

BDUK

Data Model

Explanatory Notes

Model Summary

BDUK has constructed models to estimate the costs, revenues and therefore expected investment gap required by the private sector to meet the project requirements under a range of scenarios. BDUK has also constructed a model to allocate funds to Local Authorities based on the amount of gap-funding we think each area will require.

There are two key cost models, a superfast broadband model and a wireless model:

- The superfast broadband model considers the costs to a private sector operator using BT's network (e.g. a sub-loop unbundler) to provide a fibre-to-the-cabinet (FTTC) solution to a selected percentage of the UK population.
- The wireless model calculates the costs to provide wireless and satellite solutions to the remainder of the population that cannot get access to a 2Mbit/s broadband service.

The models calculate operating cashflows over a period and allow the calculation of the investment gap that would be required by the private sector to make this investment viable. The investment gap is calculated based on the Net Present Value (NPV) of the cashflows from each model.

Coverage assumptions

The models calculate costs to cover premises that are determined by BDUK to be in "the final third" and are therefore unexpected to be provided with superfast broadband by the private sector. In this case "the final third" is defined as any premise connected to a BT cabinet that is in an exchange area where Virgin Media has less than 70% household coverage; *and* is connected to an exchange that has not been announced by BT to be part of their superfast broadband upgrade programme.

The superfast broadband model therefore calculates costs and revenues for the final third on a cabinet by cabinet basis. The cheapest cabinets in terms of investment gap per customer served are upgraded first until a floor threshold for fibre coverage (e.g. 90% of premises) has been reached in every Local Authority area and fibre connectivity to every community has been provided.

Premises that are expected to receive less than 2Mbit/s, after targets for fibre coverage have been reached, are input into a wireless and satellite cost model. For 10x10km grid squares with a population density above a chosen threshold it is assumed that a wireless mast is constructed, and all premises in grid squares below this threshold are served with satellite.

Model scope

Assumption	Description
Modelling approach	<p>Premises are covered with fibre-to-the-cabinet (FTTC) by upgrading cabinets in "the final third" until a floor threshold for fibre coverage (e.g. 90% of premises) has been reached in every Local Authority area and fibre connectivity to every community has been provided.</p> <p>Premises that are expected to receive less than 2Mbit/s, after the above targets are met, are input into a wireless and satellite cost model.</p>
Estimation of "the final third"	<p>Premises considered to be in "the final third" are connected to cabinets that are:</p> <ul style="list-style-type: none"> - in an exchange area where Virgin Media has less than 70% household coverage; and - connected to an exchange that has not been announced by BT to be part of their superfast broadband upgrade programme
Superfast broadband model scope	The superfast broadband model considers the costs to a private sector operator using BT's network (e.g. a sub-loop unbundler) to provide a fibre-to-the-cabinet (FTTC) solution to a selected percentage of the UK population.
Mobile model scope	The wireless cost model considers the costs required to construct wireless masts with appropriate microwave backhaul in areas above a selected population density threshold and the costs to serve the remaining UK population with satellite. Population densities and wireless site deployments are calculated using a 10x10km grid.

Assumptions that have a large impact on results are highlighted in **bold text** below.

Key superfast broadband infrastructure cost drivers

- Cost per cabinet shell upgrade: a fixed cost required for every cabinet upgraded
- Cabinet active electronics: a cost required for every 32 customers connected
- **BT duct re-use: the % of BT's duct that can be re-used**
- **Dig costs: the cost per metre to install new ducts, dependent on type of terrain**
- Fibre cost: the cost to purchase bundles of fibre
- **Fibre install cost: the cost per metre for install**
- **Openreach duct rental: the cost per metre of duct used per annum**
- **Migration of copper sub-loop: the cost per customer connected**
- **Rental of copper sub-loop: annual rental of Openreach**
- Active electronics in exchange: cost per router supporting 160 customers

Key wireless and satellite infrastructure cost drivers

- **Population density threshold for wireless: a threshold in each 10x10km grid square, above which a wireless site is deployed**
- **Cost of a new wireless site: one in each grid square above the threshold with additional sites to meet capacity constraints**
- **Base station costs per site**
- Antenna costs per base station
- **Terrestrial backhaul per microwave hop, times expected number of hops, with additional backhaul to meet capacity constraints**
- **Service provider subsidy of CPE: expected contribution of retail service provider towards CPE and install per subscriber connected**
- **CPE cost per subscriber (wireless) per subscriber connected**
- **CPE cost per subscriber (satellite) per subscriber connected**
- Site rental per site per annum
- Site operation and maintenance per site per annum
- Power cost per site per annum
- Backhaul to PoH per site per annum

Key superfast broadband revenue drivers

- **Connection revenue: one-off connection charge to match Openreach's GEA offering**
- **Monthly revenue: ongoing monthly charge to match Openreach's GEA offering**
- **Expected take-up of FTTC as % of households passed, for households receiving less or more than 2Mbit/s over ADSL and offered between 2Mbits/s and 15Mbits/s using FTTC, and offered greater than 15Mbits/s using FTTC**

Key wireless and satellite revenue drivers

- **Monthly revenue: ongoing monthly charge to match Openreach's GEA offering**
- **Expected take-up of wireless as for households currently receiving less than 2Mbit/s**

Financial parameters

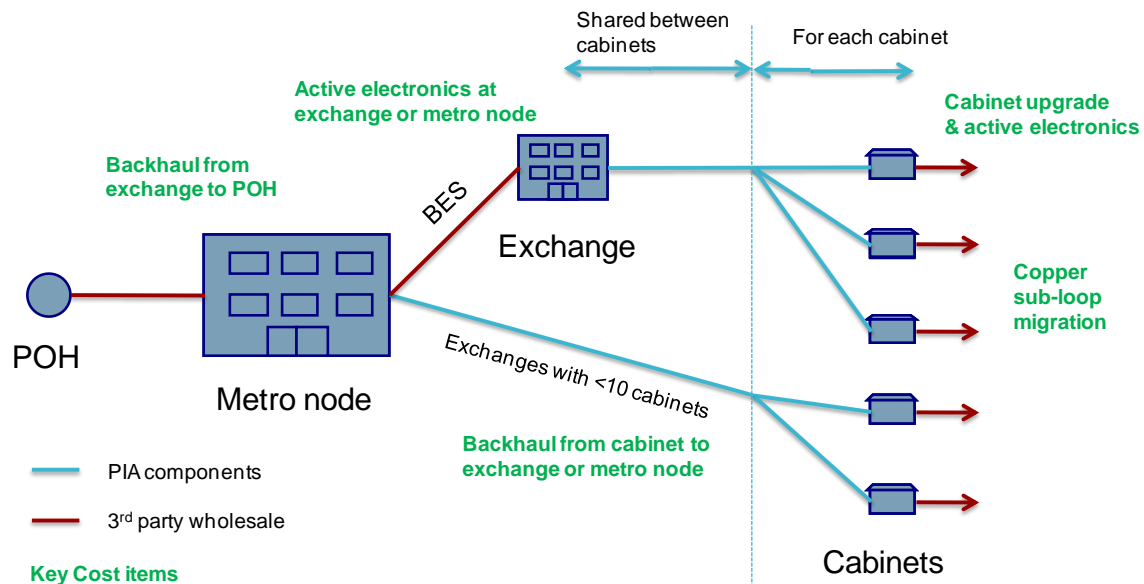
- **Payback period: number of years of business plan**
- **Internal Rate of Return expected by the private sector for an infrastructure project**
- **Optimism Bias: adjusting all unit capital costs up and reducing all unit revenues down by a set percentage to account for market uncertainty**

Cost assumptions – superfast broadband model

The superfast broadband cost model considers the costs required to provide a wholesale service, allowing service providers to interconnect at a point of handover (POH) in BT's network and offer connectivity to the end-customer.

Retail costs such as customer premises equipment (CPE) and installation are not included in this model.

A high level network diagram showing key cost components is shown below.



Capex costs for this architecture include: PCP shell upgrade cost; cabinet active electronics costs; copper local loop connection charge; duct costs (depending on whether they use roads, footpaths, or grass); fibre purchase and install costs; BES costs and excess construction; ODF costs; and connection of the Metro node to POH. All capital costs apart from MSAN costs and copper local loop migration costs (which are driven by customer take-up) are assumed to be incurred in the first year of operation. An optimism bias adjustment has been applied, uplifting all unit capital costs.

Operating costs for this architecture include: Openreach duct rental; O&M cabinet costs; power supplies for O&M cabinet and PCP; aggregation costs; copper local loop costs; BES distance charges; and charges for the Metro node to POH. All operating costs apart from copper local loop rental (which is driven by customer take-up) are assumed to be incurred annually in full from the first year of operation.

Revenue assumptions – superfast broadband model

The superfast broadband model considers the revenues a third party operator would receive by offering a wholesale service equivalent to Openreach's Generic Ethernet Access (GEA). Revenues comprise of a connection charge per customer connected equivalent to Openreach's current GEA connection charge and an ongoing charge per customer connected per month similar to Openreach's current GEA rental charge.

Take-up of the service is calculated on the basis of estimates of current available speeds over ADSL and possible speeds using FTTC for premises connected to each cabinet. These rules are designed to match BT's current expectations of national take-up of basic and superfast services: there is a potential upside to these take-up assumptions as these are BT's national estimates for take-up of a BT service including areas where Virgin Media has a competing service. Increased take-up levels could also be expected as a budget for demand stimulation

Demand is expected to ramp up linearly over the first 4 years of Revenues are based on year average subscribers. No revenues are received for the first 4 months of operation. An optimism bias adjustment has been applied, reducing all ongoing revenues

Cost assumptions – wireless and satellite model

Premises that are expected to receive less than 2Mbit/s, after these targets for fibre coverage have been reached, are input into a wireless and satellite cost model. This list includes: premises in the first two thirds that are expected to receive less than 2Mbit/s with a fibre-to-the-cabinet (FTTC) solution; premises in the final third that are upgraded to FTTC, but still receive less than 2Mbit/s; and premises in the final third that are not upgraded to FTTC and currently receive less than 2Mbit/s over ADSL. Some premises in the final third that are not upgraded to FTTC are expected to remain on ADSL, as they currently receive a service better than 2Mbit/s.

The wireless cost model considers the costs required to construct wireless masts with appropriate microwave backhaul in areas above a selected population density threshold and the costs to serve the remaining UK population with satellite. Wireless costs are driven using a 10x10km grid (as this approximately correlates to the area covered by a wireless cell of 6km radius, which is typical for rural wireless sites). If the population density in a grid square (premises per km²) is greater than a threshold then a wireless site is deployed in that grid square. Premises in grid squares without a wireless site are assumed to be covered using satellite.

It is expected that the retail service provider or end customer would be prepared to contribute towards wireless CPE and install costs and that the remainder of the CPE and install costs would need to be subsidized. For satellite services it is assumed that the investment gap is equivalent to this subsidy of CPE.

Capex costs for providing wireless and satellite connectivity include: costs of new wireless sites; base station costs; antenna costs; terrestrial backhaul; and CPE cost per subscriber depending on whether they are using wireless or satellite.

Operating costs for providing wireless and satellite connectivity include: site rental; site operation and maintenance; power costs; and backhaul to PoH.

The deployment of wireless sites is driven by the population density in each grid square. Additional sites are added in order to meet capacity requirements in each grid square, taking account of busy hour demand per household, an overprovision factor to dimension capacity, sectors per site with a varying average download capacity per sector depending on technology and frequency utilized, and a base case using Frequency Division Duplex (FDD) Long Term Evolution (LTE).

All capital costs apart from CPE costs (which are driven by customer take-up) are assumed to be incurred in the first year of operation. An optimism bias adjustment has been applied, uplifting all unit capital costs. All operating costs are assumed to be incurred annually in full from the first year of operation.

Revenue assumptions – wireless and satellite model

The wireless and satellite model considers revenues to be the same as those assumed in the superfast broadband model as the service is assumed to be a fixed equivalent, so revenues comprise of an ongoing charge per customer connected per month equivalent to superfast broadband model. Take-up of the service is assumed to match the assumed take-up of a basic service by premises currently receiving less than 2Mbit/s in the superfast broadband model. Demand is expected to ramp up linearly over the first 4 years of. Revenues are based on year average subscribers. An optimism bias adjustment has been applied, reducing all ongoing revenues

Funding allocation assumptions

The funding allocation model assumes that BDUK provides investment gap funding to each Local Authority to allow them to provide 90% coverage of premises with superfast broadband, plus fibre connectivity to every community and at least a 2Mbit/s service to every premises. The investment required gap to upgrade infrastructure in each Local Authority is calculated using the superfast broadband and wireless models.

The 90% superfast broadband floor target in each Local Authority is reached by selecting the cheapest cabinets for upgrade (in terms of investment gap per premises passed) in the superfast broadband model until 90% of premises in every Local Authority are covered. After this floor target has been reached, fibre connectivity is ensured by checking that every post sector (e.g. SE16 4) contains an upgraded cabinet. If a post sector does not contain any upgraded cabinets, then the cheapest cabinet in the post sector (in terms of investment gap per premises passed) is upgraded. If a post sector does not contain any cabinets, then a new cabinet is added at an investment gap equivalent to the average of the most expensive 10% of cabinets in the superfast broadband model.

Premises that receive less than 2Mbit/s after the local floor and fibre connectivity to every community have been implemented are fed into the wireless cost model and an investment gap to upgrade these premises is calculated.

The total investment gap required for each of these stages is aggregated at a Local Authority level to give an indicative investment gap required for each. BDUK will then provide 50% of the required gap funding to each Local Authority, with the remaining 50% to be provided through local funding.