An assessment of HFC and FTTP options for gigabit connectivity in the UK market

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Summary

Before publication of the Future Telecommunications Infrastructure Review (FTIR) in 2018, Government and Ofcom activities in the UK were largely focused on ensuring effective competition and prevention of harm to consumers. With the FTIR, a new direction was set, with a proactive stance to drive investment and build-out with full fibre and 5G technologies – to ensure strong competitive positioning for the UK, with the ever-growing importance of the digital portion of the economy. The FTIR set the need for "*world-class digital infrastructure*", supporting the ambition for the UK to be the *"best place to start and grow a digital business"*[1].

With recent recognition of the need for some consideration of other technologies, Government has shifted to consider *"gigabit-capable"* solutions, defined as those offering "*a broadband connection of at least 1 Gbps/1,000 Mbps"*[2]. With the new Johnson Government, the schedule for nationwide access to gigabit-capable connections has also been revised from 2033 to 2025. Today, digital networks are widely recognised as critical infrastructure, and thus the development of resilient and economically efficient solutions is imperative.

Government acknowledges that there are various technologies that can deliver gigabit connectivity. For wired broadband, hybrid fibre cable (HFC) and full fibre (FF, or fibre to the premises, FTTP) are the two main technologies. Whereas fixed wireless access (FWA) solutions may also be useful, these are more likely to be relevant in rural areas, where cost structure can be very challenging with sparsity of premises.

Given that investment in new access networks is capitally intensive, Government and industry are motivated to ensure that investment is well-placed, securing new digital infrastructure for several decades to come. There are thus important questions over the relative value of investments in HFC and FTTP networks.

In this paper, commissioned by CityFibre Holdings Limited, we assess the relative positioning of HFC and FTTP access networks.

With balanced assessment across a range of technical and commercial dimensions, we conclude that FTTP technology offers greater resilience, economic efficiency, and support for policy objectives, and therefore is the natural choice for public investment and gap funded initiatives.

However, with significant legacy cable assets available in the UK market, we note that there is some value in exploiting these in a measured way, with incremental investment for upgrades, which should be contained principally to the private sector.

[1] Department for Digital, Culture, Media & Sport (2017), *"UK DIGITAL STRATEGY"*, https://www.gov.uk/government/publications/uk-digital-strategy/executive-summary.
[2] Department for Digital, Culture, Media & Sport (2018), *"FUTURE TELECOMS INFRASTRUCTURE REVIEW"*, FTIR, pp. 81.

1 Government's gigabit ambition

Government published the Future Telecoms Infrastructure Review (FTIR) in July 2018. The aim of the Review was to examine the market and policy conditions that would encourage greater investment in future telecoms infrastructure in the UK. It set out a vision that included the provision of *"world class digital connectivity that is gigabit-capable, reliable, long-lasting and widely available across the UK"*[3].

At the time of publication, there was strong emphasis on full fibre deployment for the UK. Full fibre was identified, along with 5G, as a long-term solution to provide *"speed, resilience and reliability that consumers want and businesses need in order to grow"*[4]. One key aim of the Review was to get *"15 million premises connected to full fibre by 2025"* and to achieve "*coverage across all parts of the country by 2033"*[5]. Actions were identified for Government and Ofcom; there have since been various Government initiatives, such as the Local Full Fibre Network (LFFN) and Rural Gigabit Connectivity (RGC) programmes, and Ofcom has set out plans to incentivise BT's fibre network expansion with its Regulatory Asset Base (RAB) model, still under consultation[6]. In a separate paper[7], it has been noted that the variety of Government funding schemes would benefit from some consolidation.

More recently, the Johnson Government has presented revised ambitions, with a shift for nationwide access to gigabit-capable services by 2025 (rather than 2033, as in the FTIR). Notably, focus has shifted from use of full fibre to gigabit solutions, indicating a higher level of flexibility in technology solutions, but a more aggressive schedule for UK coverage. Despite these revisions, there remains considerable uncertainty in Government's targets, and a clear definition of Gigabit connectivity does not yet exist. Thus, it remains somewhat unclear how the 2025 target will be fulfilled.

2 Cable and fibre technologies

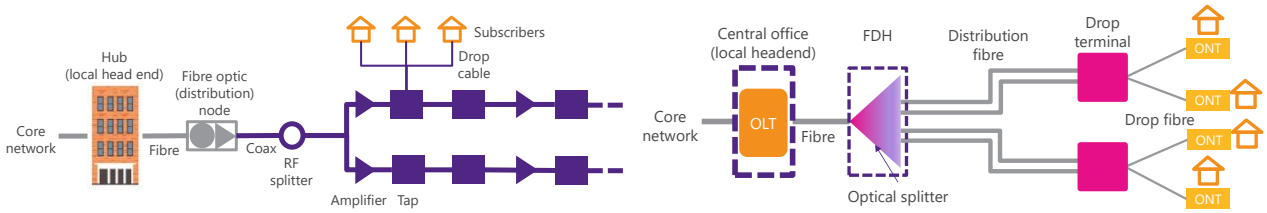
Both HFC and FTTP technologies exist in the UK market, and both continue to attract further investment, supporting gigabit services to individual premises[8]. We summarise these technologies below (see Figure 1).

In an HFC cable network, coaxial cable runs from an optical network distribution node to users' premises. Each node typically serves between 500 and 2000 premises. The typical tree and branch structure means that multiple premises share the same cable from the splitter. Signals pass along shared paths to many premises, with amplifiers to boost signals along the paths. Migration from the currently used DOCSIS 3.0 HFC technical standard to DOCSIS 3.1 is expected to enable increases in data rates to 10 Gbps downstream and 2 Gbps upstream. With active electronics in the access network, the network can be compromised or damaged in cases of water ingress.

In an FTTP network, premises are served with fibre, and all components from splitter to ONT (optical network terminal at customer premises) are passive. The fibre backhaul connection between the FDH (fibre distribution hub) and the OLT (optical line terminal) is shared by multiple ONTs; typically 64 or 128 homes will share the same local access backhaul, and several thousand premises will typically be covered by a single access network build-out (i.e. per backbone gateway cabinet). Many FTTP networks use G-PON technology which supports a maximum line rate of 2.5 Gbps/1.2 Gbps (downstream/upstream). Upgrading from G-PON to XGS-PON enables increased maximum line rates up to 10 Gbps downstream and 10 Gbps upstream. With passive optical technology, the risk of service impairment from water damage, as with HFC, is removed.

[3] FTIR, pp. 1.
[4] Ibid., pp. 16.
[5] Ibid., pp. 16.
[6] See: https://www.ofcom.org.uk/consultations-and-statements/category-1/bt-financial-reporting
[7] See: https://plumconsulting.co.uk/unlocking-value-with-rural-broadband/
[8] Note: gigabit connectivity may be defined variously. In some cases, gigabit data rates may not be supportable at all times for all users. Data rate speeds are defined according to whether peak or average rates.

Figure 1: Summary diagrams for HFC cable (left) and FTTP (right) networks



Source: Plum Consulting, 2020.

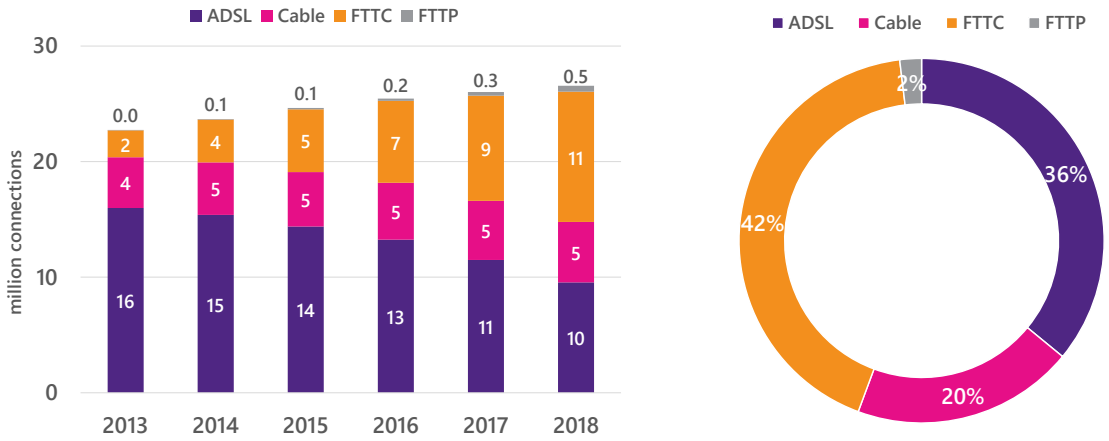
3 Market positioning

With strong focus from Government and industry, progress is being made on deploying full fibre in the UK market. Ofcom's most recent Connected Nations Report[9] indicates that around 10% of UK premises now have access to full fibre, and build-out is continuing.

Separately, there exist regions in the UK where coaxial cable networks exist. These are largely operated today by Virgin Media Limited (owned by Liberty Global plc in the UK). These cable networks, which have been evolved from legacy use for cable TV to support broadband services using DOCSIS technology, cover a significant volume of premises (see Figure 2[10]), and Virgin Media is continuing to invest in building out both cable and full fibre access networks.

Virgin Media claims[11] to have passed over 15m premises in the UK (whilst current connections on cable sit at around 5m), giving it considerable market presence. If Virgin were to upgrade its network to bring gigabit connectivity, this would appear to support Government's targets for widespread access by 2025. However, questions remain as to the effectiveness of investment in cable technology, relative to fibre. We examine these below.

Figure 2: Volume of fixed broadband connections by technology and market shares



Source: The Communications Market Report, Ofcom, accessed 2020.

[9] See: https://www.ofcom.org.uk/__data/assets/pdf_file/0023/186413/Connected-Nations-2019-UK-final.pdf
[10] See: https://www.ofcom.org.uk/research-and-data/multi-sector-research/cmr/interactive-data
[11] See: https://www.virginmedia.com/corporate/investors-overview

4 Whether to invest?

We position the question whether investment is better placed in HFC or FTTP technology, given Government's ambitions. "Better" of course deserves some definition. With any use of public funding, an effective economic outcome must be delivered, and this should include maintenance of competitive access, long term resilience, and affordable services for users, with gigabit capability.

Thus, any decision to invest, whether with public or private funds, or a combination with any gap funding, should be based on balanced assessment across a variety of key dimensions. We consider these below, with reference to current technology standards being deployed in the UK market (see Table 1).

Table 1: Assessment of HFC and FTTP technologies as gigabit service options

Assessment dimensions	HFC	FTTP	Assessment
Network architecture	Optical backhaul, with coaxial cable connections to premises.	Fully optical network between backbone and all premises.	Legacy HFC networks exist, which can be upgraded in some cases. FTTP is a newer technology which requires new build.
Technical performance	DOCSIS 3.1 can attain up to : 10 Gbps downstream 2 Gbps upstream.	XGS-PON can attain up to: 10 Gbps downstream 10 Gbps upstream.	FTTP offers symmetric data rate performance. HFC typically does not. Some applications such as dense 5G carrier services, cloud services, gaming, security monitoring, and virtual reality critically require symmetric service capability, and are therefore not supportable using HFC.
Physical performance	Copper cables and active electronics susceptible to water damage which can both damage assets, and impair service quality.	Fully optical and passive access network is resilient to water damage, with no impact to asset or service quality.	HFC networks include metallic paths and active electronics which can be susceptible to water damage. FTTP is fully resilient to water damage.
Capital investment	Legacy networks can be upgraded to newer DOCSIS standards and thereby higher data rates. With any new builds, significant cost is in civil engineering programmes.	Legacy PON fibre networks can be upgraded to XGS-PON. New builds are ongoing using a mix of XGS-PON, and point to point (P2P) fibre networks. With any new builds, significant cost is in civil engineering programmes.	With any new build-out, both HFC and FTTP require similar levels of capital investment, driven by civil engineering programmes. Where legacy HFC networks exist, these can be upgraded to provide gigabit connectivity.
Operational cost	With active electronics and metallic circuits, ongoing maintenance to the access network will be required. Asset lifespan is likely to be limited.	With fully optical circuits, maintenance costs can be expected to be lower than with HFC on a comparable basis. Asset lifespan is likely to be several decades.	Operational costs and asset lifespan are more attractive with FTTP networks.
Potential for open access	Virgin's HFC network is operated on a private basis. There is no provision for open access.	Some FTTP operators offer or plan to offer open access on their networks.	Greater potential for provision of open access exists with FTTP networks, partly due to commercial positioning, and partly due to the newer status of FTTP technology which can be more easily and cost efficiently designed to offer open access.

Technology evolution	The DOCSIS 4.0 technology standard is expected to become available post-2020, which may offer symmetrical data services up to 10 Gbps. However, there is some uncertainty over the evolution of HFC technology. As FTTP technology develops, economies of scale can be expected to worsen with HFC. Also, DOCSIS 4.0 is reliant on very high order modulation schemes, which can be susceptible to interference, as has been observed practically with G.lite copper-based technology.	XGS-PON technology is being deployed commercially in the UK today, offering symmetric services up to 10 Gbps. P2P fibre networks allow data rates in excess of 10 Gbps, where these are needed (e.g. with B2B, business park applications). Fibre technology is continuing to evolve, and new solutions based on innovations such as WDM-PON can be expected in future to offer even higher data rates in future.	Fully optical access networks offer greater potential for future upgrades to higher data rate services, in excess of 10 Gbps.
Incremental investment	A significant volume of legacy cable networks exist in the UK today, in some areas.	FTTP networks are currently accessible to c. 10% of UK premises.	Incremental investment on legacy HFC networks could support Government's targets for widespread gigabit access by 2025.

5 Conclusions

Broadly, we see investment in FTTP as the "better" option for public or gap funded investment, providing a more resilient, "future-proof", and economically efficient solution (importantly inclusive of ability to support symmetric gigabit data services), supporting open access and thereby effective market competition.

However, where legacy cable networks exist, we believe that there is some value in exploiting these with some incremental investment, which could provide evolution from legacy cable technologies to the newer DOCSIS 3.1 standards and above.

Other technologies such as fixed wireless access (FWA) (whether using cellular 4G or 5G, or dedicated FWA solutions) should not be discounted, and different areas of the UK may well require different technology solutions, if Government targets are to be met efficiently.

With some concerns over the resilience of HFC technology and ability to effectively support competitive access, we conclude that an effective approach will include leverage of HFC networks, where these can be efficiently upgraded (rather than further built out) and used to provide gigabit services. Inclusion of premises addressed by HFC technology will enable Government targets to be met more effectively in the near term.

However, FTTP technology should be deployed in areas where HFC is not available, which, practically, means all areas where new gigabit-capable network must be built (and can be deployed with reasonable cost efficiency).

In areas where FTTP is not cost-efficient, and legacy HFC is not available, innovative solutions such as FWA or hybrid fibre-wireless networks should be considered.

In the longer term, FTTP should be built out comprehensively in the UK, as a resilient and future-proof long-term solution, supporting the nation's digital services economy.

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