Making the right connection

Dan Lewis examines broadband performance in the UK, looking at why it is falling behind the rest of the world and at what can be done to improve services

The UK has many infrastructure needs: the electricity grid struggles to meet peak demand;[1] road, rail and airports require funding; and a number of regions are limping economically in comparison with London.[2] Among all these calls on the nation's purse, however, broadband arguably stands out. If the UK is to enable small businesses in the regions to thrive, if it is to keep pace with technological innovation and have a workforce that can meet the demands of the twenty-first century, it needs to ensure that, in the not too distant future, every corner of the UK has ultrafast internet connectivity.

Copper wires are only able to carry a limited amount of data

With the right broadband investment, we should also be looking forward to virtual and enhanced reality – leading to the near-death of distance, to the advent of self-driving cars and drones, to the internet of things, and to fully cloud-based services in which huge processing power and storage resides in the Web. Last but not least, it would bring us connectivity with the 4bn more people who are going to join the internet from the developing world.

Annual demand growth for data at 40 per cent appears insatiable and yet the investment lag is not only palpable but misdirected. We are clearly falling behind on international rankings for upload (39th) and download (23rd) speeds. At no small cost, priority has been given over to the short-term incremental improvement of the incumbent BT's copper wires while we are leapfrogged by other nations that choose fibre-optic cable and wireless technologies. The problem with focusing on existing copper infrastructure is that there are relatively narrow physical limits to the amount of data that copper wires can carry, even over short distances. Mobile internet connectivity also has clear constraints in comparison with fibre-optic cables[3] and, in any case, will still require a cabled network to connect to and for so-called "backhaul" (carrying data between mobile masts). If we are to compete, we need to lay much more fibre.

How we got here

To understand why twenty-first century Britain struggles so much to keep up with the rest of the world in broadband, you have to go back to the dawn of the communications industry in the mid-nineteenth century. The UK was a pioneer and communications technology initially emerged out of the railway industry. Telegraphs were used to help with signalling and messaging – the first telegraph system linked Euston station and Camden Town – and use was then expanded to public communications. Some people refer to this period as the Victorian internet.[4] While initially popular, the telegraph companies became a quasi-oligopoly, resented by newspapers for their high costs and a target for the Post Office, which wanted to accumulate more power.

The UK was also under some pressure from the European continent to join one of the world's first supranational government organisations; the Telegraph Union. It established technological standardisation and norms and tariff uniformity across the international network. But you could only become a member if the telegraph service was run by the state.[5] The telegraph companies – the tech unicorns of their day – were effectively nationalised in in 1868 with the Telegraph Act, which gave the government the right to acquire all telegraphy businesses. In the following year, the 1869 Act gave the government a monopoly. Seen from the perspective of the early twenty-first century, when regulators regularly try to promote competition and choice for consumers, this seems like a wilful act of clunking bureaucracy. But commercial companies, quite naturally, focus on those businesses that generate the highest return and they do not invest where they will lose money.

In 1981, the UK government reintroduced competition in telecoms. Mercury Communications was launched in 1982, offering landlines and call boxes in competition with British Telecom, which itself was part-privatised in 1984. The telecom boom of the late 1990s brought a lot of investment in infrastructure and the build-out of mobile networks. But much of the major fixed-line investment, was in the backbone, which runs between telephone exchanges – rather than in the so-called "last mile", the connection between street-level cabinets and premises. The "last mile" received relatively little attention for two main reasons: until recently, the existing copper wires could be upgraded to meet most capacity demands; and BT had control of the "last mile" infrastructure, which made it difficult for competitors to obtain a level playing field.

Telegraphs became the equivalent of the Victorian internet

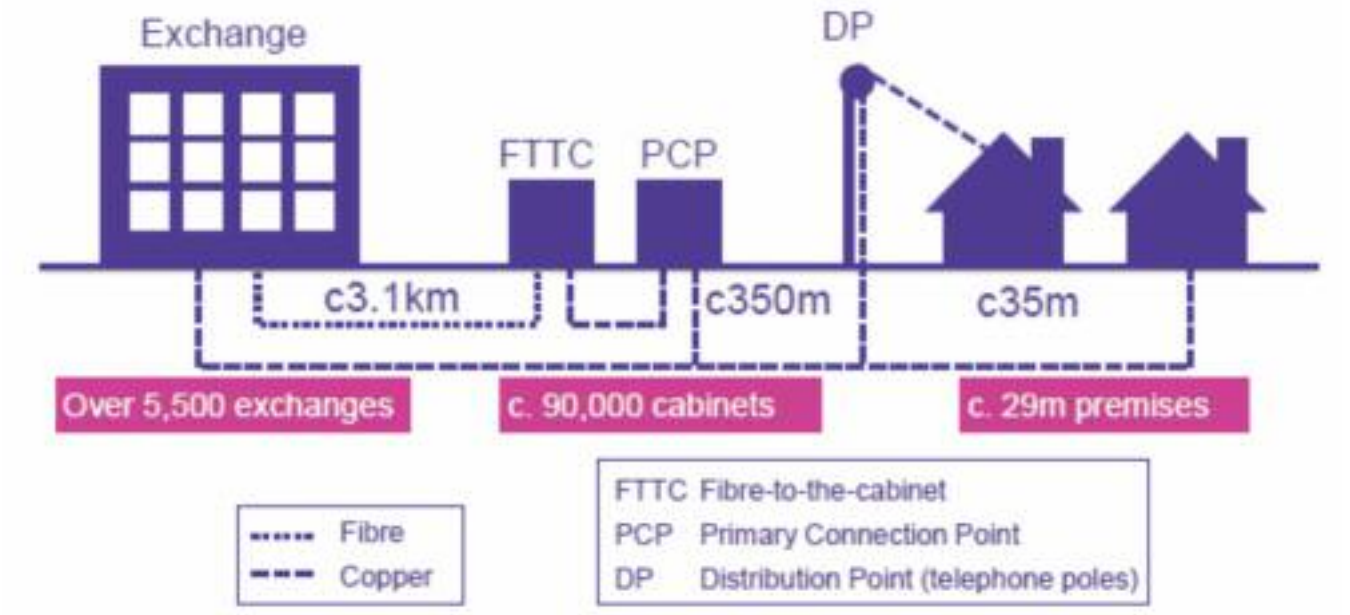
What does the broadband network look like now?

In the past few years, aided by government, BT has been replacing the copper cables from the exchanges to the 90,000 cabinets with fibre optic cable – which supports end-user download speeds of 26 Mbps per second. But there is still a bottleneck. While fibre optic

1. Kelly J-F (2016), 'UK to Double French Energy Supplies With New Cable'. *BBC*, 13 June. Available at: www.bbc.co.uk/news/business-36516585.
2. Parveen N (2016), 'North of England Review Calls for Radical Change to Close Wealth Gap'. *The Guardian*, 30 June. See: www.theguardian.com/uk-news/2016/jun/30/north-of-england-economy-review-radical-change-wealth-gap.
3. Idachaba F et al (2014), 'Future Trends in Fibre Optics Communication'. *Proceedings of the World Congress on Engineering*, Vol I, WCE 2014, July 2-4, 2014. Available at: www.iaeng.org/publication/WCE2014/WCE2014_pp438-442.pdf.
4. Atterbury P (2011), 'Victorian Technology'. *BBC*, *British History*. Available at: www.bbc.co.uk/history/british/victorians/victorian_technology_01.shtml55.
5. Cassis Y et al (eds, 2016), *Infrastructure Finance in Europe*, OUP.

cables have vastly greater capacity than copper wires, most connections into premises in the UK still use copper.[6] The final stage of infrastructure upgrade, which we are very slowly entering, will lay fibre optic cable from the cabinet to nearly all 29m premises and remove the last vestiges of copper connectivity. That will take download and upload speeds from a superfast 26 Mbps per second upwards to gigabit plus. (As things stand, around 250 postcodes out of 314,000 in London already have a 1 gigabit (1000Mb).[7]) The roll-out of fibre to all premises in the UK is approximately 0.003 per cent complete. Calculating what it will cost is hard. Matthew Hare, chief executive of Gigaclear, the fibre broadband provider, estimates the costs as 20m properties at £500 each; 5m properties at £800 each; 3m properties at £1,000 each; and 1.5m properties at £2,000 each.

Broadband infrastructure in the UK



Source: author

According to Philip Virgo, of Winsafe and a regular columnist for *Computer Weekly,* with decades of experience in the sector, the variables include how much is paid for access and wayleaves plus whether one includes mobile broadband. Virgo was involved in a 2002 modelling exercise that estimated it would cost between £18bn to £20bn. He estimates that since then the construction costs have come down by about 20 per cent and the equipment costs have come down by at least 50 per cent. He estimates the equivalent current figure at no more than £10bn to £15bn. In recent years, these costs may have actually fallen faster, if the learning curves of the AltNets such as Hyperoptic and Gigaclear are to be believed.

The figure above describes almost the entire broadband network in the UK. What is not displayed is that data is also transmitted from the exchanges to one of nine internet exchange points dotted around the UK (three in London, two in Manchester, the others in Brighton, Cardiff, Edinburgh and Leeds) and from there via mostly undersea cable (but also via satellite) around the world via global carriers such as AT&T. Alongside, and connected to this network via cable to the exchanges, are approximately 52,500 mobile base stations or masts, supporting 90m UK mobile phone subscriptions . The constraints of the air interface mean that mobile operators only use mobile connectivity as the "last mile". Mobile data are mainly carried by the fixed networks that connect mobile masts. Finally, there are 12,000 satellite broadband subscribers in the more remote regions of the UK who connect via satellite to internet exchange points.

The increasing importance of broadband connectivity led the government to introduce a universal service obligation in November 2015, whereby people will have the legal right to request broadband connectivity of at least 10/Mbits by 2020. As things stand, Ofcom estimates that around a quarter of UK homes had broadband connectivity of up to 30Mbits (which counts as superfast) as of end 2014. But there is a rural divide. It is much easier to get superfast broadband in cities than in the country. This is largely because it is much more profitable for a provider to offer high-speed broadband to a multi-dwelling unit, such as a large block of flats, already close to a fibre backbone, than it is to connect up just one house that is a long distance from a cabinet or an exchange.

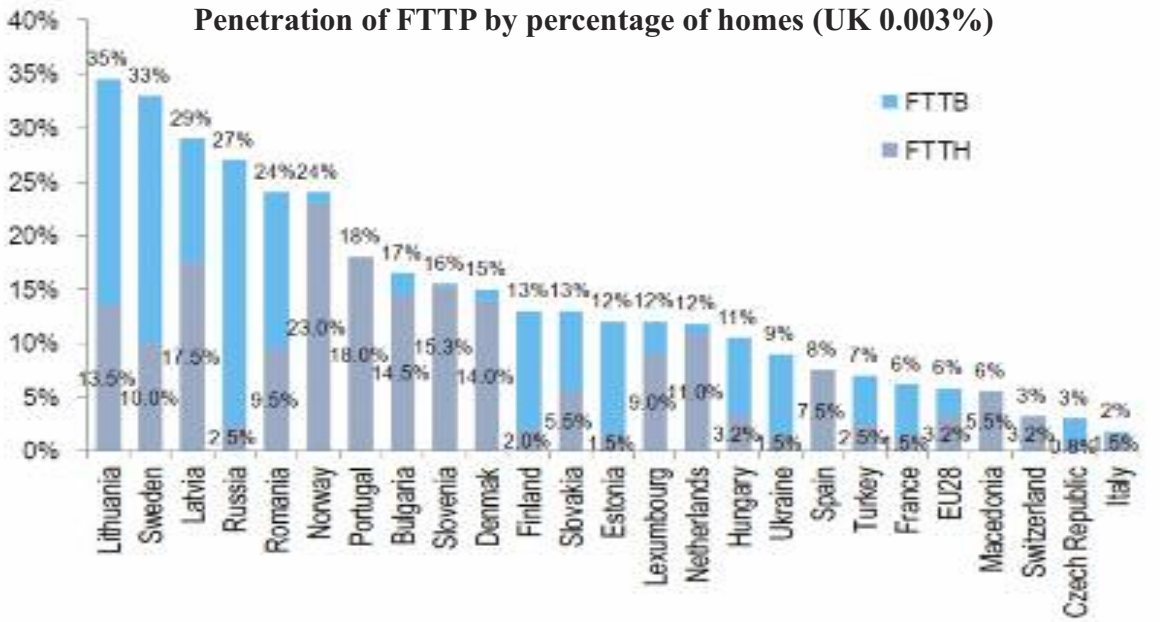
It is much easier to get superfast broadband in cities than in the country

How can ultrafast broadband best be rolled out across the UK?

There is a range of competing and complimentary broadband and connectivity technologies available or soon to be available. Costing is on a case-by-case basis, commercially sensitive and, as the technology is new, does not yet include learning curves.

Fibre to the premise (FTTP). This is for now the highest

6. Unattributed (2015), 'Engineers Break Power and Distance Barrier for Fibre Optic Communications'. *Phys.Org*, 25 June. Available at: www.phys.org/news/2015-06-electrical-power-distance-barriers-fiber.html.
7. www.broadband.co.uk/guides/ultrafast-and-hyperfast-broadband.



Source: FTTH Council

performing internet connection. A fibre cable into the home or office affords symmetrical upload and download speeds of upwards of 1GBps with very low latency rates. Costs to serve a premise have fallen dramatically partly because of the use of micro-trenching, which is what it suggests: a trench at a depth of 23 inches in the pavement or road above any other utility connections.

Satellite broadband. Satellite broadband can serve remote, poorly connected locations at much lower cost, more quickly than fibre. All of today's broadband satellites operate in geostationary orbit at a height of 22,000 miles, which creates latency of 250 microseconds or more. Download speeds are improving with a 1 gigabit connection to become available by 2020.

Fibre to the cabinet. FTTC lays fibre optic cable between the cabinet and the exchange for a very high bit rate digital subscriber line (VDSL). This is the superfast option being deployed across the UK by Openreach and can deliver speeds of up to 76 Mbps depending on the distance to the cabinet. There is still a constraint because the final connection to the premises are copper.

G.Fast or fibre to the distribution point. BT is trialling G.Fast, which promises download speeds of 300 Mbps-500 Mbps and upload speeds of around a tenth of that with upgraded or new cabinets. XG.Fast is a further iteration and promises to deliver speeds up to 5Gbps. But, in both cases, performance deteriorates rapidly with distance from the cabinet and this is a highly localised and unpredictable performance. Moreover, BT is only planning for the connectivity to be ultrafast in one direction – download – although this can be adjusted but it is not truly symmetrical without halving the download capacity. BT believes it can roll out G.Fast to 10m homes and premises by 2020.

There have been calls for the UK to do more to increase competition

Hybrid fibre-coaxial cable using DOCSIS standards. This is fibre optic cable to a proprietary street cabinet, followed by a coaxial cabinet to the home, and is what Virgin Media has. It is now owned by Liberty Global and offers download speeds of up to 150 Mbps.

Aerial fibre. To avoid the costs of digging trenches in pavements and to the premise, in some cases it may be possible to deliver FTTP wound around existing telegraph poles and lines.

Mobile wireless. In the UK, Relish has led the way with this offering, using 3G and 4G signals only for data to deliver 50 Mbps-60 Mbps and up to 700 Mbps to a router in areas such as central London or rural not-spots that are poorly served by broadband.

Mobile broadband -3G, 4G, 5G. The average download speed for mobile today is 6.1 Mbps, rising to 15.1 Mbps for 4G.[8] 5G promises to have a speed of at least 1 Gbps and may be available from 2020. Latency for most of today's mobile broadband offerings is around 110 milliseconds and 50 for 4G.

Lessons that should be learned

In *Towards Ultrafast Britain*, a paper I authored for the Institute of Directors, I identified the two best and most appropriate examples for the UK to look closely at – New Zealand and Lithuania.

In 2011, overseen by the regulator and approved overwhelmingly by shareholders, Telecom NZ was structurally divided into two separate companies – Chorus and Telecom New Zealand, which became Spark New Zealand. Chorus, the Kiwi equivalent of BT Openreach, is responsible for the network infrastructure and Spark provides internet, mobile and fixed line telephone services. Crucially, Chorus was spun off, not sold off. This meant that existing shareholders were able to see an increase in value and retain enough cash flow for future investments.

From a consumer point of view, New Zealand is racing ahead not just in delivering more fibre network investment and subscriptions, but in a flourishing range of consumer choice in video on demand, ISPs and fixed line services, with a goal to have fibre to the home/premises reaching 75 per cent of the country by 2020. There have been calls for the UK to take the same step, spinning off BT Openreach to increase competition in the provision of "last mile"

8. See: www.ispreview.co.uk/broadband_mobile.php.

connectivity. In New Zealand's rural areas that are hard and expensive to reach, mobile broadband and satellite hold sway.

But there is another example closer to home that does not involve a spin-off. Lithuania, with a GDP per head at a third of the UK's, has the fastest upload and download speeds in Europe, the highest penetration of FTTH (35 per cent at the end of 2014), and the world's number one ranking for ICT infrastructure. How did it do it?

In 2004, Lithuania's equivalent of Ofcom, RRT, mandated the compulsory sharing of all passive communications network infrastructure. To incentivise network investment, RTT went for a low-cost-access model to the ducts and poles, the access infrastructure in which fibre is laid. Together, these two measures led to a rapid build-out predominantly (61 per cent) by the altnets in strong competition with the national incumbent, which was then forced to make further investments to keep up. There are also no limitations on use in Lithuanian ducts and they can be freely used by mobile operators as well as altnets.

Lithuania benefits from having relatively high-density housing compared with the UK and, perversely perhaps, from not having the sort of advanced legacy infrastructure that the UK's long heritage of communications bequeathed.[9] The Lithuanian government also supports the build-out of broadband in rural areas that are not attractive to commercial companies. Overall though, it has been very much driven by the private sector profiting from one of the world's most open and lowest cost access telecom infrastructures.

BT's competitors regularly complain to Ofcom not just about the cost of access to Openreach's network but also of the physical and regulatory hurdles. It does seem that this Lithuanian approach has yet to be fully tried.

Where are the broadband connectivity chokepoints in the UK today?

The UK has six areas of weakness for broadband; large rural areas, not-spots; city centres; suboptimal competition; poor knowledge about the final leg of the copper network; and limited knowledge about the whole network.

For many Britons, it is perhaps the poor rural connectivity that grates most. According to Ofcom's *Connected Nations Report* of December 2015, 63 per cent of rural areas are without superfast broadband, defined as having a download speed of 30 Mbps or more. Today about 1.5m premises – about 48 per cent of all rural premises – are not even able to access speeds of 10 Mbps. Equally for mobile coverage, the UK still lags far behind in rural connectivity in 2G, 3G and 4G, with particularly poor reception indoors.

Reversing rural poor connectivity matters so much because it offers the prospect of a dynamic rural economy and reduces the need for expensive rural public and private transport. Right now, no one is going to launch a start-up in a farmyard barn with 0.5 Mbps connection. But with a 1 gigabit connection, a whole new world opens up.

9. EU overview of Lithuania's Next Generation Internet Access Development Plan. Available at: www.ec.europa.eu/digital-single-market/en/country-information-lithuania.

10. Thomas D (2015), 'BT Under Pressure as Race for Broadband Market Share Speeds Up'. *Financial Times*, 29 June. Available at: www.next.ft.com/content/215cc6da-1b52-11e5-8201-cbdb03d71480#axzz3wq5jDU4S.

11. See Ofcom's VULA margin final statement of March 2015, page 27, paragraph 3.55. Based on BT having more than 2.5m retail superfast broadband customers and Openreach connecting approximately 3.4m premises. Available at: www./stakeholders.ofcom.org.uk/consultations/VULA-margin/statement/, pdf.

It is questionable whether faster rural broadband will happen without more competition. BT's market share appears to be increasing, while line rental charges have risen much faster than inflation.[10]

Of those consumers upgrading to superfast broadband, according to Ofcom, at least 74 per cent of the upgrades have gone to BT, compared with 40 per cent for all connections.[11]

This rising market share of the lead incumbent has led to criticism of the UK government's tax-funded programme to roll out broadband faster across the whole country. Some commentators argue that, if BT had not won all 44 of the contracts for Phase 1, which is intended to enable 90 per cent of the country to have access to superfast broadband by 2016, it would not have increased its market share as it has – that fair competition has been skewed. For the Phase 2 contracts, to reach 95 per cent of the country by the end of 2017, BT has won 42 of the 47 contracts.

Finding funding for the network upgrades may prove difficult

What are the plans for the evolution of broadband over the next 10 years?

The initial conclusions of Ofcom's *Strategic Review of Digital Communications*, published in February 2016, emphasised the need for a strategic shift to large scale investment in more fibre and for much more telecom infrastructure competition. The latter would mean opening up Openreach's network to competitors.

Critics contend that while the ambition was to be welcomed, there was no policy road map to get there. Nor were many telecoms companies satisfied with what would be less than a full separation of Openreach from BT. The target of 10 Mbps was also seen as inadequate to meet fast-rising everyday consumer and business data demand.

How will the cost of network upgrades and installations be met?

This is not an easy problem to solve. Even if competition were stronger in the UK, telecom companies tend to work in three to five year investment cycles, but replacing copper wires with fibre optic cable is a longer-term and highly capital intensive undertaking. The answer may be to match up this investment with the resources of pension funds that seek preditable returns over 15 years or more. Fibre broadband would be a good asset for them because, once in place, it lasts for decades, requires little maintenance and demand for the service is high and easy to forecast.

Even if investors are in place, not all areas of the country will be equally attractive. York has been able to make a 1 gigabit fibre connection available to households for £21.70 per month, with no line rental. But in some remote and rural parts of the countryside, it could easily cost many times that. In these cases, it seems obvious that mobile broadband and/or satellite broadband will be their future for a long time to come.

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