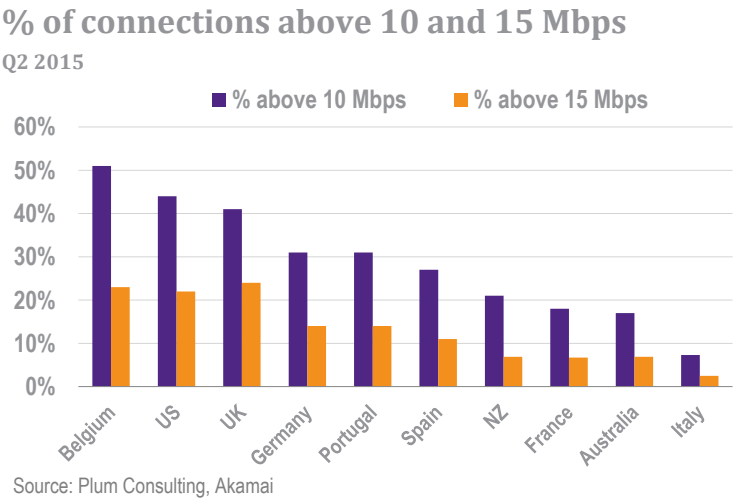
Source: Plum Consulting, Akamai

Figure 3-11 shows the proportions of connections achieving 10 and 15 Mbps thresholds (the thresholds Akamai report).

[31] https://blogs.akamai.com/2013/04/clarifying-state-of-the-internet-report-metrics.html

[32] Rankings based on the Ookla NetIndex are broadly similar with the exception of France with speeds reported to be significantly faster than the UK's (43 Mbps vs 31 Mbps). However, SamKnows (October 2013, Quality of Broadband Services in the EU) finds that DSL speeds are higher in the UK than in France. Further, based on Digital Agenda data, DSL comprises 90% of fixed broadband connections in France versus 81% in the UK, with the remaining percentage made up of cable and fibre. It therefore appears unlikely that France's speeds would be higher than the UK's.

Figure 3-11



The UK leads for connections above 15 Mbps and is third for speeds above 10 Mbps.

3.10 Fixed broadband prices, competition and service quality

Whilst we compare prices below we note that lower prices *per se* are not necessarily indicative of better outcomes. Lower prices may, for example, be associated with lower quality of service than consumers would prefer.

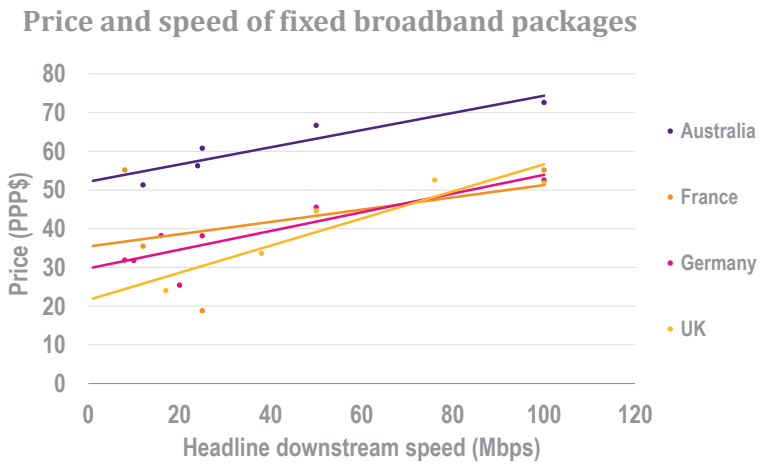
Prices should therefore be considered alongside the level of service delivered. If a single metric is to be compared we consider that quantity measures, including adoption, are superior to prices because they reflect both value and price (see Appendix B).

3.10.1 Prices and costs

Prices are difficult to compare because of differences in the way they are presented and because of other considerations such as data caps. Nevertheless, we report price comparisons from Communication Chambers for Google in relation to speed (the dataset is for December 2014).[33] As shown in Figure 3-12 the UK compares well.

[33] http://policybythenumbers.blogspot.co.uk/2015/02/global-broadband-pricing-study-updated.html

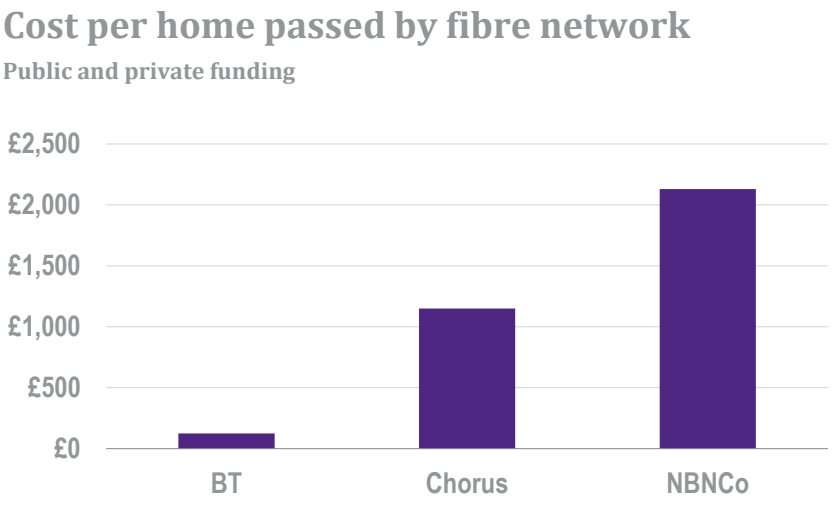
Figure 3-12



Source: Plum analysis of Google broadband pricing database

Current prices provide only a partial picture of user costs since any public subsidy element must ultimately be recovered. Figure 3-13 shows cost estimates per home passed by fibre networks in the UK (to 75% of households), New Zealand (75%) and Australia (experience to date in 2013 with very few homes passed).[34]

Figure 3-13



Source: Plum Consulting, Berenberg, NBNCo

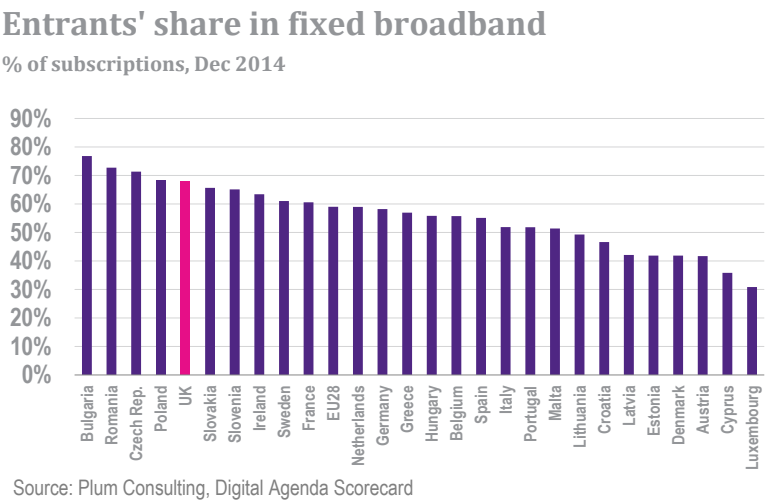
Most of the BT rollout to date was commercial i.e. made in the expectation that costs will be recovered via wholesale and retail charges, whereas the costs involved to pass homes with fibre to the premises in New Zealand and Australia may either be recovered via higher taxes or higher prices in future.

[34] Berenberg. 23 March 2015. "New Zealand is a poor regulatory benchmark for the UK".
ZDNet. December 2014. "Turnbull promises full per-premises cost of fibre NBN." http://www.zdnet.com/article/turnbull-promises-full-per-premise-cost-of-fibre-nbn/

3.10.2 Competition

Competition is a means to an end - ensuring that consumers get value for money and that there are incentives for innovation and investment. The UK market, based on entrants' (including cable) market share (Figure 3-14) and other measures, is competitive.

Figure 3-14



Source: Plum Consulting, Digital Agenda Scorecard

The UK also has infrastructure competition from mobile broadband with coverage increasing rapidly as 4G is rolled out. Virgin are also extending the cable network for around half of households to around two-thirds of households prospectively. Competition in the UK broadband market is healthy with retail competition (supported by EoI and regulation), the prospect of growing infrastructure competition and competition from over the top players in the applications market.

3.10.3 Service quality

Regarding quality of service measures, including order and fault repair performance, there was a period of deterioration which Ofcom have acted to rectify. Ofcom imposed quality of service requirements including minimum standards on Openreach in June 2014:[35]

> *"We also consider that it is clear that there are weaknesses in the current regulatory structure with respect to incentives to maintain quality of service. The absence of a clear set of overall quality standards linked to regulated services, limitations in the effectiveness of SLG [service level agreement] levels encouraging performance improvement, and a charge control structure which imposes financial targets which Openreach is encouraged to outperform all combine to undermine incentives to maintain quality of service levels*." Para 11.45

Ofcom also noted that there was no evidence of discrimination via quality of service:

> *"While we accept that there is some evidence that some consumers will favour BT's retail divisions in the event of general poor service quality, there is no direct evidence of bias in*

[35] Ofcom. June 2014. "Fixed access market reviews: wholesale local access, wholesale fixed analogue exchange lines, ISDN2 and ISDN30 – Statement" Volume 1 http://stakeholders.ofcom.org.uk/telecoms/ga-scheme/specific-conditions-entitlement/market-power/fixed-access-market-reviews-2014/statement/

Openreach's service delivery and it is clear that BT's internal customers experience poor service in a similar manner to external customers." Para 11.296

Ofcom reported that Openreach's performance has improved in line with the new requirements.[36] There was no evidence that service quality issues were discriminatory.

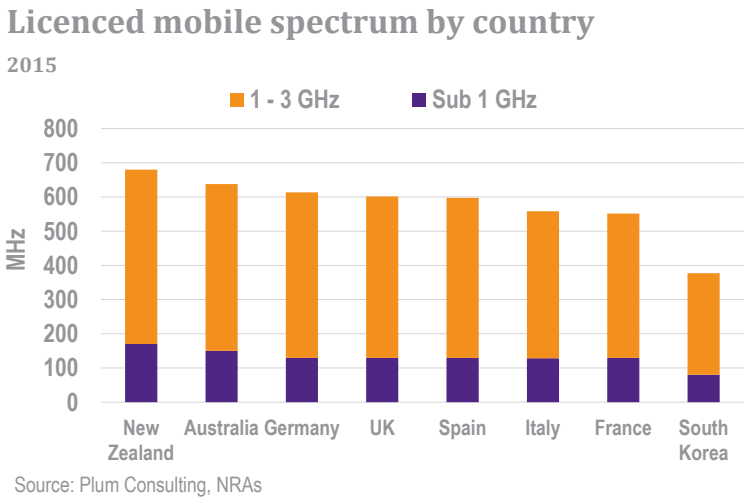
3.11 Mobile connectivity

A rapid pivot towards use of mobile devices and applications is underway,[37] with the UK having high levels of smartphone adoption and app use. Accompanying this shift is an expansion in the coverage, capacity and speed of mobile broadband access.

The UK initially lagged developments elsewhere (the UK ranked 52nd globally in terms of 4G launch). However, as spectrum was reallocated or liberalised for 4G use, network deployment and adoption has progressed rapidly with EE claiming the fastest 4G adoption in Europe[38]. Mobile operators plan to extent 4G coverage to around 98% of premises by the end of 2015.

Spectrum availability (Figure 3-12), coupled with a spectrum roadmap[39], suggest that the UK is well positioned for mobile capacity growth to meet demand.

Figure 3-15



3.12 Usage

Figure 3-16 shows that internet use (over the past 3 months) in the UK is significantly higher than the EU average but, particularly in relation to older users, below that in Denmark (the European leader).

[36] http://media.ofcom.org.uk/news/2015/consumer-experience-14/

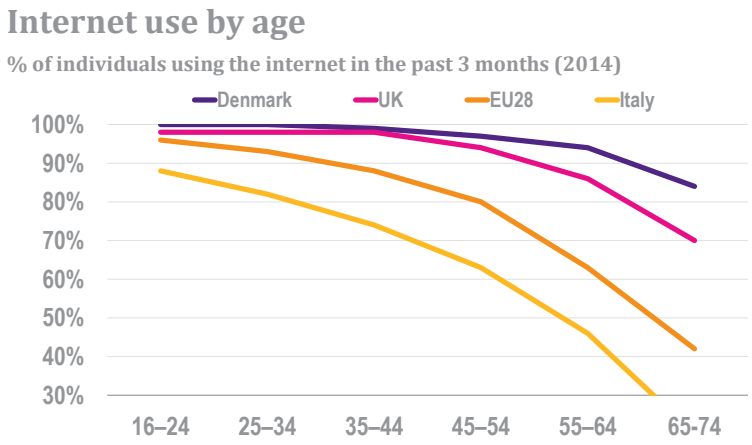
[37] Plum. March 2015. "All about that app." http://www.plumconsulting.co.uk/pdfs/Plum_March_2015_All_about_that_app.pdf

[38] http://ee.co.uk/content/dam/everything-everywhere/Newsroom/PDFs%20for%20newsroom/Signalling%20the%20Future.pdf

[39] http://stakeholders.ofcom.org.uk/binaries/consultations/spectrum-management-strategy/statement/statement.pdf

This suggests that the combination of broadband availability, service, price, marketing, value of applications and skills is comparatively favourable in the UK.

Figure 3-16

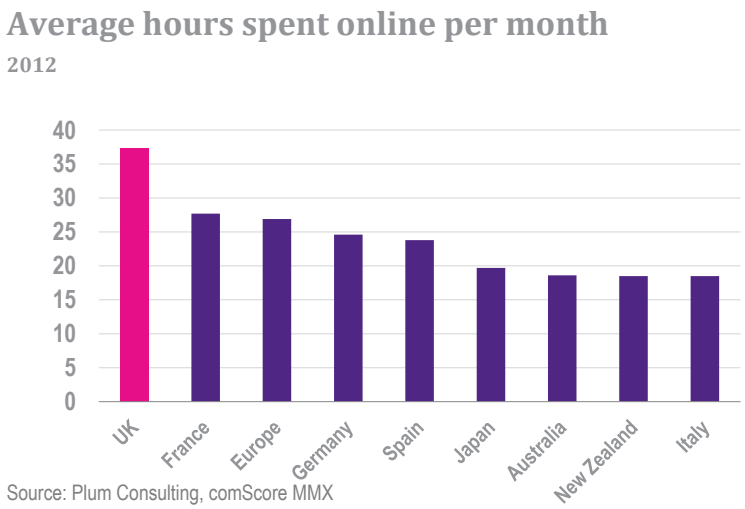


Source: Plum Consulting, Eurostat

Nevertheless, based on ONS data 12% of adults (6.2 million people) had not used in the internet in the past three months in the UK in 2015.[40] Mobile may provide an opportunity to help bridge this gap.[41]

Other metrics including hours online (Figure 3-17), e-commerce (Figure 3-18) and the internet share of advertising (Figure 3-19) show that the UK has a highly developed internet economy.

Figure 3-17

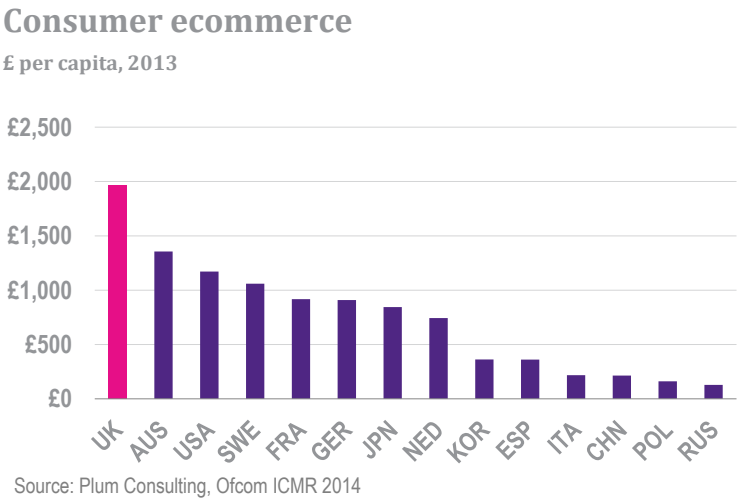


Source: Plum Consulting, comScore MMX

[40] ONS. August 2015. "Internet Access – Households and Individuals 2015." http://www.ons.gov.uk/ons/rel/rdit2/internet-access---households-and-individuals/2015/stb-ia-2015.html

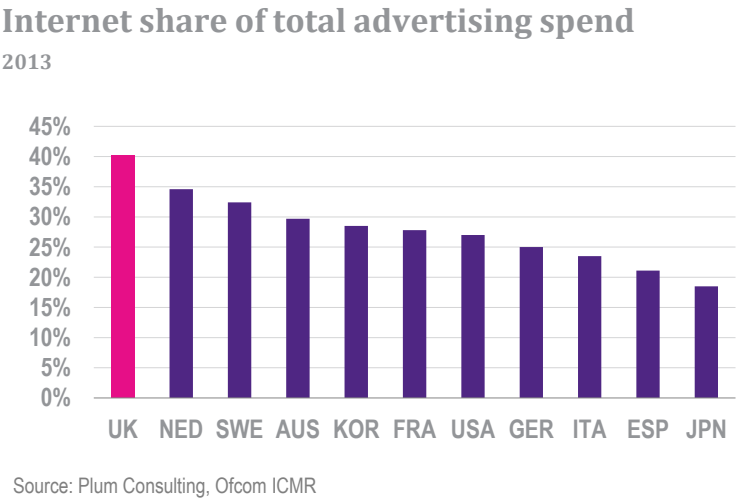
[41] Plum. March 2015. "Mobile digital inclusion – a digital future for all." http://www.plumconsulting.co.uk/pdfs/Plum_March_2015_Mobile_inclusion_-_a_digital_future_for_all.pdf

Figure 3-18



Source: Plum Consulting, Ofcom ICMR 2014

Figure 3-19



Source: Plum Consulting, Ofcom ICMR

3.13 Productivity and growth contribution

Ultimately the economic benefits of connectivity in national income terms will be reflected via the contribution to productivity growth. There is therefore value in considering the linkage between improvements in digital communications and productivity growth.

We consider available evidence in Appendix C and conclude that information and communications technology, and communications in particular, has made a substantial contribution to growth.

Goodridge *et al* (2014) also highlights the growing role of intangible investment relative to tangible investment, particularly in the information and communications technology industry.[42] Conventional capex is a poor indicator of overall investment.

3.14 Conclusion

There have been times when the development of connectivity in the UK has lagged that in other countries, but once the right policy framework was put in place (pricing flexibility for fibre in 2009 and spectrum liberalisation in 2012) the market has delivered a step change in performance with rapid fibre and 4G deployment. Various indicators relating to the use of digital communications rank the UK amongst the world leaders. Overall, outcomes in the UK are extremely positive.

[42] Goodridge, Haskel and Wallis. August 2014. "UK innovation index 2014." http://www.nesta.org.uk/sites/default/files/1407_innovation_index_2014.pdf

4 Is the approach 'future proof'?

We set out evidence in Section 3 that the regulatory approach developed during and post the 2005 Ofcom strategic review has worked well to date, but is it future proof? To assess this question we consider whether the approach can be expected to continue to deliver efficient and timely investment and competition in the digital communications market.

4.1 Anticipated market developments

We consider the implications of the following developments for investment, competition and policy:

- Rapid data traffic growth requires investment in core network capacity, but not necessarily to deliver higher fixed speeds in the access network.
- Network transition towards fibre and 4G (including evolution of 4G) – at present this is progressive and predominately market driven.
- A global pivot towards mobile which is increasing use of applications but also encouraging a search for bandwidth efficient applications. This shift has also intensified competition in the digital communications market.
- Growth of apps including over the top (OTT) communications and video apps, which are promoting traffic growth but not necessarily demand for ultra-fast speeds, and are introducing a form of competition that is independent of network access.
- Ever more efficient computing due to Moore's law and cloud computing. Advances in computing enable improved compression and higher speeds from copper (VDSL and G.Fast).

4.2 Impact on investment priorities

Some have questioned whether extension of fibre and upgrades from ADSL to VDSL (and potentially G.Fast) are ambitious enough, or whether there should be a commitment to even higher speeds, and in particular in fibre to the premise. Such a shift would necessitate a different policy approach and substantial state funding. We consider the choice between fibre to the home and fibre-copper hybrid investment in relation to the sub-headings below.

4.2.1 Bandwidth growth

This question was raised, for example, by the European Commissioner for the Digital Economy & Society Günther Oettinger in April 2015:[43]

> *"The number of hours people are watching YouTube per month is up 50% year over year and 300 hours of video are uploaded to YouTube every minute…Against this background, I can only wonder which broadband targets we will need beyond 2020."*

[43] Günther Oettinger. April 2015. "How do we future-proof Europe's broadband connectivity?" https://ec.europa.eu/commission/2014-2019/oettinger/blog/how-do-we-future-proof-europes-broadband-connectivity_en

"I am wondering why some communities, on their own initiative, are rolling out rural networks that deliver Gigabit connectivity, when the EU's existing targets are more than 30 times less ambitious."

There are two distinct points here. First, whether traffic-growth *per se* requires more ambitious access network investment. Second, whether there is sufficient demand and willingness to pay for higher speeds to justify more ambitious investment.

Traffic growth *per se* does not necessarily require higher speed access. Whether an individual watches one hour of online or binges on an entire series such as the House of Cards in sequence makes a considerable difference to traffic but no difference to the access speed required.

If, however, traffic growth results from simultaneous use of different applications or simultaneous use by different individuals within a household, then this demand may require additional speed. There are, however, natural limits to this source of demand for speed, for example, our desire or willingness to do multiple things simultaneously and the number of people within a household.

Demand for higher access speeds should be assessed explicitly and independently of anticipated traffic growth. Whilst there are a number of ways of assessing demand for higher speeds, all have their limitations. Nevertheless taken together they help inform a judgement about whether the current network transition is likely to meet demand or whether a different approach is required.

The approaches to demand estimation we consider include extrapolation of past trends, applications demand, willingness to pay estimates and estimates of the linkage between broadband access, speeds and GDP. We consider these below and in Appendix C.

4.2.2 Past trends (Nielsen's Law)

Nielsen's Law of Internet bandwidth states that connection speeds grow by 50% per year. However, we consider that this law, based on past trends, is a poor basis for assessing future demand for the following reasons:

- Human senses - hearing and sight - have natural limits in their resolution and therefore required data rates. Whilst a decade ago access speeds fell short of these limits they are now approaching or exceeding them.
- Limits in terms of simultaneous use, in particular simultaneous use by individuals within a household given household size, will limit this source of growth in peak demand.
- Fibre to the premise is significantly more costly than previous upgrades to speed since it requires extensive civil works. Costs versus willingness to pay may therefore break the previous observed trend based on lower cost upgrades to copper.

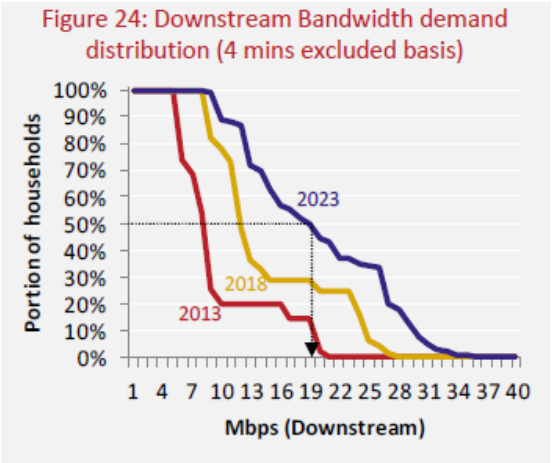
We conclude that Nielsen's Law is not a sound basis for assessing future demand for speed.

4.2.3 Applications demand

A study for the UK Broadband Stakeholder Group estimated future demand out to 2023 utilising a modelling approach.[44] The model combined the usage profiles of various applications with the usage of profiles of individuals. These individual profiles are then combined into various household profiles which were combined to create a picture of overall demand.

The model forecasts that the median household would require bandwidth of 19 Mbps by 2023, whilst the top 1% of high usage households would have demand of 35-39 Mbps. The evolution of the distribution of bandwidth demand over time is shown in Figure 4-1. VDSL, G.Fast and cable would be more than capable of meeting this estimated demand to 2023.

Figure 4-1



By 2025 it is also anticipated that demand by small businesses, whilst more diverse than household demand, will likely be met by a combination of G.Fast and cable DOCSIS 3.1.[45] Demand for the 95th percentile is anticipated to rise from 12.9 Mbit/s in 2015 to 41.1 Mbit/s by 2025.

In terms of factors contributing to future demand there are clear drivers of demand for higher bandwidth (e.g. HD and 4K video[46]), but there are also factors which mitigate demand for speed (but which may stimulate data usage) including better compression facilitated by advances in computing (H.265 and VP9 require half the bandwidth of previous compression).

The shift to mobile, whilst driving simultaneous use within households, is also driving an intensive search for bandwidth efficient applications in order to reach the largest possible global market. For example, Facebook[47] are focussed on making their applications work well on poor quality connectivity

[44] Kenny & Broughton. November 2013. "Domestic demand for bandwidth - An approach to forecasting requirements for the period 2013-2023." http://www.broadbanduk.org/wp-content/uploads/2013/11/BSG-Domestic-demand-for-bandwidth.pdf

[45] Kenny. September 2015. "The broadband requirements of small businesses in the UK." http://www.broadbanduk.org/wp-content/uploads/2013/01/Small-Business-Connectivity-Requirements.pdf

[46] The transition from SD to HD may be valued more than the transition from HD to 4K. "Does 4K resolution matter?" http://carltonbale.com/?s=4k&x=0&y=0

Nevertheless, 4K services will become more widespread and adoption of 4K capable screens will grow over time.

[47] For example "Facebook's developers focused on making video work well even on relatively low-bandwidth cell networks". http://www.theverge.com/2015/4/27/8503443/facebook-messenger-video-calling

whist Google announced at their May 2015 I/O conference that *"we're making changes to ensure that our software works even where there aren't great Internet connections".*[48]

Software innovation is allowing smaller applications (iOS 9 will be 1.3 GB versus 4.6 GB for iOS8 and allow app file sizes to be reduced), peer-to-peer software distribution thereby only requiring one download for multiple device updates (Windows 10[49]), and using prediction to mask latency (Microsoft Outatime[50]).

The shift to cloud computing also does not necessarily require ultra-fast access and cloud-based (such as email and document storage) are already being used with current generation access. Further, an application running in the cloud may gain the benefit of very high core network speeds without requiring high speed access as illustrated by the following example:[51]

> *"One of the benefits of installing applications from the internet is the blazing fast internet connection available on your VM [virtual machine], because the VM has a fast connection to the internet that isn't based on your local connection, file downloads occur in the blink of an eye…In the example shown, the network provided more than 800Mbps upload and download. This shows one of the benefits of virtualization which provides you with the ultimate internet connection"*

We also considered emerging applications, in particular cloud based gaming and virtual and augmented reality. High resolution cloud based gaming may require bandwidth in the tens of Mbps range.[52] Innovations in streaming may however reduce requirements.[53]

Virtual reality content capture and distribution may involve very large file sizes since a wide range of possible views need to be captured, as illustrated by the Google "Jump" and Nokia "Ozo" cameras in Figure 4-2. The jump camera generates video at a rate equivalent to five 4K TVs.[54]

Figure 4-2: 'Jump' VR camera

[48] http://googleblog.blogspot.co.uk/2015/05/io-2015-mobile-revolution.html

[49] http://www.theverge.com/2015/3/15/8218215/microsoft-windows-10-updates-p2p

[50] http://research.microsoft.com/apps/pubs/default.aspx?id=226843

[51] Page 16: http://www.nvidia.co.uk/content/grid/pdf/grid-test-drivers-manual.pdf

[52] http://arstechnica.co.uk/gaming/2015/05/nvidia-turns-on-1080p-60-fps-streaming-for-its-grid-cloud-gaming-service/

[53] http://arstechnica.com/gaming/2015/01/playstation-now-review-sony-finally-proves-streaming-gaming-is-viable/

[54] https://www.google.com/get/cardboard/jump/

However, distribution need not be synchronous with consumption, and end users would only be watching a fraction of the content at any given moment. One estimate of the bandwidth requirement for consumption of VR is 8 Mbps for 6K resolution at 80 frames-per-second.[55]

In conclusion, we consider that known and emerging mass market applications may require speeds in the range 10 to 100 Mbps, perhaps a few 100 Mbps for multiple simultaneous users, but not speeds in the gigabit per second range.

4.2.4 Willingness to pay

We assess evidence regarding willingness to pay and economic impact in Appendix C. We find support for demand and willingness to pay for speed increments in the tens of Mbps range, but not beyond 100 Mbps.

4.2.5 Wider public value

Whilst we conclude that available evidence does not suggest material incremental private benefits from ultra-fast broadband, it is conceivable that there would be wider social or external benefits. The European Commission, for example, express this view:[56]

> *"However, the social return from investment in higher quality networks tends to be greater than for the individual operator. The framework was not conceived to lead to generalised roll-out of new networks in accordance with public-policy objectives."*

Availability and adoption of current generation broadband is thought to involve benefits including network effects and spillovers that exceed private benefits.[57] [58] This conclusion also applies to the adoption of smartphones and mobile broadband since the full benefits of a range of applications including rich communications depend on others having them too.

However, the extent of network effects and spill-overs associated with the step from superfast broadband to ultra-fast broadband is less clear. Communications network effects would appear to be exploited in the 1-10 Mbps range, whilst wider benefits associated with connected health services either involve large institutions (who can get fibre on demand) or lower speed connectivity, particularly for mobile health applications, rather than for superfast connectivity.

FTTH deployment may also involve negative social externalities associated with civil works, and a requirement for home owners to be present for installation also imposes a cost in terms of leisure time and/or foregone working time.

A cost benefit framework developed in relation to an evaluation of the Australian FTTP deployment concluded that the external benefits could in principle be positive or negative.[59] External social benefits were assumed to be 5% on top of private benefits.[60]

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[55] http://www.planetstream.net/blog/streaming-virtual-reality.html

[56] http://ec.europa.eu/priorities/digital-single-market/docs/dsm-swd_en.pdf

[57] Carol A. Corrado. March 2011. "Communication Capital, Metcalfe's Law, and U.S. Productivity Growth." http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2117784

[58] http://www.vodafone.com/content/dam/vodafone/about/public_policy/policy_papers/public_policy_series_10.pdf

[59] http://www.communications.gov.au/broadband/national_broadband_network/cost-benefit_analysis_and_review_of_regulation/Consultation_and_working_documents

Further, some of the benefits of broadband are sometimes thought to be wider public benefits external to the user, but are in fact reflected in private willingness to pay, for example, productivity benefits, house price increases and secondary market impacts:[61]

- Productivity benefits are individual user benefits, either involving individual time savings or improvements to the profitability and competitiveness of a business.
- House price increases may not apply if everyone has fast broadband, and any increase would in any case represent double counting of underlying changes in productivity and incomes.
- Secondary market impacts should, with specific exceptions, be left out to avoid double counting of primary benefits (secondary impacts typically involve redistribution of primary impacts).[62]

In conclusion, there is no proven case for public investment in FTTH on grounds of social externality. However, there are likely to be wider social benefits from the extension of basic broadband and wider adoption and use of the internet. The immediate policy focus should be on ensuring these benefits are captured.

4.2.6 The investment decision under uncertainty

We conclude that speeds in the range 10 to 100 Mbps, perhaps a few hundred Mbps for a small fraction of households, are likely to be adequate for the foreseeable future. However, these conclusions are subject to uncertainty. One response to this uncertainty is to propose investment in the so called 'future proof' option of FTTH. However, there are several problems with this response:

- It involves a commitment to substantial up-front expenditure which could have been made later (at lower cost in present value terms) or not at all in the near to medium term if demand does not eventuate (the value of waiting may be large given the opportunity to learn about demand).
- FTTH deployments are slower than VDSL upgrades. Further, a diversity of fibre packages is typically offered and cheaper lower speed offers may prove popular, as in Australia where many have opted for 12 Mbps. VDSL may therefore deliver higher speeds faster in practice and without a protracted divide between those who have super-fast broadband and those who don't.
- Early FTTH network deployed may not in fact prove 'future proof' given that the choice of technology and network topography might have been different had investment proceeded later and more in step with demand.

The alternative of investing incrementally but comparatively quickly in lower cost upgrades ahead of demand is attractive (though this conclusion depends on the precise circumstances and will not hold universally).

An incremental approach also leaves open the option of investing in fibre - either on demand or on an area wide basis. It is future proof in this sense. Further, waiting has revealed another option, namely G.Fast, discussed in Figure 4-3.

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[60] http://www.communications.gov.au/__data/assets/pdf_file/0003/243039/Cost-Benefit_Analysis_-_FINAL_-_For_Publication.pdf

[61] Plum. June 2008. "A Framework for Evaluating the Value of Next Generation Broadband." http://www.plumconsulting.co.uk/pdfs/Plum_June08_Evaluating_the_value_of_next_generation_broadband.pdf

[62] http://webarchive.nationalarchives.gov.uk/20090609003228/http:/berr.gov.uk/whatwedo/bre/policy/scrutinising-new-regulations/preparing-impact-assessments/toolkit/page44248.html

Figure 4-3: G.Fast – opening up new capabilities for copper and for delivery of broadband targets

G.Fast was developed to improve fibre economics by avoiding the need to run fibre the final meters to the premise (which can be complex and disruptive) and to avoid the need for home installation (which involves customer no-shows and service rejection due to the work required within the home).[63]

G.Fast and VDSL offer not only higher speeds than ADSL but lower latency. Further, G.Fast – which offers potential speeds of hundreds of Mbps - also offers improvements in the time required for a lost connection to recover (line synching time) of around 5-10 seconds compared to up to a minute with ADSL or VDSL. A temporary interruption of service may not then be noticed the user with G.Fast.

Whilst G.Fast was originally developed as a short distance solution, testing and further development of the standard and technology now offers the prospects of significantly higher speed service to many from existing street cabinets.

The process of technology and standards development itself illustrates a benefit of large and committed market participants who can invest in R&D and testing. Further, like GSM, G.Fast standards development has a strong European dimension.

The development of G.Fast was started via a series of EU collaborative projects in which BT played a key role. The first was a FP5 programme called MuSE, and this was followed by a number of CELTIC projects called 4GBB and HFCC/fast. The output of these projects was used to trigger work in the Broadband Forum and the ITU and materially contributed to the development of G.Fast.

The rationale for a change in approach in Australia also illustrates the option value argument for an incremental approach:[64]

> *"Overall the MTM scenario has significantly greater option value than the FTTP scenario. The MTM scenario leaves more options for the future open because it avoids high up-front costs while still allowing the capture of benefits if, and when, they emerge. It is, in that sense, far more 'future proof' in economic terms: should future demand grow more slowly than expected, it avoids the high sunk costs of having deployed FTTP. On the other hand, should future demand grow more rapidly than expected, the rapid deployment of the MTM scenario allows more of that growth to be secured early on, with scope to then upgrade to ensure the network can support very high speeds once demand reaches those levels." Page 89.*

Investment under uncertainty puts a premium on a flexible scalable approach rather than a large up-front solution. Whilst developments in terms of applications and demand should be monitored, at this point in time we do not consider that there are sound grounds for switching to a national FTTH strategy.

4.3 Impact on competition

Competition is now well established at three layers – network, retail and over the top, and is likely to intensify:

- The development of OTT communication and video services, supported by adoption of smartphones and tablets, has introduced an additional layer in the value chain for innovation and

[63] FTTH Council Europe. G.Fast. http://www.ftthcouncil.eu/documents/Publications/DandO_Gfast_Paper_2014_Final.pdf

[64] http://www.communications.gov.au/__data/assets/pdf_file/0003/243039/Cost-Benefit_Analysis_-_FINAL_-_For_Publication.pdf

competition. OTT also counteracts the tendency towards bundling, and provides competition which is independent of network access. In effect, OTT is introducing separation of networks and communications services.

- At the retail level (access resellers) competition is established with scale players including TalkTalk and Sky. Whilst resellers did not initially market VDSL services, they have subsequently entered that market segment and now compete with BT. The proportion of net fibre additions attributed to operators other than BT has steadily grown following their launch of retail fibre offers.[65]
- At the network level cable and fixed telecoms compete - with BT investing in VDSL and Virgin announcing their intention to extend the cable network and investment in DOCSIS 3.1. Mobile only broadband households are around 10% of households[66] and 4G will compete more intensively with fixed access, particularly for customer with lower data consumption. 4G offers speeds that are adequate for many applications, has declining unit data costs and with Wi-Fi tethering can be extended to multiple devices/users.

In relation to lagged entry into the super-fast broadband market, Sky launched fibre based broadband products in April 2012, almost two and half years after BT launched Infinity in January 2010.[67] Further, as of May 2014 Sky continued to offer a single (2.4 GHz) band Wi-Fi router, which may have constrained speeds in practice for those with VDSL.[68] A possible reason for the delayed commitment to fibre retailing by access resellers has been set out by Martin Cave.[69]

> *"An unbundler which has sunk investment in building out to the exchange or cabinet will face a low marginal cost in supplying its customer with a UCLL-based, as compared with a fibre bitstream product. It will therefore have an incentive to keep the customer on the copper connection, rather than promote a switch to fibre. This aim can be achieved by cutting prices selectively to potential switchers, or simply by not promoting fibre."*

4.4 Conclusion

Looking ahead the picture in terms of investment and competition is healthy. In the next section we consider the option of structural separation – proposed by some - in greater detail before concluding with reflections on policy in Section 6.

[65] Page 34: http://www.btplc.com/Sharesandperformance/Quarterlyresults/PDFdownloads/q415-slides.pdf

[66] Around 10% of consumers had a smartphone but no fixed broadband in January 2014. Eurobarometer. 2014. "E-Communications and Telecom Single Market Household Survey" http://ec.europa.eu/public_opinion/archives/ebs/ebs_414_en.pdf

[67] http://en.wikipedia.org/wiki/Sky_Broadband

[68] http://www.broadbandchoices.co.uk/news/2014/05/talktalk-super-router-270514

[69] Martin Cave. June 2012. "Regulating the price of copper in New Zealand." https://www.chorus.co.nz/file/48859/Chorus-Attachment-5---Martin-Cave-report.pdf

5 Would separation prove a Pyrrhic victory?

In a report titled 'Cutting the Gordian knot', Redburn (2015) advocate the break-up of BT.[70] This section addresses the question of structural separation.

5.1 Separation should be assessed versus the status quo

Separation can take a variety of forms. At one extreme is accounting separation; at the other, ownership separation. In 2006, Martin Cave identified six intermediate degrees of operational (or functional) separation between these two extremes and argued that BT's separation was most similar to the fourth 'degree'.[71] The costs and benefits of structural separation should be assessed against this counterfactual.

Further, Ofcom concluded at the time the Undertakings were adopted that the approach was appropriate to address its competition concerns, and that it was not likely to be proportionate to enforcing a stricter degree of separation.[72] Subsequent assessments by Ofcom concluded that the Undertakings were working; whilst investment in fibre post 2010 suggest that pricing freedom has promoted efficient and timely investment. Whilst circumstances could have changed in a manner that implies that this conclusion should be revisited, we do not consider that this has been established.

5.2 Some have called for structural separation

TalkTalk, Sky and CityFibre have called for the structural separation of BT:

> *"A decade ago, Ofcom failed to break up BT and instead created Openreach. Whilst the last ten years have seen a lowering of prices and increased take-up, it is increasingly clear that the current market structure is not fit for purpose.*
>
> *"…Separation would accelerate investment in Britain's digital infrastructure as other providers will have the level playing field they need to build the competing modern infrastructure that our economy desperately needs."* TalkTalk[73]
>
> *"Structural separation of Openreach, the UK's only nationwide broadband infrastructure, is at the heart of creating a sustainable industry; one that provides the capacity and incentive to invest"* Sky[74]
>
> *"In infrastructure terms, the UK communications market is underperforming, with one of the lowest shares of fibre-connected buildings in Europe. BT's new focus on content and mobile will further exacerbate this problem. CityFibre is one of the few companies that is truly*

[70] Redburn. March 2015. "Cutting the Gordian Know – The break-up of BT. http://www.redburn.com/SecureDoc/Thinking%20Allowed/150304_Thinking_Allowed_Telecoms.pdf

[71] Martin Cave. 2006. "Six Degrees of Separation: Operational Separation as a Remedy in European Telecommunications Regulation" http://papers.ssrn.com/sol3/papers.cfm?abstract_id=994798

[72] Ofcom. June 2005. "Notice under Section 155(1) of the Enterprise Act 2002" http://stakeholders.ofcom.org.uk/binaries/consultations/sec155/summary/sec155.pdf para 5.61

[73] http://www.talktalkgroup.com/press/press-releases/2015/talktalk-response-to-ofcom.aspx

[74] https://corporate.sky.com/media-centre/news-page/2015/response-to-ofcom-announcement-of-strategic-review-of-digital-communications

investing and building next generation digital infrastructure – our rollout of UK Gigabit Cities is underway. To accelerate this programme and deliver meaningful infrastructure competition, this strategic review must consider the optimal structure for pro-competitive fibre investment. The creation of a true level playing field for infrastructure investment, whether that means structural separation of BT or not, is crucial if the UK is to get the digital infrastructure it deserves." CityFibre[75]

Analysts Redburn (2015) also consider that combined ownership is resulting in poor outcomes.

5.3 Literature on pros and cons of separation

BEREC discuss the potential advantages (non-discrimination and potential reduction in regulatory burden – arguably delivered by functional separation) and disadvantages (potential reduction in incentives to invest). As BEREC note:[76]

"…in the long term [separation] may lead to a reduction of incentives for other operators to invest in alternative access infrastructures, thereby inhibiting infrastructure-based competition in the access network. This may be caused by all market players sharing the same infrastructures under exactly the same conditions."

De Bijl (2005) makes a similar observation:[77]

"separation may lead to a crystallization of market power in the access market, which may distort the rollout of alternative networks."

The OECD (2011) identified that it was:[78]

"generally accepted that structural separation may involve a trade-off between efficiency and competition"

The literature does not therefore provide support for separation in the telecommunications industry. In particular, an imposition of structural separation would appear to involve a possible downside of harm to investment.

Separation could result in less regulation. However, Ofcom have provided some regulatory relief following functional separation, whilst experience in New Zealand and Australia points to additional complexities in terms of coordination of regulation with separation. Structural separation would however render an economic replicability test irrelevant.

Other arguments fall outside the literature. In particular, CityFibre cite the lack of investment in fibre to the premise as evidence of underperformance and "*BT's new focus on content and mobile"* as exacerbating this problem.

[75] http://www.cityfibre.com/news/2015/3/13/cityfibre-response-to-ofcom-strategic-review-announcement

[76] BEREC. February 2011. "BEREC Guidance on functional separation under Articles 13a and 13b of the revised Access Directive and national experiences" http://berec.europa.eu/eng/document_register/subject_matter/berec/regulatory_best_practices/guidelines/195-berec-guidance-on-functional-separation-under-articles-13a-and-13b-of-the-revised-access-directive-and-national-experiences

[77] Paul W.J. De Bijl. 2005. "Structural Separation and Access in Telecommunications Markets" http://www.SSRN.com/abstract=843324

[78] OECD. 2011. "Report on Experiences with Structural Separation" http://www.oecd.org/daf/competition/50056685.pdf

However, mass market investment in fibre to the premise may not be efficient. Further the argument that content and mobile distract from investment in fibre is not convincing since one would all expect investments offering an adequate return to be pursued (particularly given that investors have the option of increasing or decreasing their commitment of funds).

5.4 Divergent views regarding causation

As discussed in Section 3 telecommunications market outcomes and internet use outcomes are very positive in the UK. The UK also arguably has the clearest policy in Europe in relation to non-discrimination, including EoI and functional separation.

We note however divergent views amongst commentators on outcomes in the UK and their implications for the merits of separation. Redburn (2015), cited at the start of this section, conclude that separation is desirable given poor outcomes to date:

> *"Combined ownership of the natural monopoly broadband infrastructure with the provision of services over that infrastructure is creating perverse incentives in the UK. It is resulting in falling investment and poor broadband speeds…"*

In contrast, Sidak and Vassallo (October 2014)[79] argue that functional separation is responsible for poor outcomes to date:

> *"Our econometric analysis indicates that prices for broadband and residential fixed-line telephone services are lower than one would expect based on prices in comparable countries. However, telecommunications investment, customer satisfaction, and measures of the United Kingdom's global competitiveness in telecommunications have also fallen. In particular, the United Kingdom's investment in next-generation networks is lagging compared with the rest of the world."*

Neither study informs the policy choice regarding separation. Both studies also, in our view, utilise metrics that paint a misleading picture in terms of outcomes (we also note that Sidak and Vassallo focus on investment outcomes prior to 2010, before BT began investing in fibre to the cabinet).

5.5 The political economy of separation

5.5.1 Separation may flow from a commitment to FTTH

In Australia and in New Zealand the governments made commitments to FTTH which required public funding and, in turn, involved the creation of a new separate network entity (the NBN in Australia) or a requirement that bidders are structurally separated (leading to the creation of the network-only business Chorus in New Zealand).

In practice, separation in telecommunications should therefore be viewed as a result of the political economy of a commitment to a particular technology choice (FTTH) which in turn necessitates substantial public funding. Separation may be sought because of previous concerns regarding non-

[79] Sidak and Vassallo. October 2014. "Did Separating Openreach from British Telecom Benefit Consumers?" http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2507463

discrimination with the fibre investment strategy providing an opportunity to achieve separation. However, this logic would not apply if non-discrimination had already been adequately addressed, as in the UK.

5.5.2 Separation tends to distort and discourage competition in practice

Whilst a goal of separation may be non-discrimination and service-based competition, in practice the political economy of separation tends to lead to the distortion and suppression of infrastructure competition. Competing infrastructure may be shut down via government policy, or the fact that alternative infrastructure providers can integrate whilst the fibre provider cannot introduces a competitive distortion.

Reduced platform competition may be seen by the government as a way of reducing public funding requirements once a commitment to FTTH is made, and the entity delivering FTTH may lobby to limit competition,[80] particularly if consumers do not value fibre sufficiently to switch voluntarily.

Australia illustrates this dynamic clearly. Copper based ADSL is shut down within 18 months of fibre deployment (which has led to some instances of neither fibre nor copper service availability[81]) and cable was also to be shut down (but now reverts to the NBN who may be use it instead of deploying FTTH in cable areas). Others are not in general permitted to offer fibre service.

5.5.3 Coordination issues

Given that separation was part of an overall package of measures alongside a commitment to FTTH it is not possible to infer evidence of investment coordination problems with separation from this experience. Nevertheless fibre rollout has been glacial and costly in Australia and adoption has been slow in New Zealand.

In Australia, customer complaints to the Telecommunications Industry Ombudsmen (TIO) regarding disconnection have highlighted a coordination problem compounded by a fixed timetable for withdrawal of copper service. In New Zealand the adoption of a national fibre strategy led to a separation of regulation of fibre (via contract) from regulation of copper (by the regulator). The subsequent lowering of the copper price discouraged migration to fibre and undermined the fibre business case.

5.6 Conclusion

Structural separation should be assessed against the status quo – functional separation. In the UK, where functional separation already provides assurance of non-discrimination, it is hard to see what the incremental benefits of imposing structural separation would be. However, it would involve real costs: structural separation would be costly to implement, may harm investment incentives and have adverse impacts on platform competition. Separation would represent a Pyrrhic victory.

[80] http://www.businessspectator.com.au/news/2014/7/1/technology/infrastructure-competition-could-sink-nbn

[81] http://www.abc.net.au/news/2015-05-01/medical-centre-has-phone-and-internet-cut-off-during-nbn-rollout/6438598 http://www.dailytelegraph.com.au/newslocal/central-coast/gosford-golf-club-stuck-in-the-rough-after-adsl-line-cut-off/story-fngr8h0p-1227307609345

6 Policy reflections – building on success

We conclude, based on outcomes, that functional separation has addressed discrimination whilst proving sufficiently adaptable to permit network evolution. We also conclude that functional separation is preferred to structural separation. This element of policy has, and is expected to continue, to stand the test of time.

A primary focus on market delivery of next generation access, supported by a policy of pricing freedom, subject to the discipline of an anchor product and non-discrimination requirements, has delivered timely and efficient investment and is expected to continue to do so.

We consider that case for a more activist fibre to the premise investment policy, and find it is not warranted either in terms of anticipated demand or on the grounds of social externality. If and when demand and willingness to pay for speeds in excess of those available from VDSL or G.Fast develop we would also expect the market to deliver, provided pricing freedom allows investors to monetise some of the resulting surplus.

Whilst we do not find that there is a case for a national FTTH investment strategy we do consider that there are network effect and positive social externalities associated with universal availability of basic broadband, more ubiquitous mobile broadband and greater internet adoption and use. These areas should remain the focus of policy and more could potentially be done, particularly leveraging the possibilities opened up by mobile and wireless to improve digital inclusion.

We also find that a number of performance metrics are misleading and that greater attention should be focussed on outcomes rather than inputs and on what is fit for purpose rather than on performance and national "league tables" considered in the abstract. Policy approaches, metrics and targets need to be brought up to speed with a market where mobile and over the top play a far greater role. Ofcom, and the UK government, could champion the use of improved metrics both in the UK and by others including the European Commission and OECD.

A final issue which deserves greater attention, and is a natural counterpart of the transition to next generation access and "all-IP" networks, is ensuring the efficient and timely retirement of legacy services and network elements. There are a number of existing impediments to efficient network and service rationalisation that should be reviewed.[82]

Further, whilst opportunities for copper retirement are smaller than they would be under a FTTH strategy they will nevertheless arise. Experience in the US and Australia points to the need for the opportunity but not an obligation to retire copper when and where it makes commercial sense.

We note that responsibility for addressing all of the above issues extends beyond Ofcom to include central government and the European Commission. The Ofcom strategic review and forthcoming review of the European framework for communications provide an opportunity to pursue this wider agenda.

[82] Brian Williamson and Sam Wood. February 2015. "Leaving a legacy - enabling efficient network transition." http://www.plumconsulting.co.uk/pdfs/Plum_February_2015_Leaving_a_legacy.pdf

Appendix A: Digital Economy and Connectivity indices

Index	Most recent update	Description
Huawei Global Connectivity Index (GCI)	2015	This index[83] was developed to provide a detailed picture of connectivity measurements across 50 countries. The index comprises four components, each containing 9 to 10 variables. These components are supply (measuring current levels of supply for ICT products and services), demand (measuring demand for connectivity), experience (measuring the outcomes or uses of connectivity), and potential (a forward looking set of indicators).
WEF Networked Readiness Index (NRI)	2015	The NRI is published by the World Economic Forum,[84] and aims to provide a tool to benchmark ICT readiness and usage across countries. The NRI is made up of 54 individual indicators, aggregated into four sub-indices: the political, business and regulatory environment, readiness (infrastructure and skills), usage and impact. Half of the source indicators are quantitative; the other half are derived from a survey carried out by the WEF. The index is computed for 148 countries.
ITU ICT Development Index (IDI)	2014	The IDI[85] is a composite index comprising 11 indicators, which aims to reflect developments in ICT across a wide set of countries. The indicators are grouped into three categories. The Access sub-index captures ICT readiness, and includes five infrastructure and access indicators. The Use sub-index captures ICT intensity, and includes three indicators, while the Skills sub-index captures ICT capability or skills with three proxy indicators reflecting educational outcomes. Some of the metrics used to compute the IDI (namely, fixed telephone subscriptions, households with a computer) are arguably less relevant in the mobile era.
Connectivity Scorecard	2013	The Connectivity Scorecard[86] ranks 52 countries on their deployment and use of ICT infrastructure. The scorecard is comprised of three categories – Consumers, Business and Government. Within each category each country's ICT infrastructure and ICT usage is ranked against the best-in-class in their tier. After weighting the indicators, based on which pillar (businesses, consumers, government) contributes the most to long term productivity, countries are given a final score out of 10.
European Commission Digital Economy and Society	2015	The DESI is "a composite index that summarises relevant indicators on Europe's digital performance and tracks the evolution of EU member states in digital competitiveness."[87] The DESI comprises five main dimensions: connectivity, human capital, use of the internet, integration of digital technology and digital public services. Each of these is made up of between two and four indicators. The DESI includes factors such as eHealth and eGovernment as well as eCommerce and the use of ICT by businesses.

[83] http://www.huawei.com/minisite/gci/en/huawei-global-connectivity-index-2015-whitepaper-en.pdf

[84] http://reports.weforum.org/global-information-technology-report-2014/

[85] http://www.itu.int/en/ITU-D/Statistics/Pages/publications/mis2014.aspx

[86] http://www.connectivityscorecard.org/

[87] http://ec.europa.eu/digital-agenda/en/digital-economy-and-society-index-desi

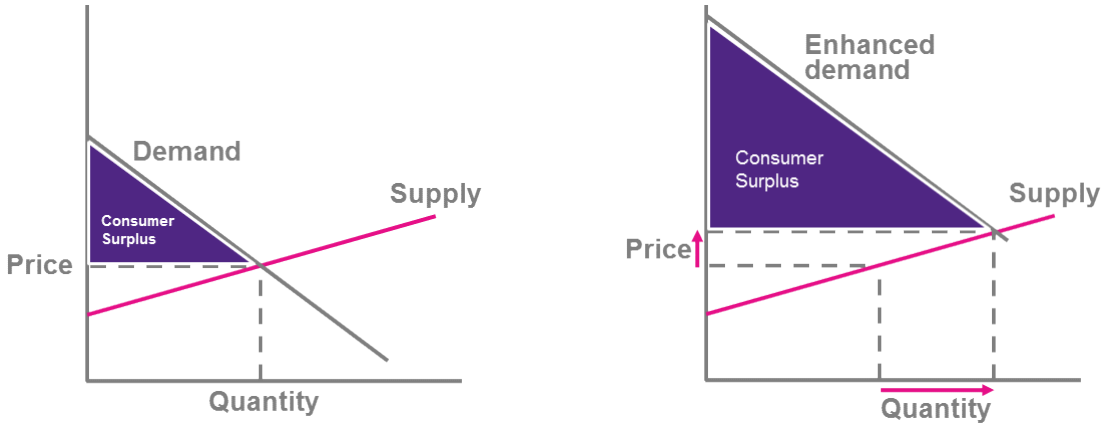
Appendix B: Prices vs. quantities

Emphasis has been placed in the past on prices and price changes as a comparative measure. For a given homogeneous service this is reasonable. However, as services become more varied and differentiated, lower prices may not indicate higher levels of welfare. Consumers may pay more to do more, as the growth of smartphones illustrates.

Indeed, quantity may be a better measure of welfare than price as convergence proceeds. If people are willing to buy more of something then they must value it more – whether the price is somewhat higher or not. Quantities reflect quality and price and may therefore provide better transitional measures of success until applications, quality and the value consumers place on them are better understood.

Figure B-1 illustrates how enhanced demand due to improved quality of service might be viewed through the lens of price alone as negative, but is associated with a higher quantity of consumption (and welfare gains as measured by the change in the area between the demand and supply curves – consumer surplus is indicated) even though the price is higher. In the absence of a welfare measure, quantity demanded can be a superior proxy for progress to price.

Figure B-1: Price versus quantity as a measure of improvement



If the supply curve moved up the net change in consumer surplus would be ambiguous. However, consumers can be expected to only choose higher quality at a higher price over lower quality at a lower price if they are better off. Therefore in a market with choice demand is superior to price as a proxy for welfare changes when incomplete information holds.

Should prices be considered, then disaggregated measures may be misleading. It does not matter to a household if their broadband charge is low when their line charge is high. Explicit mobile data charges and revenues may also differ simply because of the structure of prices, for example, if consumers pay a premium for a smart device contract including broadband connectivity.

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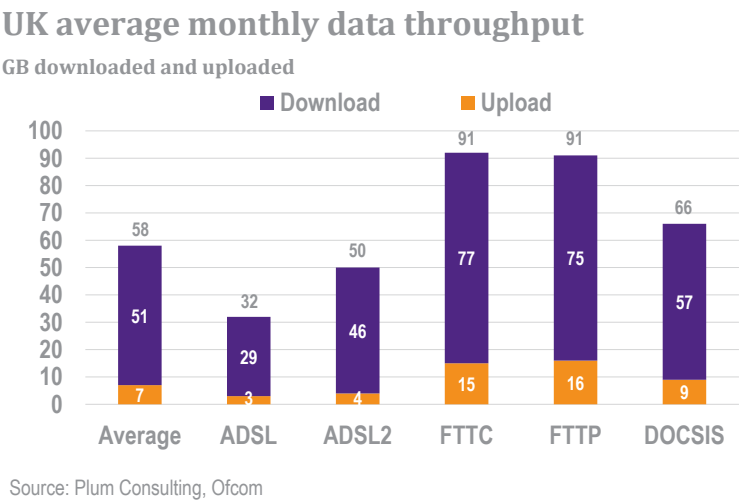
Appendix C: Willingness to pay and economic benefit estimates

C.1 Revealed preferences

Consumers with fibre to the cabinet (FTTC) use more data than those with ADSL, but those with fibre to the premise (FTTP) currently do not use more data than those with FTTC (Figure C-1).

Figure C-1:



Source: Plum Consulting, Ofcom

Another basis for assessing demand and willingness to pay for higher speeds is to observe what speed tiers consumers opt for when higher speeds are available at a higher price:

- In the US Verizon offer symmetric speed tiers over FTTP 25, 50, 75, 150, 300 and 500 Mbps for incremental price increases of $5 per month across the first three tiers, with prices increasing in larger steps above 75 Mbps (the products are marketed to residential and business customers).[88] 62% of customers have adopted a package of 50 Mbps or more and just over 20% of customers are on the 75 Mbps package.[89]
- In Australia, for June 2014, 38% of consumers order the most basic fibre to the premise package offering 12/1 Mbps, with 37% on the 25/5 Mbps and 20% on 100/40 Mbps.[90] The average speed across all fibre users was 36 Mbps, a decrease of 3 Mbps since 30 June 2013.
- In NZ *"The majority of UFB end-users are on entry level 30Mbps fibre products, although the proportion of end-users on 100Mbps plans has increased since Chorus' introduction of a $40 product in mid-2014."*[91]

[88] http://www.verizon.com/about/investors/quarterly-reports/1q-2015-quarter-earnings-conference-call-webcast

[89] http://www.verizon.com/about/investors/quarterly-reports/1q-2015-quarter-earnings-conference-call-webcast

[90] NBN Co Annual report June 2014. http://www.nbnco.com.au/content/dam/nbnco2/documents/nbnco-annual-report-2014.pdf The remaining 5% are likely to be on the 50/20 Mbps plan (NBNCo Strategic Review, Dec 2013)

[91] Chorus. 2015. Half year report. https://www.chorus.co.nz/file/59042/208448.pdf

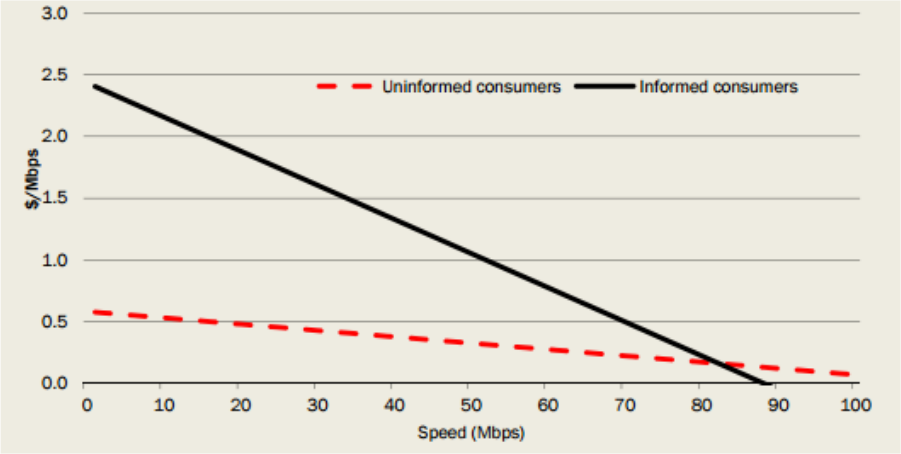
The “revealed preference” evidence suggests little incremental willingness to pay for speed speeds approaching or in excess of 100 Mbps.

C.2 Stated preferences

In Australia a stated preference study was commissioned for the cost benefit assessment of fibre options led by Dr Michael Vertigan and referred to as the “Vertigan report”.[92] Study participants were divided into two groups with one group informed about how speeds impacted on activities.

Figure C-2 shows that willingness to pay for successive speed increments declined for both groups, and whilst higher for lower speeds for the “informed” group declined more rapidly. There was no willingness to pay for higher speeds beyond 90 Mbps.

Figure C-2: Stated incremental willingness to pay for speed increments

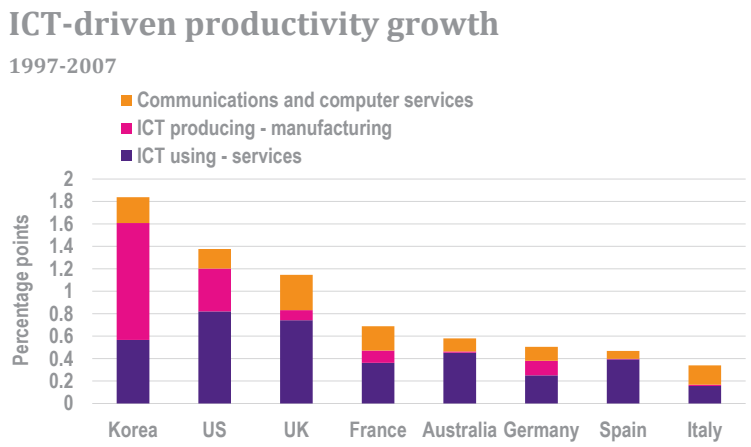


C.3 Growth accounting estimates

An alternative approach is to utilise growth accounting to isolate impacts and linkages at a sectorial level. We consider this approach more robust, though the focus in the literature has mostly been on information and communications technology (ICT) rather than communications or high speed communications. Figure C-3 shows estimates of the contribution of ICT production and use using KLEMS data for the decade to 2007.

[92] “The costs and benefits of high-speed broadband.” August 2014.
http://www.communications.gov.au/__data/assets/pdf_file/0003/243039/Cost-Benefit_Analysis_-_FINAL_-_For_Publication.pdf

Figure C-3:



Source: Plum Consulting, KLEMS

We note that this period to some extent pre-dates mass market broadband adoption. Nevertheless other evidence suggests that communications has played a key role in driving productivity growth.

The UK has experienced an overall productivity growth slowdown, in part because of falling unemployment. The ICT producing sector including communications nevertheless stood out in continuing to contribute directly to productivity growth during the period to Q4 2013.[93]

Goodridge *et al* (2013) find that the contribution of telecoms in the UK approximately doubles if quality-adjusted communications equipment prices are used.[94] Telecommunications equipment capital was found to account for 20.7% of total factor productivity growth from 1990-2008. Further, the contribution of communications equipment capital services grew from 2% of total capital services in the early 1990s to 10% by the late 2000s.

Goodridge *et al* (2014) highlight the relative strength of productivity growth in the ICT industry up to 1990 to 2011.[95] They find that manufacturing and ICT made the greatest contributions to growth (with many industries making a negative contribution) and that *"The most intangible-intensive industry is information & communication (intangible investment as a proportion of value added = 19%".* This suggests the need to look beyond conventional capex in assessing developments in the telecommunications sector and more generally in the wider economy.

C.4 Cost benefit assessments

There are many cost benefit studies in relation to high speed broadband. These draw on a range of approaches to estimating demand and the benefits of broadband. However, many studies suffer from

[93] Bank of England. June 2014. "The UK productivity puzzle – a sectoral perspective". Table 1. http://www.bankofengland.co.uk/publications/Documents/speeches/2014/speech739.pdf

[94] Peter Goodridge, Jonathan Haskel and Gavin Wallis. 2013. "The "C" in ICT: Communications Capital, Spillovers and UK Growth". *Journal of Economic Literature.* http://webmeets.com/files/papers/res/2014/490/Contrib_Telecom_Paper_26July2013.pdf

[95] Goodridge, Haskel and Wallis. August 2014. "UK innovation index 2014." http://www.nesta.org.uk/sites/default/files/1407_innovation_index_2014.pdf

basic defects, in particular attributing benefits to applications that do not require high speed broadband and double counting of benefits via inappropriate inclusion of direct and indirect effects.

One study which is built on sound economic foundations is the re-appraisal of the FTTH deployment in Australia - the "Vertigan report". The analysis considered a range of evidence and concluded that fibre investment beyond what would be commercially attractive involved negative benefits compared to commercial deployment whilst a multi technology mix approach including FTTC and cable (with 25% FTTP) involved positive benefits but nevertheless had a negative value after taking account of costs (Table C-1).[96]

Table C-1: Cost benefit analysis of fibre investment options in Australia

Relative to unsubsidised rollout	MTM scenario	FTTP scenario
Cost ($b)	7.2	17.6
Benefit ($b)	1.0	-4.7
Net benefit ($b)	-6.1	-22.2
Per household ($)	-620	-2,220

[96] "The costs and benefits of high-speed broadband." August 2014.
http://www.communications.gov.au/__data/assets/pdf_file/0003/243039/Cost-Benefit_Analysis_-_FINAL_-_For_Publication.pdf