Delivering cost effective telecoms solutions

Call Flow Solutions Ltd
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Call Flow Solutions Limited- Hampshire

Provision of Pilot Services in Relation to the Superfast Broadband Rollout Programme

Project Report: Final feasibility update 2.0

March 2016

Contents

1 Executive summary

This feasibility report investigates the technical and commercial viability of delivering Superfast Broadband (SFBB) to a geographical area that has been designated as the 'Final 5%', i.e. the remaining UK premises that are beyond the reach of the existing and planned SFBB networks. It is recognised that the standard rural delivery mechanism in the UK of Fibre to the Cabinet (FTTC) is unlikely to be able to achieve the coverage levels desired in these challenging areas.

Under this BDUK Market Testing Pilot ('MTP'), Call Flow Solutions Ltd ('CFS') has demonstrated how maximum SFBB coverage can be achieved in the project area using the hybrid delivery methods that CFS has developed, detailing the commercial and cost implications.

CFS has successfully completed its deployment of FTTP, FTTC and FWA to over 96% of a rural area that covers 1,500 premises. CFS has concluded that its hybrid delivery model is feasible for this type of area and scalable to other areas in the 'Final 5%'. The model is demonstrating significant NGA coverage (minimum 30 Mbit/s) of a large rural area for £800 per premises passed. This cost is lower than any other terrestrial based solution and offers clear benefits over satellite in the form of faster response times and no usage based charging[1].

In terms of scaling, this cost/coverage ratio is also important when considering supplier contribution. A FTTP solution quoting £2,000 per premises and a 50% contribution is less financially attractive (in terms of public contribution) than a SFBB solution of £1,000 per premises with a 10% contribution.

CFS has delivered an additional, predominantly FWA, solution to an exchange area that BDUK added to the intervention area part way through the pilot project. All 260 premises served by this exchange are on long exchange-only lines, and as such this area offered an opportunity to learn more about the costs to build NGA to areas where cabinet-based technologies could not form a part of the hybrid solution.

In summary, the CFS model achieves very high coverage rates in these challenging areas for relatively low contributions of both public and private investment. CFS believes the model offers the potential of far greater UK coverage per total level of investment than other comparable (maximum coverage) options.

CFS has shown the project area to be well within the assumption based modelling proposed under the BDUK pilot tender for its forecast coverage of the designated project area, and remaining within the budget envelope. As such, CFS believes its hybrid approach could cost effectively move large parts of the UK from 95% SFBB coverage to near 100% coverage with a commercially sustainable model.

[1] Very few customers exceed their monthly allowance of either 40MB or 200MB depending on the package they chose.

1.1 Key findings

- The pilot has demonstrated a 'hybrid solution' that successfully reaches NGA white premises across three whole rural exchange areas. The hybrid solution has two dimensions: access technology, and build approach.
- CFS believe the pilot area to be typical of the Final 5%, and clearly highlights the advantages of the hybrid model being deployed. Each access technology has its limitations and these are well understood. Combining the technologies in a way that the strengths of each complement each other is an effective method to reach dispersed rural areas.
- Multiple options for build approach such as PIA (using BT's ducts and poles), own build – new dig or poles, and whether to build through public or private land, adds further flexibility to tackle each challenge to suit specific feasibility, time, Capex and Opex constraints.
- Cost per premises ranges from £623 to £806 on a sliding scale between 61% and 96% coverage of the original intervention area.
- CFS believes that the hybrid model can address the various challenges that a typical Final 5% area will present, provided it is across the whole 5% rather than, for example, just the most challenging 2%. CFS believes the model is geographically applicable to 60% to 75% of the Final 5% premises.
- Once a communications provider has a presence in an area, finding commercially viable extensions in the Final 5% then reduces some subsequent requirement for public money.
- The pilot has applied innovations that can deliver increased value for money in deployment and operations: mole ploughing, impact mole, use of water contractors for civils work, successful PIA deployment, and the development of a proof-of-concept trial for new SLU products with Openreach.
- The commercial model has benefited from successful negotiations of low cost wayleaves and an easement agreed with the National Trust.
- The commercial model for this specific pilot area of <2,000 premises has a monthly break even rate at around 200 connections (12.5% subscription rate). This was achieved at the end of February 2016, less than 12 months after the first part of the network was launched. The network was a geographically new installation; a network that could leverage existing network/backhaul infrastructure in the area would have an earlier break-even point.
- CFS believes that the economies of scale that come with a larger project area are essential in the Final 5% to achieve financially viable networks in the short term. In the medium term, isolated smaller networks such as this project area, can achieve financial viability/profitability as subscription rates achieve circa 30% - which is not unrealistic over 3 years based on current market conditions (usually heavily dependent on current broadband speeds).
- For new geographical installations, there is a need for the network to bias expenditure towards Capex to achieve the most resilient network possible i.e. to minimise Opex costs. As the network grows this bias can change in line with the commercial model being deployed e.g. deploy more overhead network at commercially advantageous rates - but which is typically more fault prone than underground network – justified due to the increased availability of locally skilled engineers to maintain the enlarged network.
- The Valuation Office Agency (VOA) approach to new NGA networks in the Final 5% (actually final 33% as CFS understand it) is not particularly detrimental to the commercial viability of such

networks. However, there remains uncertainty of the implications for FWA networks, and these are largely mitigated under the CFS hybrid model.

- Gigabit radio links in the E band 'lightly licensed' spectrum are a cost effective and hence important enabler to deliver high capacity bandwidth over relatively short distances in rural areas i.e. to aid delivery of SFBB that is able to achieve suitable economies of scale to the final 5% of premises passed.
- Some lanes in the rural areas are too narrow to permit installing new poles in the highways verge, or the available aerial space is already occupied by electricity cables. The scope for cost effective and more comprehensive FTTP delivery would be enhanced if PIA was extended to shared (electricity and telecoms dual user) poles.
- CFS has successfully followed a Statement of Requirement (SoR) process with BT Openreach to trial a new 'CuRe' node SLU product, supported by BDUK and industry via the OTA2[2] sub-working group. CFS believes the new SLU product can unlock huge potential for reducing the cost of extending copper based NGA to the hardest to reach premises.

[2] OTA2 is an independent organisation tasked by Ofcom to oversee co-operation between communications providers and enable a competitive environment in the telecommunications sector.

2 Introduction

2.1 Background

This Pilot Feasibility Report for Call Flow Solutions Ltd ('CFS') is the final deliverable for its contract with BDUK to deliver a 'Market Testing Pilot' ('MTP') project. This report presents the final assessment of the feasibility of the CFS solution for tackling 'Final 5%'[3] areas based on the deployment of a commercially sustainable superfast broadband network.

BDUK awarded a contract to CFS to deliver a MTP network in Hampshire from its £10m Innovation Fund. CFS was selected under the 'Technology' category to test alternative technical solutions and the associated commercial models, to determine whether these can be effective and sustainable in delivering superfast broadband solutions to rural areas in the Final 5%.

CFS has used a hybrid technology approach that meets the requirements for State Aid for a Next Generation Access (NGA) intervention. The network serves over 96% of the premises within the original intervention area at an average £800 per premises passed with a combination of FTTP (20%), FTTC (64%) and FWA (16%); to March 2016 CFS has also covered over 60% of an additional area that was introduced part way through the project, with a mixture of FWA and FTTP for £774 per premises passed.

The network has exceeded the target 12% take up rate by March 2016; take up rate is still increasing.

2.2 The project area

A map of the intervention area is provided in Appendix A – Coverage map. The Hampshire County Council website provides an interactive map with postcode search[4]. The project area is broadly contiguous and consists of:

- Two complete exchange areas - Bramdean and Ropley - where no NGA exists. It is reasonably assumed that BT Openreach (BTO) has concluded these exchange areas are commercially unviable for the deployment of NGA.
- In addition to these exchange areas are the villages of Gundleton and Bighton. These villages are too far from their serving cabinets to ever receive NGA by SLU/FTTC.
- A further complete exchange area – Privett – that was added to the project area in September 2015 (with only 6 months of the project remaining) when CFS and BDUK identified substantial new learnings around FWA costs by extending to this area. The exchange has no NGA and furthermore each of the premises is Exchange Only (EO) fed and as such there was no option for SLU/FTTC.

In terms of delivering NGA the key statistics set out in Figure **1** give an overview of the challenge presented in the project area when relying on the existing copper network.

[3] The circa 5% of UK premises that are forecast to be without NGA after commercial deployments and subsidised network deployments by 2017.

[4] http://www.hampshiresuperfastbroadband.com/about-the-project/dcms-innovation-fund-pilot/

Category	Number of premises Original project area	Number of premises Extension area
Premises Exchange Only (EO) fed (no option for NGA via SLU)	286 (19%)	261 (100%)
Premises > 1.85Km from their serving street cabinet (no option for NGA via SLU)	294 (20%)	0
Premises <1Km from their serving street cabinet (option for NGA via SLU)	699 (47%)	0
Premises >1Km <1.85Km from their serving street cabinet (option for NGA via SLU)	224 (15%)	0

Figure 1: Detail of premises covered

2.3 Preceding broadband service

At the start of the MTP project both Bramdean and Ropley exchanges had only exchange based ADSLmax services installed. There are no LLU operators in these exchanges. This is quite typical of the last 5%. As such, the fastest download speeds in the project area before the pilot project was 7.15Mbps, with many receiving far less. Privett exchange also has only ADSLmax services and no LLU.

During Q3 2015 BT started marketing its ADSL2+ based service ('up to 24Mbit/s') to the premises on the Ropley exchange. ADSL2+ equipment is installed at the exchange and enables premises within approximately 3km of the exchange an improvement on their previous ADSLmax service. Although this is not a qualifying NGA technology it provides a significant step up from previous services, and this investment had not been announced as part of BT's 2015 exchange upgrades programme.

CFS expects this development to challenge its original take up assumptions for the CFS NGA service on the Ropley exchange.

3 Pilot Feasibility commercial model

3.1 Assumptions

3.1.1 Capital expenditure and sources of funding

CFS has drawn down close to 100% of the grant funding for deployment, total £1,258,508 of the £1,258,560 grant that BDUK allocated to the project.

The total cost to deploy the network was £1,286,241, a +2% variation on the original budget. CFS has funded the £27,682 variation which was a factor of the higher than expected number of customer connections to March 2016. The capex breakdown between the original intervention area and the Privett extension is provided in **Figure 2**.

Area	Premises in the area	Coverage by March 2016	Backhaul Capex	Core network Capex	Access network Capex	Total Capex to March 2016
Original	1,503	96.1%	£38,500	£234,936	£891,250	£1,164,686
Extension	261	60.2%	£0	£30,800	£90,756	£121,556

Figure 2: Capex

3.1.2 Operational costs

The modelled Opex is broadly unchanged since the previous publications and the peak operation cash flow will be less than £17,000.

The modelled Opex includes duct and pole (PIA) rental**,** power, own infrastructure testing & repairs, BT SLU tie pair rental, backhaul gigabit EAD rental, and rack space rental for interconnect.

The backhaul rental costs represent a substantial proportion (over a third) of the basic fixed operational running costs of the network. Larger network deployments, that pass more premises and subsequently more connected premises, can significantly reduce the ratio of such fixed running costs per premise connected.

Additional direct subscriber costs per month are modelled at £7 per customer. This includes helpdesk costs, IP transit costs per retail customer and the Valuation Office Agency (VOA) liability per connected customer (business rates).

The VOA approach to new NGA networks in the Final 5% is not particularly detrimental to the commercial viability of such networks. However, there remains uncertainty of the implications for FWA networks, which are largely mitigated under the CFS hybrid model. The initial feasibility publication included an analysis of the business rates implications based on a new VOA model that applies to NGA network. Under this new model, the VOA have assigned counties/areas a rateable value per connected customer[5] . For Hampshire, this value is £13 p.a. per connected customer.

[5] http://www.voa.gov.uk/corporate/publications/Manuals/RatingManual/RatingManualVolume5/sect873/t oc.html#TopOfPage

3.1.3 Retail and wholesale pricing

See Annex B for the retail price offer and Annex C for the wholesale price offer. Retail and active wholesale pricing is consistent across all three access technologies – FTTP, FTTC and FWA.

Connection and rental charges are approximately 30% higher than urban 'market norms'. These charges reflect the high fixed operational costs of installing a new stand-alone rural network and is needed for the deployed network to be able to achieve a return. If the network is subsequently enlarged to address a larger potential market (typically >3000 premises passed), then there is the opportunity to reduce these rental charges.

The active and passive wholesale reference offer is published on the Call Flow website.

3.1.4 End user take-up and revenues

The forecast for customer connections was re-planned in August 2015 to model a slower rate of increase to show that the network remained self-sustaining if the unplanned BT upgrade to the Ropley exchange (see section 2.3) resulted in a low take up rate from the ~600 premises in that exchange area. The re-planned take up reaches the 24.3% originally forecast by December 2016, 9 months later than the original forecast.

In CFS experience the subscription rates are largely dependent on current speeds. Typical 'tipping points' (likelihood to upgrade to superfast broadband based on a reasonable differential in rental costs) that CFS has observed in the past are circa 1.5 Mbps where LLU exists and 2 Mbps where LLU does not exist. .

The assumptions on the ratio of demand by product, wholesale vs retail and residential vs business subscriptions remain unchanged to Q4 2020 from the original commercial model.

- At March 2016 ARPU is £32/month (forecast £32). Residential ARPU = £31 (forecast £30)
- Business ARPU =£37 (forecast £40)
- Higher business take up to date than forecast (18% of total customers actual vs 10% modelled). This could level off over the coming months as businesses could have a disproportionate level of early adopters.
- 80:20 ratio forecast for the unlimited product vs 40GB product was accurate for residential customers to March 20165; for business customers only 20% have opted for the unlimited product to date.

3.1.5 Key cost and revenue drivers

Recognising that deploying a fibre network is usually the largest cost in such projects, CFS has minimised the costs where possible by using:

- BT Openreach (BTO) Passive Infrastructure Access (PIA). Commonly termed 'shared poles and ducts'. CFS believes it is the only company currently using PIA to deliver NGA.
- New network build, with a default option of new telegraph poles under the recently introduced relaxed planning regulations to reduce the costs of delivering NGA.

- New network build using innovative installation techniques that suit the project area e.g. use of a vibratory plough in rural grass verges and private land.
- A variety of high capacity radio technologies using licensed and unlicensed spectrum.
- Exploring new options for SLU products with BT Openreach that help extend the reach of SLU.

Modelling shows that the key driver to commercial sustainability is the subscription rate, with a circa 12% of premises passed target being the minimum level to achieve Opex run rate break even i.e. not allowing for Opex accumulated losses to this point.

3.1.6 Milestone delivery timescales

CFS has achieved its network deployment milestones on time and to budget. Deployment commenced in January 2015 once State aid clearance was confirmed, and the first section of the network – a SLU cabinet – went live in March 2015. All six original SLU cabinets were live and taking orders by October 2015.

During the course of the project an important collaboration with BT Openreach was established with assistance from BDUK and the OTA (Office of the Telecommunications Adjudicator). The collaboration resulted in a successful Statement of Requirement (SOR) from CFS to BT Openreach for new SLU products and the successful deployment of a new cabinet to serve the villages of Gundleton and Bighton within the milestone delivery timescales. The new SLU products that are now being trialled are a form of copper rearrangement (CuRe) that CFS believes will unlock huge potential for reducing the cost of extending copper based NGA to the hardest to reach premises.

The FTTP segments of the network were delivered ahead of schedule. All FWA site installations were delivered on time, but there were delays to activating the power to these sites. However, all 8 FWA sites for the original area and an additional 4 for the extension area were live by the end of the pilot in March 2016.

In terms of the number of premises served, the principal elements of the access network solution are SLU and FTTP. The build plan consisted of the most reliable/certain build methods where appropriate e.g. PIA, new poles, wayleaves on private land, early ordering of electrical supplies.

Where the volume of premises to be passed were forecast to be lower (typically FWA and dispersed FTTP) a balance of the most cost effective and aesthetically pleasing methods of deployment were planned e.g. underground impact mole road crossings. Where this has been too difficult to achieve due to road closures required, the ‘fall back’ methods of poles to achieve road crossings have been deployed.

By applying a flexible approach to the areas of network passing the lowest density of premises, CFS has ensured that the project remains on plan when the preferred option has suffered delays or was not possible to implement.

3.1.7 Pilot Network lifetime

CFS plans to operate the built network beyond the seven year period required under wholesale access requirements.

3.2 Model outputs

3.2.1 Supplier's internal rate of return

The IRR is 16%.

3.2.2 The payback period

The deployed network is forecast to be loss making for circa eleven months, and not achieve cash-flow break even until circa 21 months. The peak operations cash outflow is forecast to be less than £17,000. The initial modelled take-up rate of 24% by March 2016 was adjusted to 12% as explained in Section 3.1.4. The re-planned take-up follows the same curve but with a 9 month lag from the original plan. The peak operational cash-flow does not change significantly as a result, as over 26% of operational costs are success based i.e. based on take-up. These peak operational cash-flows are easily accommodated with CFS' existing business.

The minimum take up required for break-even for a combined wholesale/retail model is circa 12% i.e. circa 200 customers as a general number based on forecast wholesale/retail ratio.

3.2.3 The capital cost to be incurred per premises

The cost per premises for the original intervention area of Bramdean, Ropley, Gundleton and Bighton remains in line with the previous findings reports. Cost per premises ranges from £623 to £806 on a sliding scale between 61% and 96% coverage of the original intervention area.

The additional exchange area of Privett has a cost per premises of £775 to reach 60% coverage. The benefits of the hybrid model are clear; the hybrid model could not be applied in Privett as it was in the original area and the maximum achievable coverage within the cost envelope was vastly reduced.

3.2.4 The requirement for BDUK funding

The intervention rate for the pilot deployment is close to 100%. This rate is not representative of a typical 5% area – a supplier would expect to take on greater risk outside a pilot project. CFS believes that this could be as low as 50% in some areas, but closer to 100% in the most challenging final 5% areas.

4 Updated Solution Design

4.1 Technical Infrastructure

The high level design has remained the same from the initial findings report, which is illustrated in **Figure 3** below. The technical solution includes a paper-based 'proof-of-concept' trial that explores new SLU products with BT Openreach, described in Section 4.1.3.

CFS has delivered NGA via a variety of technologies (termed a hybrid approach) to achieve maximum coverage at minimum cost. The access technologies being deployed are:

- Fibre To The cabinet (FTTC) also known as Sub Loop Unbundling (SLU).
- Fixed Wireless Access (FWA), also known as Radio Broadband.
- Fibre To The Premises (FTTP).

Coupled with the above range of access technology options are the various options for build approach to offer the ultimate flexibility and trade-offs between Capex and Opex.

Some minor route changes have taken place during the deployment and these are detailed in the supporting material in Annex B - slides 2, 29, 38, 47, 48. The high level metrics remain unchanged:

- Total route length per 'SLU node area' – 5km
- Proportion FTTP extension using BTO/PIA – 70%
- Proportion FTTP extension using new build – 30%
- Proportion BTO PIA duct versus pole – 50% / 50%.

Some images from the deployment are provided in Appendix F – Network build photos.

4.1.1 High level schematic diagram for the solution

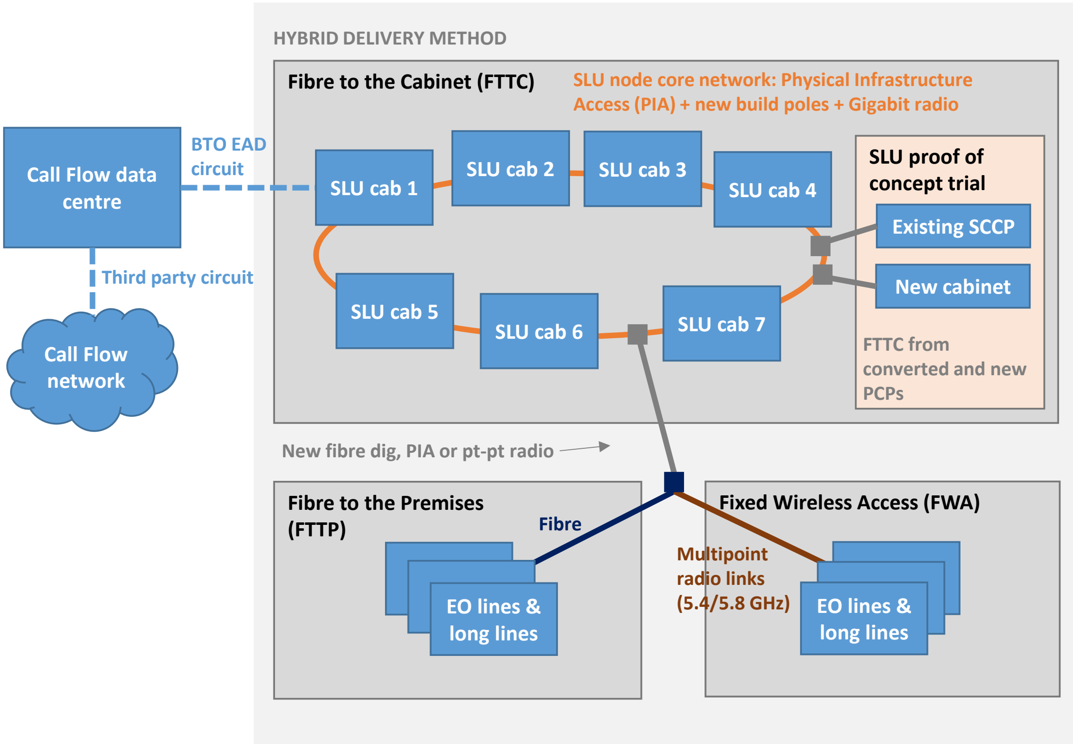


Figure 3: Schematic diagram

4.1.2 Solution architecture

Please refer to Annex D for a detailed representation of the solution architecture.

4.1.2.1 Backhaul

CFS is using a BTO 1Gbps EAD connection from one of the SLU cabinets to a local data centre. At the data centre, the EAD connects into a gigabit circuit provided by a third party supplier that connects to the CFS node in Kent. Radius authentication, network management and IP transit takes place at the node in Kent. A fall-back IP transit mechanism via the data centre is also planned.

Data Centre Selection Criteria:

- **Location:** within a 25km range of the project area is preferable. Whilst BTO EAD connections can be ordered up to a radial distance of 35km, the cost is reduced significantly when under 25km. Other providers can supply such connectivity but BTO has the most comprehensive fibre network, especially in rural Final 5% areas. As such, it is common to plan to use BTO EAD circuits to connect such rural projects, although alternative more cost effective options may occasionally be available.
- **Connectivity**: The data centre should have a major bandwidth provider (e.g. Virgin, Level 3 etc.), to the chosen data centre and the existing ISP (CFS) network. For CFS, this is usually Level 3. Any

chosen data centres should offer resilient connections to major hubs such as Docklands in London – which is typically an industry norm.

- **Redundancy**: Power redundancy to be considered – again an industry 'norm'. All data centres investigated offered UPS with generator backups to a minimum power redundancy level of 'N+1'.
- **Cost**: The key costs to evaluate are the colocation cost for hosting equipment; IP Transit/backhaul costs; interconnection costs to existing ISP network.

EAD Selection Criteria

- **Rental cost**: EAD indicative pricing is available from the BTO online 'quick quote' tool[6]. In current market conditions the typical rent is >£12k per annum in most rural locations in CFS' experience. The EAD for this project was projected to cost £13,888, and the actual confirmed cost was £12,423 p.a.

- **Excess construction charges (ECC):** A significant factor in the overall cost for backhaul. These are the charges BTO levy to install a fibre circuit from their nearest fibre flexibility node to the premises required. There are many examples of ECC being >£100K, and can hence have a significant impact on such a rural project.

The high rental cost means that the model of delivering individual EADs as a single cabinet FTTC 'feed', or indeed any distribution mechanism to a single small rural community, are unlikely to ever be commercially viable. Such substantial operational costs can only be justified if the deployed network is of a scale, typically >1500 premises passed, to be able to cover such costs.

To keep potential ECC charges to a minimum, it is desirable to have the EAD delivered either:

- Alongside an existing fibre circuit e.g. a school. As fibres are installed in bundles, with the smallest typically being a bundle of four fibres, using redundant fibres at the same installation point (and extending thereafter to the network being built) can avoid ECC.

- As close as possible to an existing BTO fibre node.

BTO offers a service, costing £350, to conduct a survey for an EAD installation. As part of the feasibility stage, CFS commissioned BTO to conduct two such EAD surveys to ascertain which cabinet location, of two, offered the lowest ECC charges. Note that the 'far end' of both the fibres being surveyed were the local data centre. BTO does not offer any discount for multiple surveys, even if one end is common.

The surveys showed that there is a BTO fibre node in close proximity to the Bramdean PCP1 area, and hence offered the best EAD installation option.

[6] http://www.openreach.co.uk/pls/or_qq_owner/or_qq_frames.drawframe

4.1.2.2 Core

Recognising that the core transport (typically fibre) implementation of such a network is usually the largest cost in such projects, CFS has illustrated the cost implications of deploying core transport using:

1. BTO Passive Infrastructure Access (PIA). Commonly termed ‘shared poles and ducts’.
2. New network build, with a default option of new telegraph poles under the recently relaxed planning regulations to deliver SFBB.
3. New network build using innovative techniques that suit the project area.
4. Gigabit radio links in the E band spectrum (lightly licensed).
5. Radio links in the unlicensed/lightly licensed 5.4/5.8GHz spectrum (primarily FWA multipoint delivery to end premises).
6. Radio links in the licensed spectrum e.g. 18GHz.

4.1.2.3 Access network

The initial findings publication detailed the generic network design process for the access network using CFS hybrid model illustrated in Figure 4 and described below. This process can be viewed in pictorial terms in the slides in Annex D. These slides also include notes on the process for the project area in question.

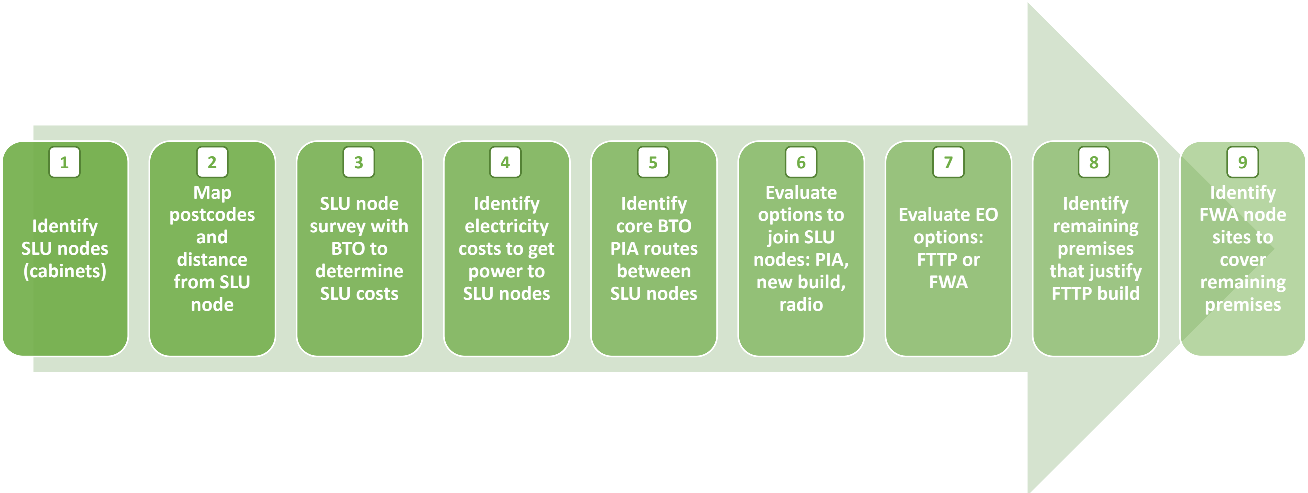


Figure 4: The hybrid network design process

1. **Identify SLU nodes (cabinets).** Five of the seven cabinets could be identified via desk-top planning, and the final two were quickly located through a local site survey.

2. **Map postcodes fed via SLU node along with ‘straight line distance’ from SLU node.** Along with EO postcodes, it is easy to visualise the challenge presented beyond SLU VDSL technical limits. As per supporting slides (Annex C), the challenge ‘beyond SLU’ can be achieved by mapping all the postcodes that fall within:

- 1km straight line distance from the cabinet. Such postcode areas are highly likely to have a cable route distance of under 1.3km and hence capable of receiving SFBB over their telephone line using SLU VDSL technology.
- Between 1km and 1.85km 'straight line' distance from the cabinet. Such postcode areas are highly likely to have a cable route distance of under 2.4km and hence capable of receiving 13Mbps over a single telephone line. Note as per supporting slides, CFS have examples of SFBB being achieved to 'straight line' distances from the cabinet of circa 1.6Km

3. **Undertake SLU node survey with BTO to ascertain SLU costs.** With the cabinet locations identified, CFS issues a request to BTO to undertake a joint survey of the cabinet locations. This survey ascertains the BTO costs to undertake their activities to achieve SLU interconnection of cabinets. If the existing cabinet does not have sufficient space to accommodate the new tie pair cables (typically 2 * 100 pair cables), a 'cab shell uplift' is required. Where there is insufficient space, BTO add the costs for removing the current cabinet 'shell' and replacing it with a larger cabinet 'shell' and extra connection points within. It is occasionally also required to install new ducts linking the cabinet to the BT footway junction box at extra cost.
    - The base cost for BTO SLU activities is circa £1,300
    - A cab shell uplift has an incremental cost of typically circa £1,800
    - Of the six cabinets surveyed by BTO and CFS, an unusually high proportion of cabinets – three of the six cabinets - required a cab shell uplift. CFS experience is that this ratio is usually more typically one in five cabinets. The incremental costs were not of a sufficient level to make a major impact on the modelled costs.
4. **Identify electricity costs to get power to 'fixed' SLU nodes.** Local initial survey can often give a good early indication (240V on nearby poles, nearby dwellings etc.). Surveying SLU nodes it is usual to be able to ascertain likely electrical connection costs if Low Voltage (LV) supplies are nearby. The 'ball-park' methodology CFS adopt to estimate likely connection costs from the power company are:
    - Nearby LV pole or dwelling - £2,000 base connection cost
    - Road crossing - £2,000 incremental cost
    - Traffic management to achieve connection - £2,000 incremental cost
    - Ducting from connection point to CFS cabinet - £100/metre.

    It is desirable to have a low voltage connection nearby, that needs neither needs traffic management nor a road crossing to achieve an electricity connection to the SLU cabinet.

    Where electrical connection costs are excessive, CFS consider the viability of having the electrical demarcation point (meter, RCD consumer unit etc.) nearer the power company supply point, and extending this to the CFS cabinet node at a lower cost to that levied by the power company.

On this project six of the seven cabinet locations had LV supplies within 100m of the CFS cabinet node. The seventh cabinet needed to follow the approach similar to that described above whereby CFS builds to a location where a metered supply was connected to i.e. to lower the cost.

5. **Identify core BTO PIA routes between cabs.** Use this to assess PIA versus new build fibre or gigabit radio and taking into account the local topography for example busy roads, size of grass verge, local landowner involvement.

   Under the BTO PIA product, CFS are able to pay BTO to provide network plans of their infrastructure for a defined route. CFS request such plans where there is a high probability that using PIA to aid SFBB (typically SLU) will be more cost effective than new build.

   CFS was on the initial PIA trial run by BTO with Sky, Fujitsu and Geo to develop the PIA processes in 2011, and as one of the only companies successfully using this PIA, has a unique wealth of experience of using this product to deliver rural SFBB.

   CFS obtained plans from BTO that show the infrastructure between the project area SLU nodes. Surveys of infrastructure 'above ground' indicated that PIA should be suitable for at least 70% of the fibre route distance planned between SLU nodes. The actual deployed PIA ratio of 60.5% reflects the success of the new dig/wayleaves in this area which meant that this model was often favourable over PIA.

   When considering PIA, CFS assesses:

   - The number of premises being served in a duct route to estimate the likely sizes of cables in the available ducts. For example a cable route to a cabinet serving 140 premises might typically have a 200 pair 0.5mm cable installed in that route along with some local distribution cables such as 5, 10 and 20 pair etc.
   - The alternative of new build and the impact this will have on the Capex versus Opex model. As building a commercial case for rural broadband is nearly always challenging, it is sometimes preferable to deploy new build at a higher Capex cost, to achieve lower Opex costs of running the network. This can make the difference between a network being commercially viable, depending on the funding sources or using a commercial model.

   For the SLU node core network, where PIA is not available, the most obvious option following local surveys is new telegraph pole installations. However, where appropriate, CFS will still investigate alternatives under the deployment stage, including private land where highways deployment is particularly expensive or problematic.

6. **Identify all options to 'join' network together where PIA/new build is not commercially viable.** Assess PIA versus new build fibre or Gigabit radio and local topography e.g. busy roads, size of grass verges, local landowner involvement etc. Consider power requirements at nodes when deciding PIA or new build i.e. if power is expensive at a required node, can this be

mitigated by new network build – rather than PIA – enabling power to be connected 'en-route' at a much lower cost.

During the network design phase, it was appropriate to implement a high capacity radio link between the exchange areas of Bramdean and Ropley. The first obvious option (subsequently proved inappropriate) was to use PIA/new build to run a fibre cable the circa 5km 'straight line' necessary to achieve this. However, under the 'layered' design process, the designer needs to consider the subsequent 'layers' to be built, in addition to those already built. Adopting this methodology, it was possible to identify an alternative, overall better, route to the 'least distance' route, that:

1. Takes a new fibre route in the direction of EO premises requiring an NGA solution.
2. Achieves a clear line of sight link that is able to 'join' the two areas together, at under 4km distance and hence offering the possibility of a gigabit E band radio solution with low op-ex costs to run.
3. Also offers an advantageous FWA node to serve several premises >1.85Km from their serving SLU cabinet.

Although this step may sound complicated, with quick radio planning tools and Google earth/Street View, it is possible to investigate and iterate multiple such route options in a matter of hours. As part of this design process, it has revealed that a lot of the fibre route required could potentially be routed in grass verges. As such, during the delivery phase of the project where new build is required, CFS planned to use a vibratory plough to install ducting or blown fibre tubing where suitable verges exist - an innovative installation technique - to assess its viability in such a rural context where grass verges are relatively common.

However, in practice in the project area, it was found that the landowners on the 'other side' of the grass verges were readily accepting of the ploughing being done on their land. This was often on the agreement that the route taken would pass their difficult to reach farm buildings or in return for a small payment (typically less than £1000). In all such instances the net cost was lower than using the grass verge (due to somewhat onerous highways requirements) and achieved a higher premises passed ratio. Such a win-win approach between the landowners and CFS is an important learning of the MTP.

The supporting slides in Annex B show the route design achieved along with the full network design.

7. **Identify EO options, and if to be delivered by FTTP or FWA.** Once the core SLU connectivity design has been achieved, it is then appropriate to design the network to address the EO connections. As this design illustrates, it is common for the majority of EO connections to be in the vicinity of the exchange and there is no need to reach them via a flexibility point of a street cabinet. Where the entire rural exchange area is part of the last 5%, it would be relatively common that the SLU node core network passes a great deal of the EO premises, as is this case for this project area. As such, the network design offers nearly 100% viability for the EO premises to be offered FTTP.

In practice this has been broadly true. Delay in obtaining an easement from National Trust has meant that a few planned EO premises were delayed with their FTTP installation.

Where possible, PIA is used to deliver a fibre to the EO fed premise, via either a drop cable from the distribution pole, or underground lead-in duct. This minimises new build in the more densely populated areas that EO connections typically reside. However, where the existing delivery method is drop cable via a joint user (electricity) pole, new infrastructure (typically a pole) is unavoidable. Such new deployments, whilst within the planning regulations, can be contentious for local residents. This is typically due to such residents enjoying reasonably good broadband speeds – up to 8 Mbit/s - being relatively close to the exchange - and their preference for services to be underground.

8. **Identify outstanding locations with a sufficiently large premise density – and challenging FWA conditions – to justify FTTP build.**

Using the postcode mapping process presented, it is relatively easy to be able to visualise the challenge outside of SLU and EO. However, in planning the SLU and EO parts of the network, reasonable 'forward' consideration should also been given to this subsequent phases i.e. delivering connectivity (FTTP or FWA) to the non EO connections that are >1.85Km from their serving cabinet.

In this project area, there were four obvious opportunities to leverage the core SLU and EO parts of the network to assist in the delivery of the >1.85km SLU connections via either FTTP or FWA (see Appendix B for route maps):

1. The gigabit radio node linking Bramdean to Ropley (Brockwood Park School) also offering a suitable FWA node to >1.85Km premises in the Bramdean area.
2. The gigabit radio link delivering SLU core node connectivity at the 'top of Stapley Lane' also offering a gigabit feed link to near Gundleton.
3. The gigabit link to the EO premises on Lyeway Road offering a FWA node to premises near Monkwood.
4. The SLU core gigabit network going via The West Tisted Manor Estate offering FTTP to the premises in this area.

In addition to the above win-win network design opportunities, it is then necessary to design the network extensions necessary to achieve NGA to the remaining premises in the project area. Radio and Google mapping of the remaining premises will reveal where FWA to relatively large premise populations will be challenging or impossible. Where this is the case, e.g. Preshaw Estate area in Bramdean, then identifying FTTP options is necessary using the usual hybrid options of PIA, new build and point-to-point gigabit radio links.

In reviewing FTTP deployment, one should investigate delivery methods that are most cost effective depending on the commercial model being used. With evolving deployment concepts, consideration is always appropriate to explore the latest innovative methods to reduce cost of deployment and/or maintenance. In this instance, the use of a vibratory plough was planned where there were potentially large route distances with suitable grass verges.

9. **Identify obvious FWA nodes that offer maximum coverage of outstanding locations.**

   With the network design thus far, it is appropriate to identify what FWA options are available. In reality, as the network design has evolved, it is usual to map potential FWA coverage as each preceding node is considered or decided on i.e. so an initial FWA potential map is available. Where there are still coverage gaps (which is obviously quite normal), FWA nodes are identified that can yield maximum coverage of the remaining areas whilst also considering the lowest costs/most effective way to get backhaul bandwidth to the planned FWA node.

   In some instances where few premises are to be covered, the backhaul to the FWA node will be from another FWA node (often termed a 'repeater') rather than a gigabit radio link or a direct fibre feed.

   The few premises at the very Western boundary of the project area (e.g. Warren Farm) were always going to be difficult to reach. The originally planned Lane End Down location for a FWA repeater has been replaced by a location better able to provide reliable coverage to the Beauworth and Kilmeston areas.

10. **Repeat steps 8 and 9 until maximum commercially viable coverage has been achieved.** A few iterations are expected before the optimum balance of FTTP and FWA to the outlying premises has been determined that provides the most commercially viable solution for the desired coverage. In repeating these two steps (and occasionally some of the earlier steps as a result), consideration needs be given throughout to the delivery of power to the FWA or gigabit radio nodes. Where infrastructure build is necessary to deliver fibre to the node in question, consideration should be given to new build activity that allows for low power delivery that can minimise power connection costs. Consideration has to be given to the power being delivered to nodes 'en route' in a safe and engineering robust manner (e.g. RCD protected, armoured, low voltage, current limited etc.). Such considerations will typically depend on distance and power transfer requirements.

4.1.2.4 Customer Premises

There are two types of router deployed by CFS for CPE:

1. For SLU and FWA delivery the Billion 8800 is used. http://www.billion.uk.com/product/vdsl/8800NL.htm
2. For FTTP delivery the Billion 9800 is used. http://www.billion.uk.com/product/AE-FTTH.htm

CFS offers a 'minimum disruption' final drop FTTP connection where reasonably, and commercially viable i.e. where BTO PIA can be utilised. Such delivery is usually achieved where the BTO drop pole (DP) is available and suitable or there is BT Openreach lead-in underground duct available.

Where these delivery mechanisms are not available, or are not commercially viable i.e. due to a significant cable run within the subscribing customer's land, CFS adopts the 'Gigaclear model' of installing a fibre connection point at the boundary of the customers land and public highway land.

Around 90% of connections were delivered by the PIA method and 10% by the 'Gigaclear model'.

4.1.3 Proof of concept trial for new SLU products

In March 2015 CFS commenced a paper based 'proof of concept' exercise with BTO to test the feasibility of using non-BT SLU at alternative flexibility points in the copper sub loop. At that time the BTO SLU products allowed SLU from exchanges and PCPs (street cabinets) only.

There were two phases to this trial:

- Phase 1: Feasibility of converting an existing secondary cross connect point (SCCP) into a PCP so that CFS can order the existing SLU product from it.
- Phase 2: Feasibility of inserting a new cabinet into the copper network where no cross-connect point currently exists.

The exercise resulted in a formal Statement of Requirement (SoR) to BTO in November 2015 via the relevant industry working group (the Copper and Fibre Products Commercial Group - CFPCG) to extend the paper based exercise to a practical trial. The SoR has progressed to a trial of a new CP-led CuRe node product with a new cabinet in this MTP intervention area and other cabinets across Call Flow's other commercial and BDUK deployment areas.

CFS believes that both of the new SLU products that are being tested will provide a cost-effective way to go further into the Final 5% premises with fibre. CFS and BDUK have benefited from significant new learnings from this trial:

- Understanding the potential role of new SLU products in extending the reach of FTTC.
- Understanding the potential barriers for new SLU products, whether technical feasibility or the complexity around the business processes.
- Improved inputs and assumptions for the BDUK FTTx cost modelling for the Final 5%.
- Providing the necessary evidence such as benefits and costs to assist with the SOR process for seeking access to new versions of BTO's regulated SLU product.

4.1.4 Volume of infrastructure

The volume of infrastructure deployed is largely as originally planned. The final volume of infrastructure remained broadly in line with the original estimates.

- SLU cabinets x 7
- SLU core fibre x 12.5 km
- EAD fibre backhaul [for a circuit up to 25km]
- High capacity radio masts & links x 5
- FWA radio masts & links x 8 (changed from 10) – plus 4 masts & links for the subsequent addition of Privett to the project area.
- FTTP fibre x 24km

The few modest changes to date include:

1. Removal of two FWA nodes in the Gundleton and Bighton area in favour of an additional SLU cabinet. The costs of this were higher than planned, although CFS achieved savings were in other areas and the change was cost neutral overall.
2. An extra 1.2km of new build (non PIA) core SLU route fibre to the original plan due to having to take cable routes slightly different to that originally planned (to achieve Line of Sight radio links and to achieve a better outcome in Gundleton and Bighton).

The ratios assumed of PIA/non PIA have proved higher towards non PIA.

4.2 Coverage

4.2.1 Number of residential and business premises

The network has been deployed to postcodes cleared for State Aid[7] and CFS set out to cover most of the premises within these postcodes – the breakdown of premises by area is set out in **Figure 5** below. CFS achieved over 96% coverage using its full hybrid approach in the original area, and over 60% coverage in Privett, where the technical solution was less flexible due to the lack of SLU as an access technology option because all lines are exchange-only fed.

Exchange or villages	Premises total
Bramdean – whole exchange	626
Ropley – whole exchange	763
Gundleton & Bighton - villages	114
Privett – whole exchange	261
TOTAL	**1,764**

Figure 5: Number of premises by area

It is also worth noting that the majority of the project area is well defined i.e. by exchange boundaries. This gives extra confidence that the project area is not biased in any particular way to the hybrid delivery methods deployed by CFS.

4.3 Scalability

CFS is confident that the solution was of the minimum scale necessary to test the effectiveness of the hybrid model, and of a sufficient scale to provide a conclusive answer as to whether a full-scale roll-out of the solution would be viable.

The CFS model is scalable in terms of resource requirements and also flexible in overcoming network challenges. As such, it offers significantly higher potential coverage at a reduced cost than the primary existing techniques of SLU and FTTP. It is therefore ideally suited for the final 5% challenge.

7 https://www.gov.uk/government/publications/state-aid-consultation-market-test-pilot-intervention-areas

The CFS model utilises the following key delivery methodologies/techniques (excluding FTTP techniques as these usually form the minority of any such solution) that are repeatable across multiple Final 5% areas:

1. Data analysis of BT cabinets to establish what SFBB can be achieved using existing BT cabinets (PCPs). This is relatively simple data analysis, which CFS either outsources or can carry out in-house. Scaling this activity to large areas is considered straight-forward as suitable contractor skills exist.
2. PIA planning of core route. This is a straight-forward planning process (request prints, desktop plan) that needs the skills of an equivalent BTO planner, which are readily available.
3. Radio mapping of the local area to establish where point-to-point links can reduce the need for BTO PIA (both highways links and links that would benefit from being deployed on private land). This is a straightforward task with the appropriate tools and can be easily trained to direct labour or contractors.
4. Radio mapping of the local area requiring FWA 'in-fill' not covered by SLU and taking into account the core network planned (both highways locations and private land locations). Again, this is a straightforward task with the appropriate tools and can be easily trained to direct labour or contractors.
5. Local surveys and engagement with landowners. Usually undertaken by a project manager, with starting point being the local parish council. Fairly 'standard' project management skills required i.e. readily available.
6. Surveying and deploying PIA networks. There are an abundance of sub-contractors working on the BTO network, deploying the BTO '95% network'. The same sub-contractors are suitable for this work. Indeed, as the BTO 95% network gets closer to final delivery, there is likely to be a significant over-supply of resource for these activities.
7. New pole deployments. Again, existing BTO sub contractors are used to deploy new poles, and they are able to scale as required i.e. maintaining and renewing the existing pole assets is a significant undertaking with significant amounts out-sourced to sub-contractors.
8. New fibre build deployments. CFS has found that there is a good supply of sub-contractors available to undertake these activities, which include:
    a. Sub-contractors working for BTO.
    b. Sub-contractors who undertake underground activities (typically water/irrigation type) e.g. golf course construction firms, water pipe installation companies etc. The same skills are required for water pipe installation as for fibre installation i.e. mole ploughing of such pipes/cables.
    c. Sub-contractors who dig/lay cables using traditional trenching techniques.
9. Fibre installation/splicing engineers. Whilst CFS largely undertakes these works using direct labour at this point in time, there is a significant sub-contractor base working for the likes of BTO, Level 3 and Virgin who can undertake these activities.
10. Project management. A local project manager is essential to oversee the building of the network. Project managers with a civil engineering type background are suitable for this activity.

11. Planning. CFS takes advantage of the relaxed planning requirements for street furniture and telegraph poles. Such relaxed planning has had a significant positive (and demonstrable) impact on the ability of the CFS model to scale.
12. Suppliers. CFS uses national/global recognised suppliers, typically the same as BTO use (e.g. ECI for cabinets and DSLAMs etc).
13. Flexibility. The CFS model, which combines PIA with new build (typically private land on a win-win basis) and radio, offers the ultimate flexibility to minimise costly 'blockages and delays' unlike the majority of current planned 90% coverage network where significant costs and delays can be incurred due to a single delivery model (largely new fibre).

4.4 Wholesale access

CFS has designed a network with the aim of offering at least the minimum required levels of wholesale access specified in the UK Decision. Passive and active wholesale reference offers are published on the Call Flow website.

4.5 Operational and Business Support Solutions (OSS/BSS)

CFS had intended to work with one of the other MTP Suppliers, MLL, for the wholesale interconnect solution but the MLL project has since been terminated. CFS has since joined the Fluidata service exchange platform.

4.6 Retail partners

CFS is not able to predict which ISPs will choose to retail the CFS wholesale provided services. However, as a well-established retailer of its own services, there is a clear route to market under the pilot.

CFS believes that ISPs are likely to retail services broadly similar to the retail/wholesale pricing tables provided in Annex B and C. Some might model their customer traffic profiles and offer fewer retail propositions.

4.7 Project Partners

Key sub-contractors used in the pilot schemes:

- Amey PLC – Term highway contractor (civil engineering).
- BT Openreach – SLU tie pairs etc.
- ECI – cabinets and DSLAMs.
- SSE – power.
- AFL - cable/fibre installation.
- I&A Comms - pole installations.
- Agricultural Water Engineers (AWE) – mole ploughing and trenching.
- CCN - highway contractor (civil engineering).

4.8 Funding

Prior to this Innovation Fund pilot CFS had invested around £600K of public money and £1.4m of its own funds in the last four years. The pilot has leveraged, and benefited from, this significant previous investment and acquired learning. CFS is not contributing its own funds to the deployment but is funding customer connections. CFS has designed and built the network on the assumption of making it commercially viable with a reasonable internal rate of return so that it operates the built network in the long term and requires no further public funding.

The capital cost of incremental connections beyond 160 connections (10% take up) is funded by CFS at circa £441 per connection. This represents a £75,500 investment by CFS for every additional 10% take up.

4.8.1 Minimising the public subsidy required

- **The hybrid model** - As described above the hybrid model is key to minimising the deployment costs.
- **Scale** - ensuring the intervention area is of a scale that makes it more commercially viable. The area for this MTP is below this scale required. The coverage target should not be set too high either. This could give rise to a situation for example where a small hamlet is left out and has to contribute to their own very high cost per premises.

4.8.2 Development of the financing options

CFS believes the model can be developed to leverage private funds and use a lower public subsidy - e.g. 50%. Further options then exist on whether the funding is taken as loans or equity (e.g. Gigaclear or Hyperoptic models). Smaller suppliers do not currently have ready access to such loan/debt and would seek support for a government scheme that would help these suppliers raise money.

5 Project governance and outputs

5.1 Written outputs

Call Flow successfully delivered its quarterly Feasibility Report to the required timetable in the contract:

- December 2014: Version 1.0 (published)
- 31 March 2015: Version 1.1 (addendum to v1.0)
- 30 June 2015: Version 1.2 (addendum to v1.0)
- 30 September 2015: Version 1.3
- 31 December 2015: Version 1.4 (published)
- 31 March 2016: Version 2.0 (Final report - published)

5.2 Barriers, risks and dependencies.

Key risks at the start of the project:

- **Operating in a new area** – CFS is based in Kent and its commercial networks are located within the Kent and West Sussex area. The pilot project required the engagement with different civils contractors and planning authorities, and building new relationships. It also raised the risk of any deployed network not being viable due to a higher risk of Opex costs exceeding revenues. These potential barriers and risks have been manageable within the pilot and have assisted DCMS in maximising its learnings around the cost effectiveness and long term viability of deployed network.
- **Open wholesale access requirements** – ensuring the wholesale access models can be implemented with low risk or impact to the underlying commercial viability of the network.
- **Enhanced helpdesk support** - extending existing helpdesk support from current six days per week to seven days per week. New apprentices were recruited so that the move to seven day a week helpdesk management was addressed proactively.
- **Loss of key personnel**. CFS ensures that no single employee is a single point of failure should they become unavailable for any particular reason. CFS also has relationships and support contracts with its key suppliers to ensure prompt support and hardware replacement in the event of any major network issues.
- **Managing future growth**. CFS believes in maximum out-sourcing of activities that are considered either ‘non-core’ or ‘highly available’ e.g. civils contractors, cablers, aerial installer etc. As such the extra direct labour resource required to fulfil this pilot was considered modest and easily achievable.
- **Connection rate**. The commercial model is sensitive to the take up rate, and if this falls below 12.5% of premises passed, the long term sustainability of the network could be at risk. However, this Opex break-even point is relatively low and Call Flow believes this represents a low risk. There are various mitigation options available particularly around sales and marketing of the service. Future similar projects can be de-risked by deploying less of the proportionally far more expensive FTTP connections. Any such reduction can substantially reduce the cap-ex funding

required but significantly also reduce the proportionally far more expensive Opex per premises passed using this delivery method.

- **Local objections** to local infrastructure build where PIA is not an option – particularly in the village centres that may deem their broadband as being 'good enough for now'. While this could impact coverage achieved, planning rules allow for this to be overcome if necessary/appropriate.
- **PIA to connect cabinets not viable**. This is unlikely based on CFS experience, and a reasonable allowance of 30% new build was been allocated to mitigate much of this risk.
- **Bonding of SLU lines to achieve NGA**. CFS planned to explore under the pilot techniques to bond copper pairs together i.e. to achieve a near doubling of speeds. This technology is not proven, and is not guaranteed to work. Additionally, there is no guarantee that there will be sufficient spare capacity in the BTO network, or of a suitable quality (e.g. aluminium) in the final 5% for this to be scalable. CFS does not plan to explore the use of bonding copper pairs because the equipment provider, ECI, has yet to provide two pair bonding capability from their DLSAMs, which was originally anticipated to be available in mid-2015.
- **Trialling of trenching** instead of pole deployment using a vibratory plough. The aim was to install fibre underground rather than overhead, as it is believed to be more reliable from an operational expenditure/maintenance perspective – as well as aesthetically more desirable. The success of this was largely dependent on the subterranean nature of the pilot area. Mole ploughing cable does require confidence that there are no services along or crossing the route, or that that such service can be reliably identified. The need to avoid existing services and tree roots can limit the scope of mole ploughing especially alongside roads. CFS had a fall-back option of deploying of telegraph poles which is a proven infrastructure deployment technique.
- **PIA – blocked ducts.** The risk of BT's ducts being blocked during the build phase. Jetting of ducts to clear is within CFS's ownership/responsibility without recourse to BTO. Only 'dig downs' require further BTO intervention if required. This is considered a low risk as blockages can always be cleared, albeit they add costs (considered low risk/manageable). Additionally, for the highways involved, in a rural area, mean that this should always be achievable at relatively low cost. Such low cost may exceed the forecast/budget.

Delivery risks were mitigated by CFS already operating a growing customer base of circa 1,000 broadband customers, with the vast majority being on rural SLU/radio networks, and CFS offers a well experienced and appropriately sized direct labour team.

Additionally, where reasonably possible, Call Flow always aims to have at least one alternative (usually incurring slightly higher costs) should a risk event occur e.g.:

1. Alternative cabinet and DSLAM suppliers.
2. Being able to select from a choice of build option: PIA, new dig, poles or radio links.
3. Ability to use poles and an overhead road crossing where a road closure for an underground road crossing has been either too expensive or has introduced excessive delays to the project.

6 Lessons Learned

At the start of the project the two key outputs of the pilot were identified as:

- How Capex build costs in the most rural areas can be minimised by the innovative use of the described hybrid engineering techniques.
- Understanding the operational costs of running such a network.

The learnings to date are presented in this section under the following categories:

- Technology
- Commercial model
- End user experience
- Issues encountered and resolved
- Scalability of the solution.

6.1 Technology

6.1.1 PIA

PIA is an important enabler to achieve appropriate fibre connectivity to deliver SFBB in rural areas whilst minimising new network build requirements – which can also be contentious as well as costly. However, the operational rental cost of using PIA needs to be considered in the commercial model being used for such a solution.

Utilising PIA in the project area so far has been more challenging than previous CFS deployments. The key issues encountered to date include:

1. A substantial number of BTO underground chambers being in the carriageway rather than the footway. This has had a modest impact in terms of extra costs for traffic management.
2. A substantial number of duct blockages have been encountered to date. This has meant extra costs for 'jetting' ducts. This is most unusual and is believed to be due to the floods of 2013/2014 where much of the highways above the duct sections were flooded. As a consequence the BT ducts acted more as drains than usual, carrying silt and consequently causing the ducts to become blocked. Whilst such duct blockages are not uncommon, the sheer quantity in such a relatively short distance is. This has added significant extra costs to the use of PIA.
3. Road closure required for a particularly narrow section of country roads in and around the Ropley area. This has added both delay and modest cost increases to the project.

CFS believes that the recent Ofcom requirement of Openreach to make PIA availability on a near 'equivalence' basis will dramatically change the use of PIA in the provision of SFBB i.e. far more PIA will be deployed in future projects and the ratio of FTTP will increase.

PIA installation has cost between two and three times the estimate of £6K/km. CFS believes this to be unusual.

6.1.2 SLU

The cost per SLU cabinet is in line with its projection of £30K per SLU cabinet.

6.1.3 New build fibre

CFS builds its own fibre network (in addition to PIA), predominantly using the mole ploughing method under private land. In nearly all instances, CFS has been able to achieve a 'win-win' agreement with the landowners in question i.e. low costs of agreement and wayleave, in return for the possibility to be able to benefit/subscribe to the resultant SFBB service. The new build fibre networks are being achieved at less than the estimate of £30k/km. The reduced costs of new build fibre (non PIA) versus the increased costs in PIA on this project have off-set each other.

Fibre routes have been largely continuous using one of the two methods - either exclusively PIA or new build (non PIA). This is due to adjacent landowners being agreeable to new fibre build across their land which avoids the need to build sections using PIA where a landowner has refused such new build.

At the planning stage there appeared to be many verge areas where fibre needed to be installed, and that this offered a good potential to explore the innovative installation technique of trenching by a vibratory plough, which was likely to achieve a lower op-ex cost due to a lower fault rate than that assumed based on overhead fibre.

In reality, working to the requirements of HCC Highways proved more costly than anticipated. Call Flow encountered extra highways noticing and guarding requirements, along with multiple tree route challenges/requirements. It became clear that these barriers could be easily overcome by digging fibre 'over the hedge' in private farmland. A vibratory plough was still used, and the amount of km installed in a day was impressive when compared to what might reasonably have been achieved in a day on highways land. The contractors were able to dig and install the ducts at some 2km per day where the anticipated rate on Highways verges has been 400m per day. As such, the cost of using a vibratory mole plough was considerably less than planned.

6.1.4 Gigabit radio

Gigabit radio links in the uncoordinated E band 'lightly licenced' spectrum can be a cost effective means to deliver high capacity bandwidth over relatively short distances for deploying the core network in rural areas, and assists in achieving the required economies of scale in the final 5%, where premises are highly dispersed.

6.2 Commercial Model

From the outset it was clear that the impact of incremental fixed operational costs on a small scale deployment meant that CFS would be charging customers in this pilot 30% more than a standard broadband package to reflect the additional costs it incurs by deploying a stand-alone rural network that is unable to leverage existing backhaul infrastructure in the area. CFS believes that an area of approximately 3,000 premises would provide the necessary scale to bring the retail cost to the current market levels.

Call Flow has investigated the Valuation Office Agency (VOA) approach to business rates. The VOA approach for new fibre NGA networks is not specifically harmful to the commercial viability of these networks. CFS believes that the uncertainty of the implications for FWA networks are mitigated by their hybrid deployment model.

A number of observations can be made on the costs/revenue variability discovered during the deployment phase. The deviations to date (both positive and negative) illustrate the flexibility of the hybrid model in overcoming challenges on the ground and in optimising the coverage where opportunities can be identified:

- 1km of new fibre installed (dug in) as part of the core network for a network redesign to allow for an extra cabinet to be unbundled where FWA had been planned.
- 1.7km of new fibre installed (dug in) to extend routes where there has been a reasonable trade-off between extra distance, extra FTTP that would otherwise be unserved (the extra FTTP largely benefitting the landowner granting the overall 'peppercorn' wayleave), and the cost of digging/ploughing on private land being substantially cheaper that the equivalent shorter routes on highways land.
- Significantly extra PIA costs due to nearly all routes needing 'jetting' to clear silt accumulated from the floods that affected the area a few years ago. This is considered an exceptional circumstance, even though it has affected the majority of the MTP area.
- Pending further detailed modelling of the UK Final 5% challenge, Call Flow remains of the opinion that their model is likely to offer a realistic solution to some 60% to 75% of the Final 5% i.e. along the financial terms of the MTP. This is improved further by the new ‘CuRe’ SLU product that has been developed on this pilot.

6.2.1 Opex

At the start of the project CFS anticipated that the operational costs of running such a rural network will be in the region of 50% higher than that of an urban area. These higher costs are yet to be proven, and may not be fully proven until the network has been operational for a few years. These higher costs are based on the assumptions of:

- Higher maintenance costs of the network due to its rural locality and longer line lengths, less reliable electrical supplies, longer fibre overhead lines prone to weather and ‘shot’ damage (due to birds sitting on such cables), more susceptible to flooding.
- Radio license fees.
- Higher cap-ex costs per premises due to lower densities and hence higher depreciation and upgrade costs per premise served - it is anticipated that there will be significantly more DSLAMs per premises than in an urban area, which will depreciate at the same rate as an urban DSLAM.
- The simplified processes to take advantage of the relaxed planning requirements for installation of street furniture and telegraph poles.

6.3 End user experience and metrics

6.3.1 Marketing

Marketing in the Final 5% areas should be extremely focussed and targeted to the deployed coverage area. Expensive 'blanket' marketing (large newspaper, radio, TV etc.) to the wider area is counter-productive as it raises the number of enquiries from areas outside of the final 5% area – which then costs more to support. As such, CFS target marketing to the specific area using techniques including posters on the SLU cabinets (similar to BTO), targeted community awareness meetings, adverts in the local parish magazine and marketing through the Parish Council and Hants County Council where this is mutually agreeable. Not only is such marketing extremely focussed, it is also incredibly cost effective (annual adverts in parish magazines varying from £30 per annum to £300 per annum). As such, marketing is considered de-minimis to the op-ex financial modelling.

6.3.2 Feedback in relation to services and products

DCMS has conducted its own customer survey across all the Innovation Fund pilot projects and has developed the findings across all the pilot projects.

Call Flow's own feedback from potential customers in the MTP areas has been broadly positive, with the majority of prospective customers accepting that a small premium needs to be paid for receiving such a service in a Final 5% area.

The approach of Call Flow, BDUK and HCC hosting launch awareness events has proved extremely successful, with a significant number of attendees at these events being keen to take the service immediately it is available. While waiving the installation fee (representing a £78 saving) has been received positively, CFS does not believe that this impacts the sign up rates significantly.

One in three new customers is also opting for the 'premium router' option at £49+VAT. This is a dual band router with 5GHz functionality in addition to the standard 2.4GHz functionality for WiFi connectivity within the customer premises. This implies that customers are prepared to pay to get the best possible experience once they have decided to upgrade to SFBB.

At this point in time, the take up rate implies that the small premium being charged is not having an adverse impact on subscription rates.

The take up rate to March 2016 is well within the forecast range that ensures a sustainable commercial model.

6.4 Issues encountered and resolved

6.4.1 Local liaison

For rural projects, targeted local liaison can be extremely useful, particularly the network design stages, for:

- Leading negotiations for placing gigabit nodes on private buildings and digging the duct at advantageous rates to enable FTTP to the premises on the landowners' estates.

- Provision of plans of estate utility routes and verbal results of previous FWA survey showing FWA to be unsuitable for the estate. Agreement in principle for new network build where required for FTTP.
- Local knowledge of landowners and potential radio nodes for good FWA coverage.
- With good local knowledge, to put CFS in contact with majority landowner REDACTED – who subsequently confirmed a suitable FWA node where he already has a radio mast.

6.4.2 Planning for geographically remote areas

- Being geographically more remote than CFS' existing networks, more emphasis has been placed on desktop planning using radio planning tools, Google Earth and Google Street View. This has shown that a substantial amount of network planning can be achieved by desktop planning, making subsequent surveys far more efficient. As such, the approach is largely geographically transportable and scalable.
- The project area was clearly defined and agreed to avoid 'project creep' when neighbouring premises and communities adjacent to the intervention area expressed an interest in coverage.

6.4.3 Deployment

- Granting of wayleave on 'challenging estate'. The trustees of one estate did not readily accepted the CFS standard wayleave to install FTTP to the 40 premises on the estate. Whilst this was overcome, CFS explored the option of new BT/CFS SLU node installation to improve forecast coverage in the area whilst also overcoming the current wayleave issue.
- Deployment of PIA has proved more problematic and costly than anticipated (based on CFS previous deployments). This has largely been due to:
    1. A substantial number of BTO underground chambers being in the carriageway rather than the footway. This has had a modest impact in terms of extra costs for traffic management.
    2. A substantial number of duct blockages have been encountered to date. This has meant significant extra costs for 'jetting' ducts. This is most unusual and is believed to be due to the floods of 2013/2014 where much of the highways above the duct sections were flooded. As a consequence the BT ducts acted more as drains than usual, carrying silt and consequently causing the ducts to become blocked. Whilst such duct blockages are not uncommon, the sheer quantity in such a relatively short distance is. This has added significant extra costs to the use of PIA.
    3. Road closure required for a particularly narrow section of country roads in and around the Ropley area. This has added both delay and modest cost increases to the project.
- Delivery of electricity supplies to the FWA/gigabit nodes has taken longer than anticipated. Escalation has revealed that time was lost due to the jobs being allocated to an apprentice. Regular chasing/updates now happening to ensure jobs are progressed in a timely manner.
- Amey as a main contractor. CFS has used Amey as the main contractor on the MTP based on previous positive experience in Kent. The main benefit of using Amey is that they are fully skilled in planning/managing all highway activities. However, being a relatively small contract for them, CFS believe that this has caused delays and inefficiencies for some highways activities. As such, CFS has now subscribed to an EToN (Electronic Transfer of Notices) service. Based on experience on this and following projects, this will reduce delays and allow a wider choice of sub-contractors.

6.5 Scalability of the solution

CFS believes that provided a project area is large enough (typically starting at minimum 1,500 premises), with appropriate funding (starting at 100% cap-ex funding for the smallest project areas) and that there is a reasonable degree of flexibility of the ultimate coverage rate of the Final 5% area (target >90%), then the hybrid solution can address some 60% to 75% of the Final 5% challenge. Further modelling would be required to give extra confidence to this assumption – which is largely based on CFS experience of building rural broadband projects in Kent, East Sussex and Hampshire.

The CFS model accepts that no single delivery mechanism (SLU or FWA) can achieve >90% coverage and FTTP is generally too expensive to use as a single delivery method. With the possible availability of new SLU products via the SOR in progress with BTO (See section 4.1.3), then cost/coverage options are likely to improve and extend the viability of the Call Flow model beyond 75% of the Final 5% challenge. Indeed, an example where Call Flow believe these proposed SLU solutions would have been effective is Dartmoor and Exmoor.

6.5.1 Scalability of the hybrid model

Its accumulated experience from similar projects in a variety of challenging areas has led CFS to the conclusion that the hybrid model can offer a solution that is scalable to significant portions of the UK's 'Final 5%' areas and is capable of being deployed cost effectively and operated sustainably. CFS believes that this approach is likely to be suitable for between 60% and 75% of the 'final 5%' challenge. As such, it offers the potential for these areas to achieve near 100% SFBB coverage in a commercially viable way and make a significant impact on UK SFBB coverage.

The model has evolved to address the various challenges that a typical Final 5% area will present, provided it is across the whole 'last 5%' rather than, for example, just the 'last 2%'. This pilot has been able to demonstrate the suitability of the model to entire rural exchange areas. Although the coverage area is broadly contiguous, this is not vital to the success of the model. The model is based on identifying a suitable point to bring in the backhaul, and then planning the capex build that connects each 'island' together to this backhaul to form a core network. This can be achieved with fibre where PIA or suitable highways verges/private land are available. Gigabit radio links are effective in connecting 'islands' within 4km as part of the core network, and lower capacity radio links can be used to connect smaller islands into the core from up to 10km away.

6.5.2 Scalability of SLU solutions to the Final 5%

Deploying SLU to cabinets that BTO have not unbundled is the preferred first 'building block' of the CFS solution. To understand how this model might scale to wider parts of the UK, there are two key considerations:

1. **Density of non SLU cabinets in the final 5%.** The model relies on an average distance of 4km between cabinets as a starting point, allowing for some variations. The first step in applying the model is to take the (non-enabled) cabinets and model to the area of the county. However, where non SLU cabinets are limited then the model can allow for new FWA nodes to be the '4km node' or indeed new CuRe nodes should these become available, subject to the ongoing SOR process. As such, the real model being used is a 'density of premises' every 4km, which is

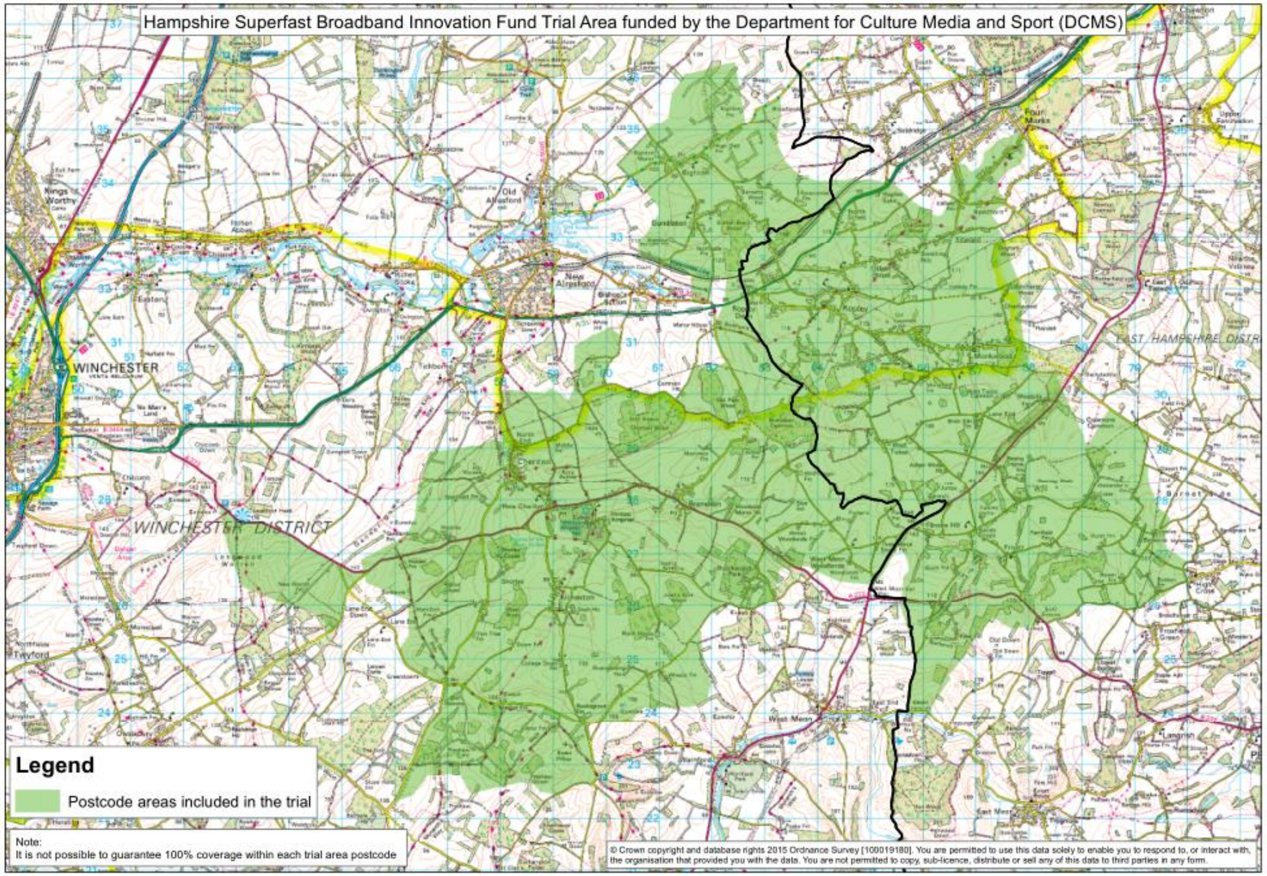
typically 150-200 premises. It should be possible to calculate the metric for all counties to identify those that the CFS hybrid model is particularly suited to.

2. **Alternative nodes where SLU cabinets do not exist.** As part of the first 'building block', SLU nodes can simply be replaced with two tactically placed FWA nodes for near identical costs. In doing so, the main variability to the model is likely to be coverage achieved i.e. CFS experience is that FWA does not usually achieve the same coverage rate as that achieved by SLU unless there is a high density of premises with favourable FWA characteristics e.g. an adjacent high point/hill or a tactically advantageous FWA node such as a church tower.

In summary, it is possible to model/forecast the counties that are likely to most benefit from the CFS hybrid model. In addition, where non SLU cabinet densities are less that the 4km average, the hybrid nature of the CFS model simply allows for extra FWA nodes to be deployed. As such, CFS believe that this model is extremely scalable to significant (i.e. >60% of the final 5%) areas of the UK.

Appendix A – Coverage map

The project area was clearly defined and agreed to avoid 'project creep.



Appendix B - Retail price offer

Residential

Select your broadband package: Please TICK the box of which option you require

	Download Speeds	Upload Speeds	Connection Fee	Monthly Broadband Rental	Usage Limits
Call Flow **40**	Up to 30Mbps	Up to 2Mbps	£65.00+VAT	☐ £22.50+VAT	40GB pcm
Call Flow **XXL**	Up to 30Mbps	Up to 2Mbps	£65.00+VAT	☐ £26.99+VAT	200GB 17p+VAT per GB thereafter

Telephone line for broadband connection
Please enter your telephone number below on which your broadband will be activated

Already got broadband? – Enter your Migration Key (MAC Key)

☐ I don't have broadband already – this is a New Connection

Router Options: Please select your Router

All orders include a FREE Wireless N Router, upgrade to the latest wireless AC technology offering improved speeds & coverage for only £49!

☐ Standard Wireless N VDSL Router FREE
☐ Premium Wireless AC VDSL Router £49 + VAT

Business

	Download Speed	Upload Speed	Connection Fee	Monthly Rental	Usage Limits
Call Flow Business **40**	Up to 30Mbps	Up to 5Mbps	£99.00+VAT	☐ £36.50+VAT	40GB pcm
Call Flow Business **XXL**	Up to 30Mbps	Up to 5Mbps	£99.00+VAT	☐ £41.00+VAT	200GB 17p+VAT per GB thereafter

Telephone line for broadband connection
Please enter your telephone number below on which your broadband will be activated
If your broadband is to be provisioned via radio, please leave this and the MAC section blank

Includes **FREE** Wireless Router and single fixed IP address

Additional Range of 5 IP addresses £15.00 + VAT Per Month

Already got broadband? – Enter your Migration Key (MAC Key)

Appendix C – Wholesale pricing

Bitstream product pricing

Product Name	Sell Price	Profile	Term	Type
Residential 30/2	£20.83	30/2	18	FTTC/FTTP/RADIO
Business 30/5	£35.00	30/5	18	FTTC/FTTP/RADIO
General Costs	**Sell Price**			
Residential FTTC/FTTP/RADIO Activation	£50.00			
Business FTTC/FTTP/RADIO Activation	£85.00			
FTTC/FTTP/RADIO Cease	£120.00			
Missed Engineer Appointment	£90.00			
End User Modify Request	£15.00			
Amendment of Product	£11.25			
Order Cancellation up to the point of no return	£11.25			
FTTC/FTTP/RADIO Expedite	£200.00			
SFI	**Sell Price**			
CFS SFI Visit Base	£144.00			
CFS Connect	**Sell Price**			
CFS Connect 95th Percentile Mb/s	£30.00			

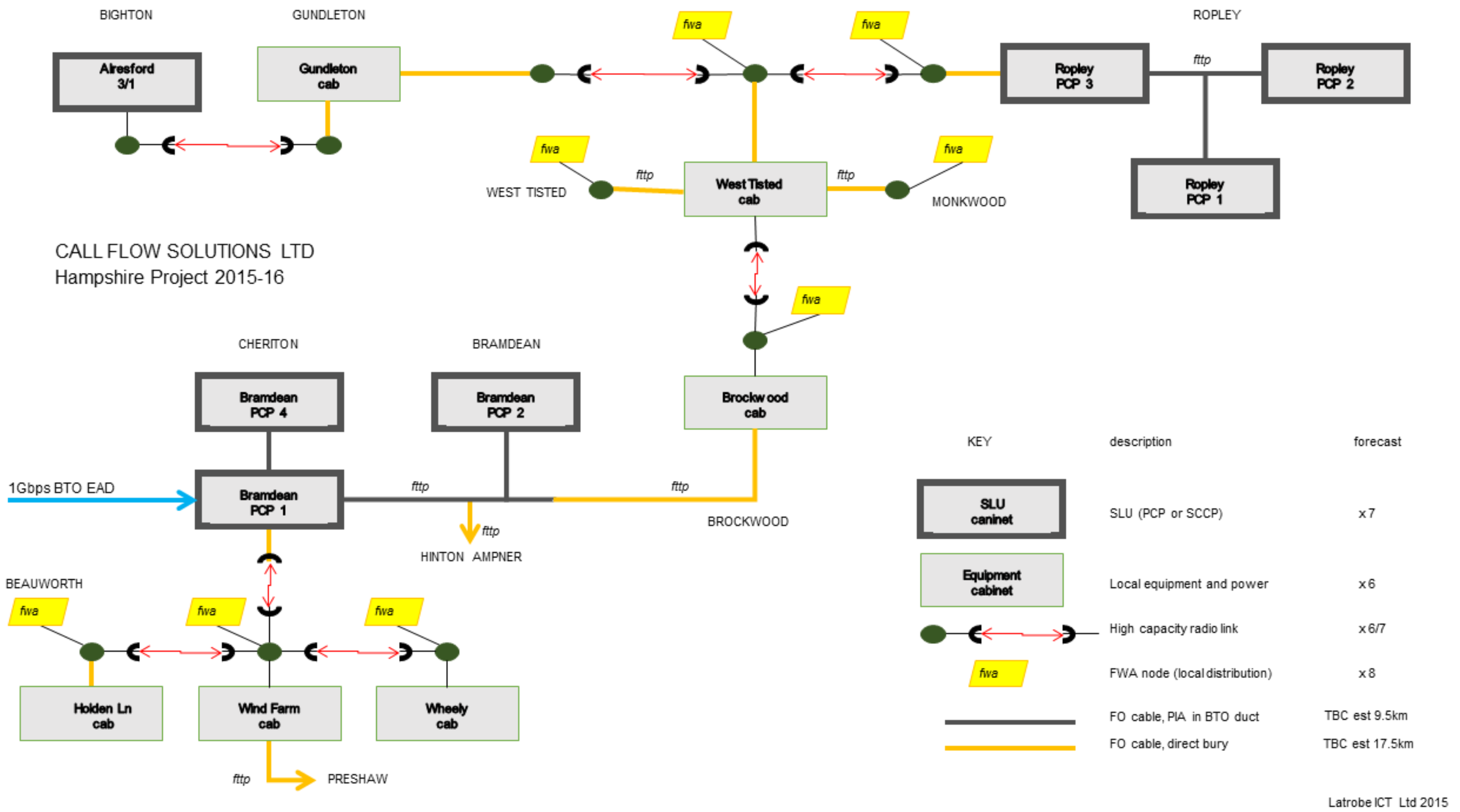
Passive products pricing

Product	**Unit**	**Rental cost p.a.**	**Notes**
Spine BFT	Per metre	£0.6	*10 year term*
Lead in BFT	Per metre	£0.84	*10 year term*
BFT handover point	Each	£40	*10 year term*
Dark Fibre	Per metre	£0.75	*10 year term*
Dark Fibre handover point	Each	£40	*10 year term*
Chambers – Per core drill entry/exit	Each	£11.18	*10 year term*
Cable up a pole	Per cable	£2.39	*10 year term*
Pole top equipment	Per joint/equivalent	£3.72	*10 year term*
Drop fibre on pole	Per attachment	£15.48	*10 year term*
Aerial to 30cm square/diameter	Per aerial	£200	*10 year term*
Aerial to 60 cm square/diameter	Per aerial	£400	*10 year term*

Appendix D – Technical solution

[Supporting slides]

Appendix E – Solution architecture



Appendix F – Network build photos

New CFS SLU cabinet shell and base

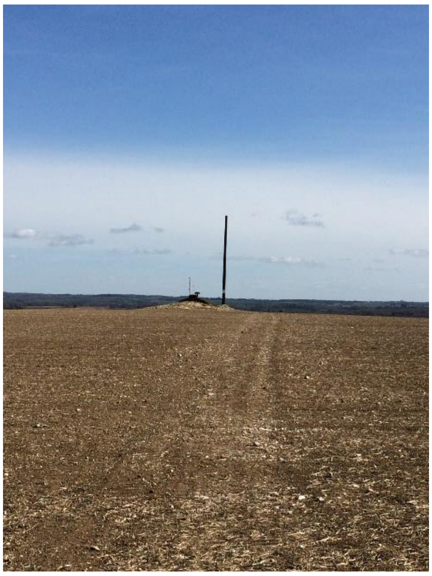
BT cab re-shell and tie cables

Direct buried fibre

Trench for direct buried fibre

Mole plough starting at the end of an open trench

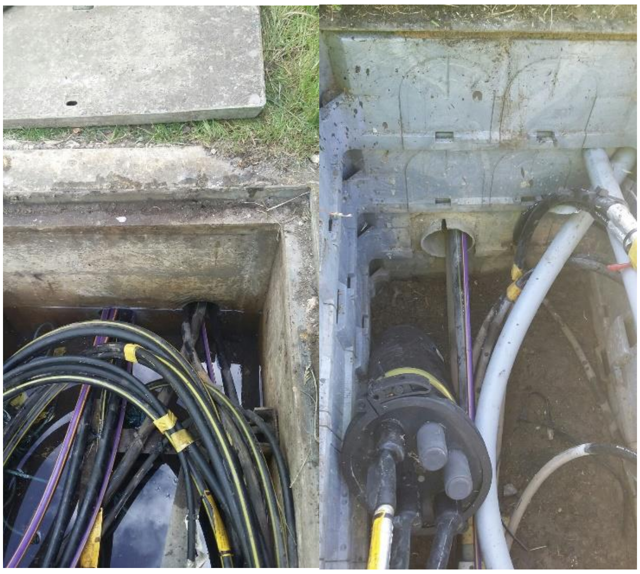
Installation of a trench and pole that feeds a FWA pole



Complete pole and fibre link - reinstated

Cabinet that feeds Gbit radio / FWA links

CFS FTTP cabinet showing the nearby carriageway cover to access BT duct for PIA



PIA: the CFS cable (purple) installed in BT's ducts

Combined Gbit radio / FWA pole

Fibre make up box on an aerial pole showing the fibre joint

Fibre cable ready for connection inside an FTTP cabinet

Combined Gbit radio / FWA pole