Report

FIBRE OPTIC DESKTOP STUDY

Enigma Data Centre
Maxwell House LLP

CONFIDENTIAL

Revision: P02 – Client Information
Issued: 1 November 2011

NORMAN DISNEY & YOUNG

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1. EXECUTIVE SUMMARY

Norman Disney & Young have been engaged to investigate the existing telecommunications infrastructure at Maxwell House, Third Avenue, Bletchley, Milton Keynes, MK1 1TG. On the basis of a preliminary review, the site is being considered for mirrored services from the Bank of England in Central London.

Carriers have been approached as part of this review to provide information on the proximity of the site to the carriers' fibre network, and budgetary pricing for diverse high capacity links. The services investigated are dual 10Gb fibre links on diverse routes and also, dual 1Gb fibre links on diverse routes, to determine the likely variances in cost and technical practicality.

Maxwell House is considered to offer a suitable site for a number of data centre services. It will support a range of end user business operations, both practically and in terms of the carrier networks flexibility.

In summary, many carriers have fibre infrastructure in close proximity to the site, reducing installation costs and enabling diverse telecommunication services to be provided if required.

Costs for civil works were found to vary considerably and it is anticipated that civil works will be required for most providers to connect to the access network. The civil works cost to establish diverse 10Gb links to site is estimated to be:

- £90k

The provision of a diverse 10Gb service is estimated as follows:

- A £150k capital cost for installation of the dual service, and
- £97k annually for a managed service.

The provision of a diverse 1Gb service is estimated to be:

- £100k for installation of service, and
- £60k annually for a managed service.

Dark fibre can be provided and the annual service fee would be less than that for an ongoing managed service.

Link latency and fibre routing across the dual 10Gb links has been estimated and is presented in Table A:

Telco	Primary Route Distance (km) [1]	Est. Latency (ms)	Secondary Route Distance (km)[1]	Est. Latency (ms)
BT	110	0.55	120	0.55
Cable and Wireless	-	0.55 (or better)	-	0.55 (or better)
COLT Telecom	-	-	-	-
Geo	111.3	0.55	N/A	N/A
Global Crossing	-	-	-	-
Virgin Media	110	0.55	110	0.55
Neos Network	160	0.8	N/A	N/A
EasyNet	110	0.55	110	0.55
Verizon	-	-	-	-

Table A: Summary of Carrier Availability and Latency Estimates

[1] Routes are estimated from information provided by carriers. Actual routes to be confirmed following detailed survey

Note. Information provided above is indicative and true figures are subject to detailed survey by individual carriers.

- Estimated latency from site to the Bank of England is between 0.55 ms and 0.8 ms
- Primary route distances range from 110 to 160 kilometres

To develop a finer resolution of costs and connectivity information it is considered that detailed site surveys by the respective carriers would need to be completed. The minimum period to obtain this information is estimated to be in the order of 30 working days to complete. Lead times for the provision of communications services vary; a minimum of six (6) weeks can be expected.

2. INTRODUCTION

2.1. Purpose

The purpose of this report is to undertake a Desktop Telco fibre review of site connectivity to aid in the assessment of telecommunications services and diversity options for potential end users.

2.2. Objectives

The primary objective is to assess the suitability of the Maxwell House site to offer multiple telecommunications services, link connectivity and diversity.

This report is based upon the provision of Dual 10Gb links using dense wavelength division multiplexing (DWDM) over direct fibre from London to the nominated site. In addition, dual 1Gb links are also considered, where practical for comparison purposes.

The following locations have been identified as the points of presentation:

- Maxwell House, Third Avenue, Bletchley, Milton Keynes, MK1 1TG and
- Bank of England, London EC2R 8AH

2.3. Key Requirements

The report identifies the following information:

- Nearest Telco Exchanges to the site including the services available.
- Primary Carriers and service distance to the site.
- Provision of Optical Fibre Infrastructure topological mapping for each Primary carrier in the vicinity of the site.
- Potential primary and secondary Telco routes to site.
- Estimated costs for installation, connection and annual fee for primary and secondary services.
- Provision of lead times for connection.
- Provision of latency of service information for links.
- Potential dark fibre available to the site.

2.4. Information Sources

The following carrier providers have been approached and have provided information to support the production of the report.

- BT
- Easynet
- Geo
- Colt
- Global Crossing
- Neos Network
- Virgin Media
- Verizon

- Cable & Wireless

2.5. Authority

Authority to undertake this report was provided by Edward Jones of Maxwell House LLP in August 2010.

2.6. Revision History

Issue	Rev	Date Issued	Comment
First Issue	P01	25 August 2010	Information

3. NEW SITE DETAILS

3.1. Location

The site under consideration is an existing warehouse/distribution centre which is proposed for redevelopment as a Data Centre facility with diverse telecommunication links to London.

Site and Service Details	
Postcode	MK1 1TG
Name	Maxwell House
Address	Third Avenue, Bletchley, Milton Keynes
OS Grid Ref	SP 867 346 GB
Site Description	Data Centre Facility

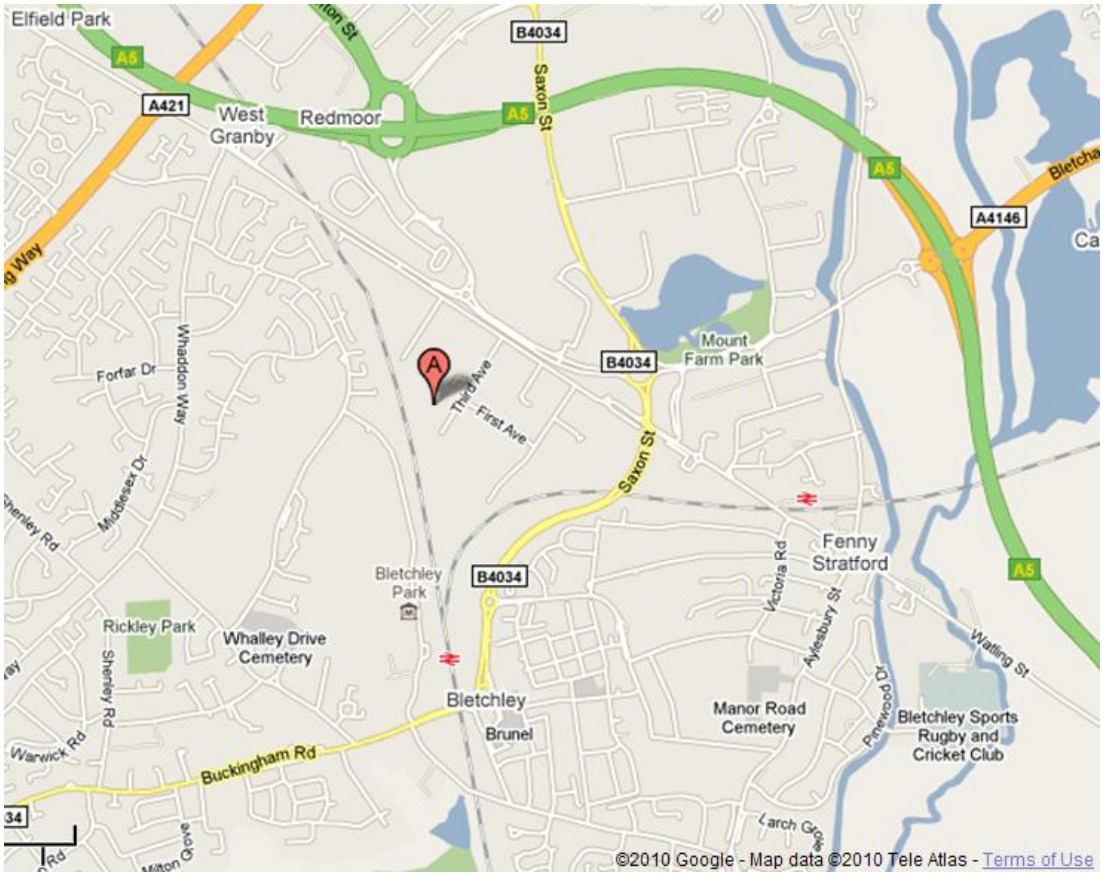


Figure 1: Road map of site (marker A) and surrounding area

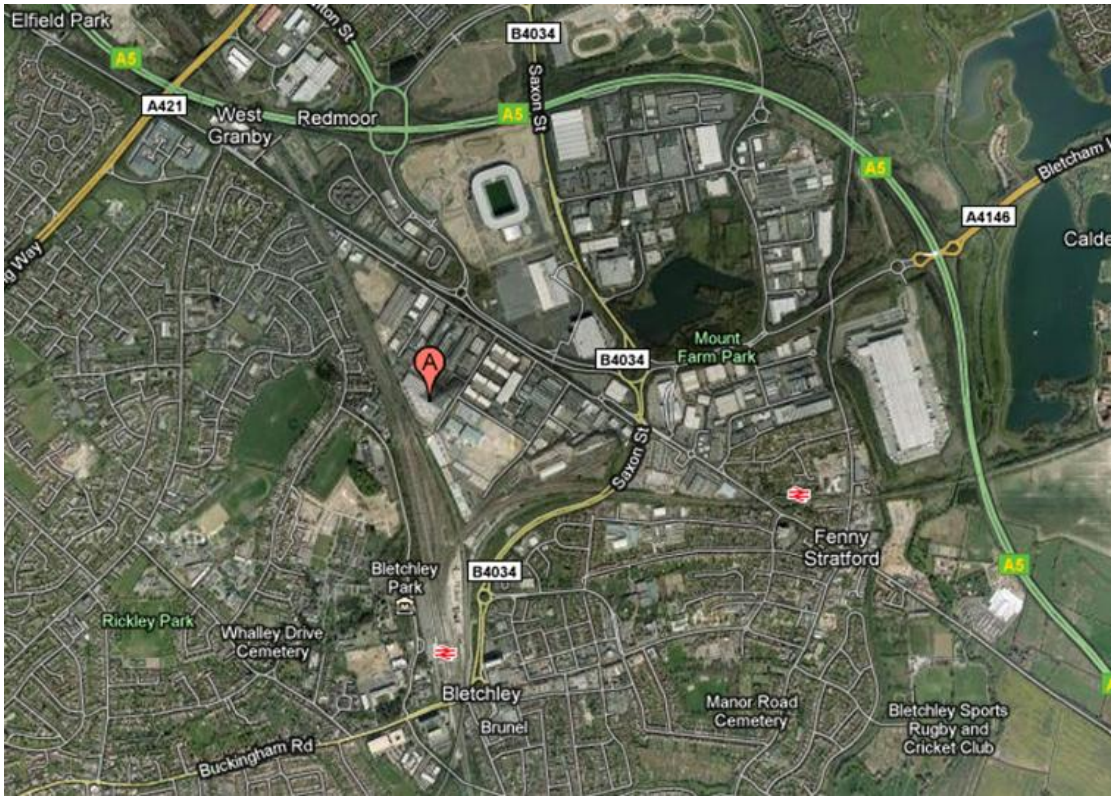


Figure 2: Aerial view of site (marker A) and surrounding area

3.2. Proposed Connectivity

Final end user requirements cannot be readily defined at this stage of the scheme; however the links are expected to provide full replication of services from the primary site. The following assumptions have been made for budget purposes:

- Two (2) Diverse 10 Gigabit DWDM Optical Fibre links connecting the two nominated sites, namely:
- Maxwell House, Third Avenue, Bletchley, Milton Keynes, MK1 1TG and
- Bank of England, London EC2R 8AH (BoE)

Note. As mentioned previously, in addition to 10 Gigabit services, 1 Gigabit services are to be considered.

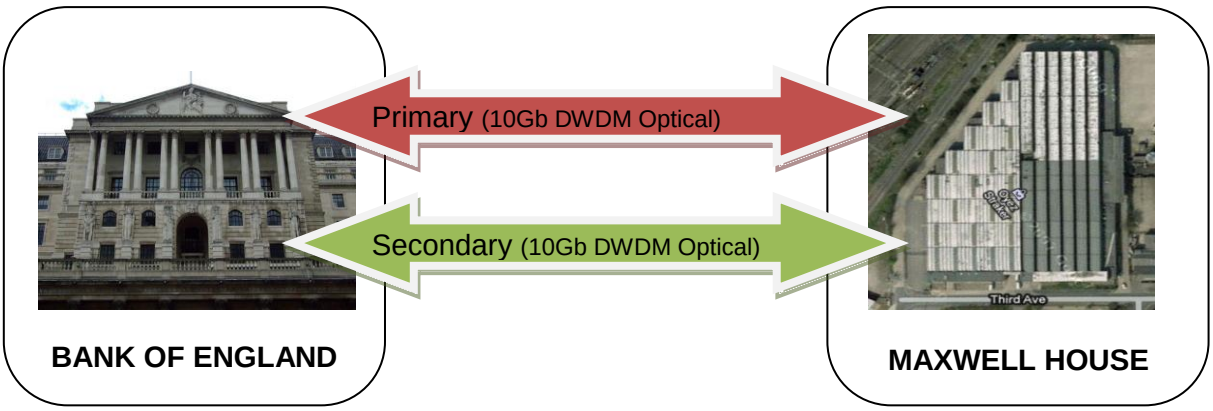


Figure 3 Proposed Site Connectivity with 10Gb links

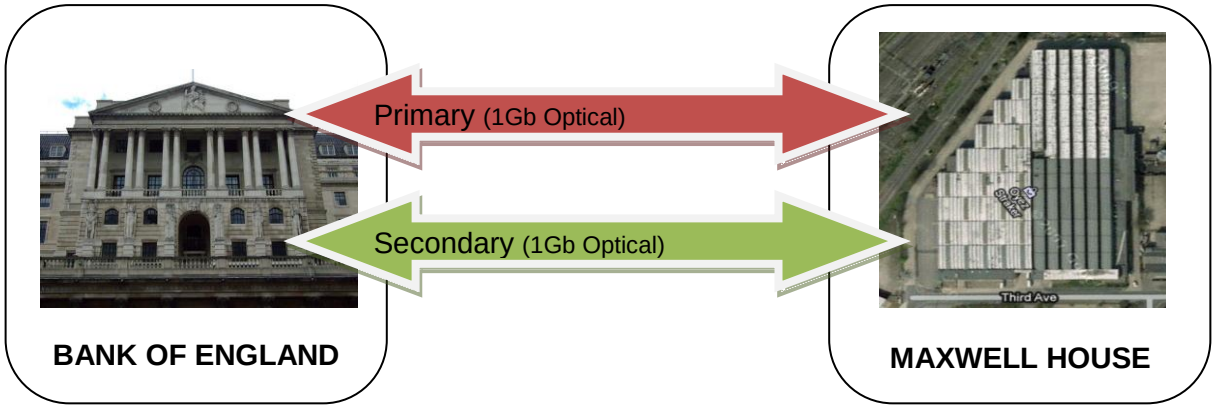


Figure 4 Proposed Site Connectivity with 1Gb links

4. FIBRE CARRIERS

4.1. Summary

The following carriers have been approached for this review:

- Geo
- COLT Telecom
- BT
- Cable and Wireless
- Virgin Media (including NTL and Telewest)
- Global Crossing
- Verizon Business
- EasyNet
- Neos Networks (now part of SSE)

The following carriers have existing connections within proximity to this site:

- Geo
- BT
- Cable and Wireless
- Virgin Media
- EasyNet
- Neos Networks

The following carriers do not have existing infrastructure close to site:

- COLT
- Global Crossing

4.2. Individual Carrier Review

4.2.1. Geo

The maps indicated in figure 5 and 6 indicate the overall network route from the BoE to Maxwell House, Bletchley and the indicative route of how Geo would dig the 1.3km from their existing network in Milton Keynes to Maxwell House itself.

This is Geo's own fibre (no leased fibre at all) so they can guarantee both availability, capacity and upon completion of the network, the latency as well. They can provide both 10G and 1G fibre links over a dedicated point to point link.

Geo have estimated network distance and latency, and it should be noted that the whole network topology and pricing structure is subject to a full site and network survey. Geo have no PoP's or Exchanges in their network and will offer the Client a dedicated dark fibre between the sites, lit and managed with new dedicated transmission equipment. Dark Fibre guarantees a fixed latency, as well as future scalability for extra bandwidth if required.

Geo estimated the fibre network latency to be 0.55 milliseconds and estimate that the transmission equipment will add 0.01 milliseconds of total latency to the network.

The procurement period to provide this service is estimated to be 4 months from order is subject to a full site survey.

The proposed architecture is as per the following table and figure7 below:

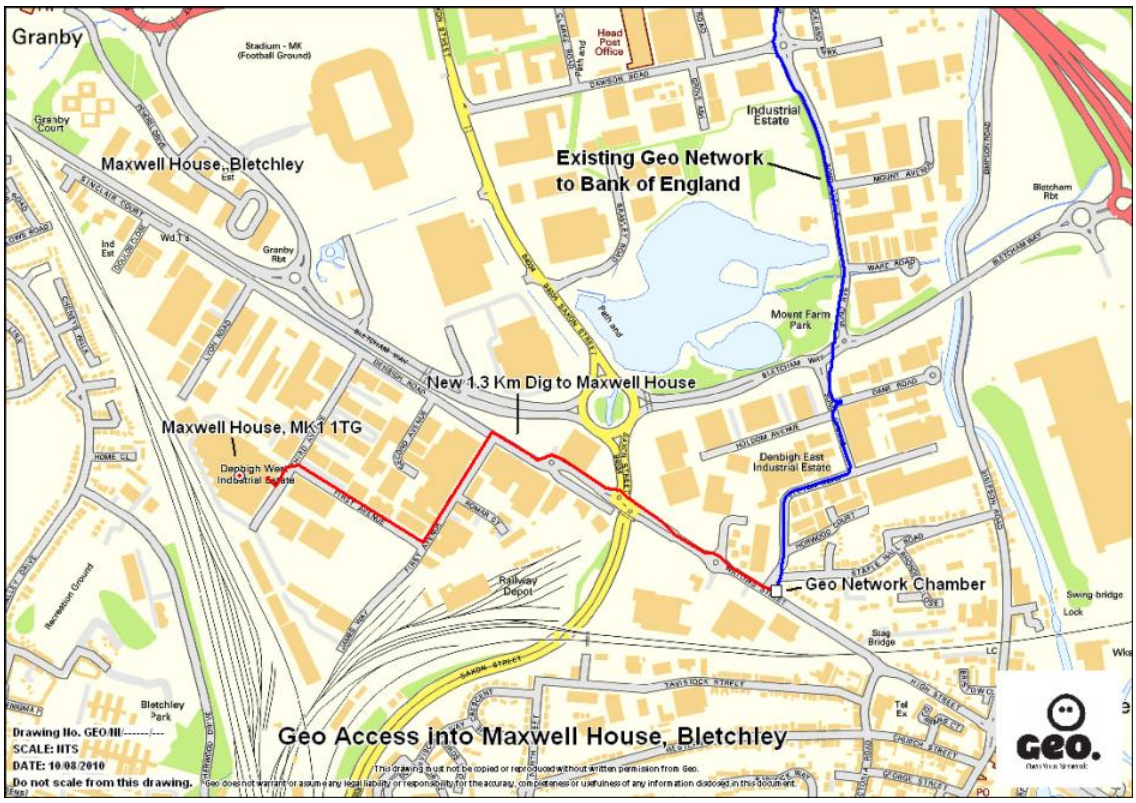


Figure 5 Geo's dig into Maxwell House

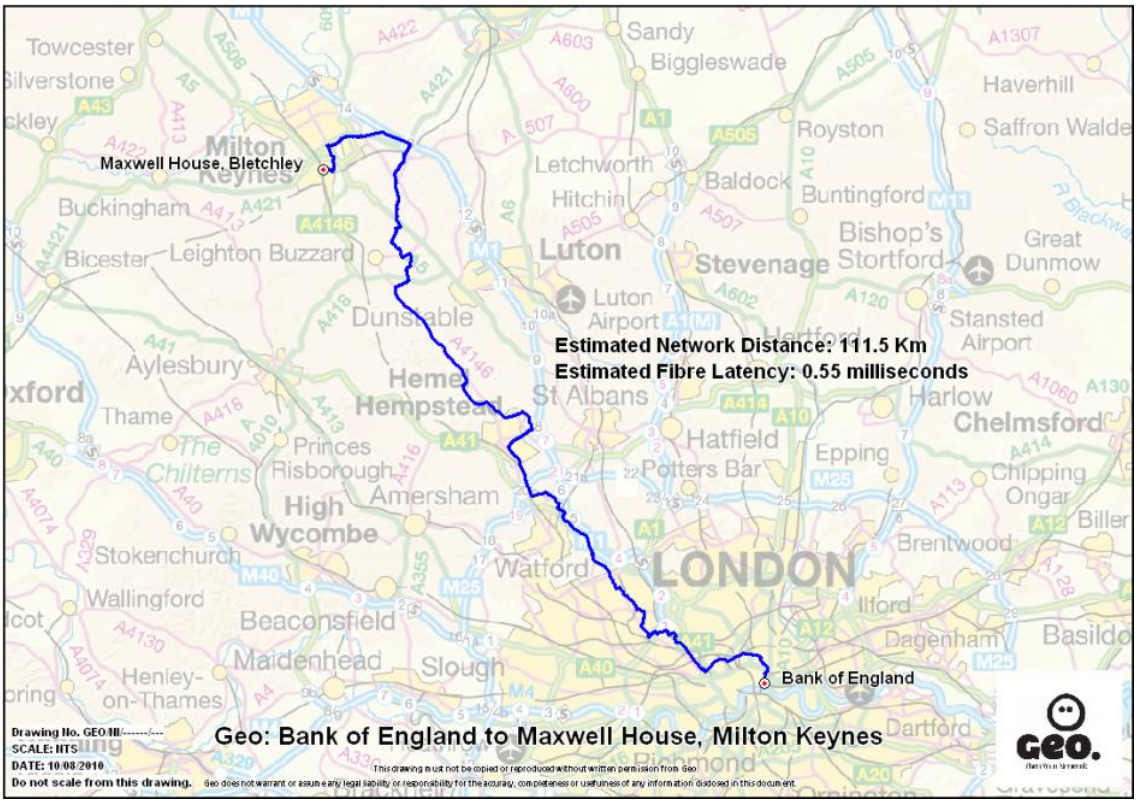


Figure 6 Overall fibre network, primary route only

	Distance	Latency
Primary Route (via Milton Keynes)	111.3 km (estimate)	0.55ms
Secondary Route	-	-

Within proximity of the Bank of England, Geo has diverse paths and existing fibre infrastructure to 1 km of the site. To connect to the site the fibre infrastructure would be extended along the existing sewer network and a new or existing entry point established for each leg.

Geo's network uses the Thames Water sewer system, providing existing cabling paths for their sole use. The fibre deployed for each Client is for that Client alone. This isolation provides a degree of resilience. A managed active link or dark fibre alone can be provided.

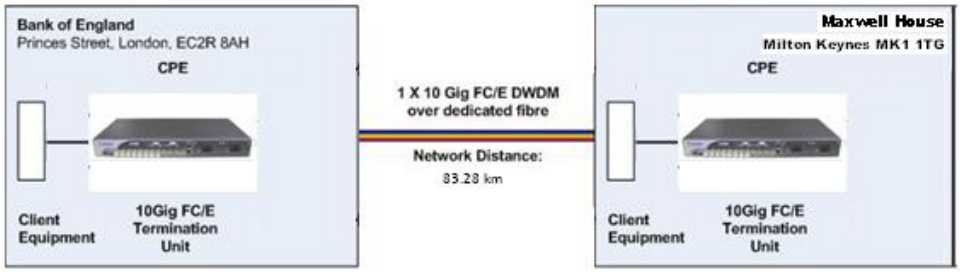


Figure 7 Proposed GEO Managed Service

The lit and managed fibre installation cost, based on a 5 year service contract is budgeted at £100k (£87k annual recurring cost) and £130k (£97k annual recurring cost) on a 3 year service. Additional 10Gb links can be provided over the infrastructure in the future at an install cost of approximately £7.5k annual fee per additional circuit (3 additional 10G circuits available from day 1).

For the purpose of this report and high level costing, Geo have offered a 1 x 10Gigabit network for only leg of the network, over dedicated dark fibre. The install fee is reflective of the dig cost Geo face to present their fibre to Maxwell House. They have indicated they would not be charging the Client any additional installation costs to connect into the Bank of England.

4.2.2. COLT Telecom

COLT's main long distance network is just outside of Milton Keynes (aprox 3.5 from Maxwell House)

COLT have confirmed that if demand warranted it they could break into this network and create a MAN (metropolitan area network) and potentially creating a POP.

Costs and Civil costs would have to be investigated further when a distinct opportunity arose.

4.2.3. BT

BT Openreach has existing network connections to the site, from different road frontages. The service type or capacity of these connections is currently unclear. The estimated nearest exchange is Bletchley Park at 3km from the site; Elder House is 5.5km and Phoenix House is 6km from the site.

Illustrated below is the connectivity diagram for two options, 100Mb Ethernet fibre service to BoE, London and 1Gb service to BoE, London. BT currently do not have a 10Gb service availability for this site. However it is in their product road-map.

The lead time for this service is estimated to be 60 working days.

It is anticipated that BT Openreach will have existing connection to the Bank of England.

	Distance	Latency
Primary Route (via Bletchley Park)	110km (estimate)	0.55ms
Secondary Route (via Elder House)	120km (estimate)	0.60ms

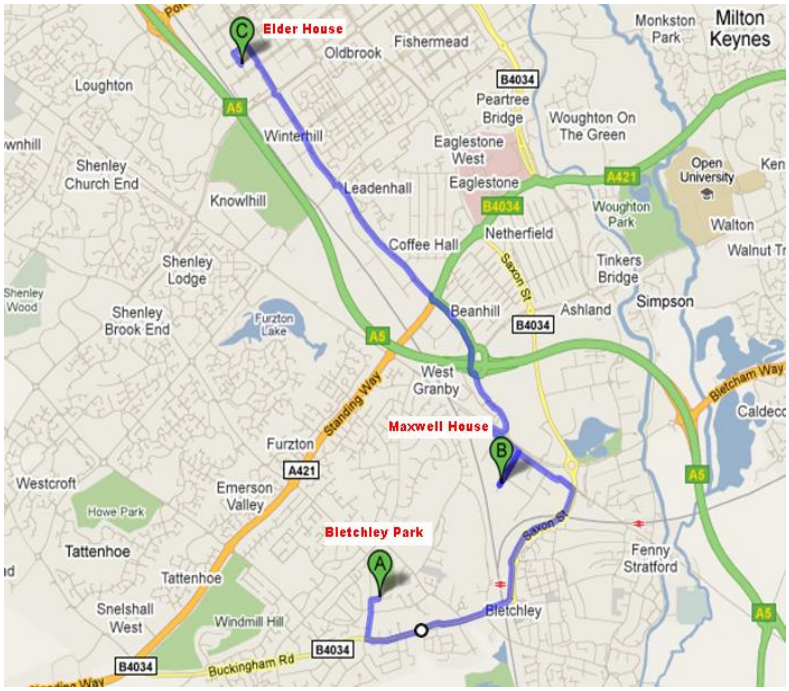


Figure 8 Indicative Connections at Bletchley Park and Elder House Exchanges

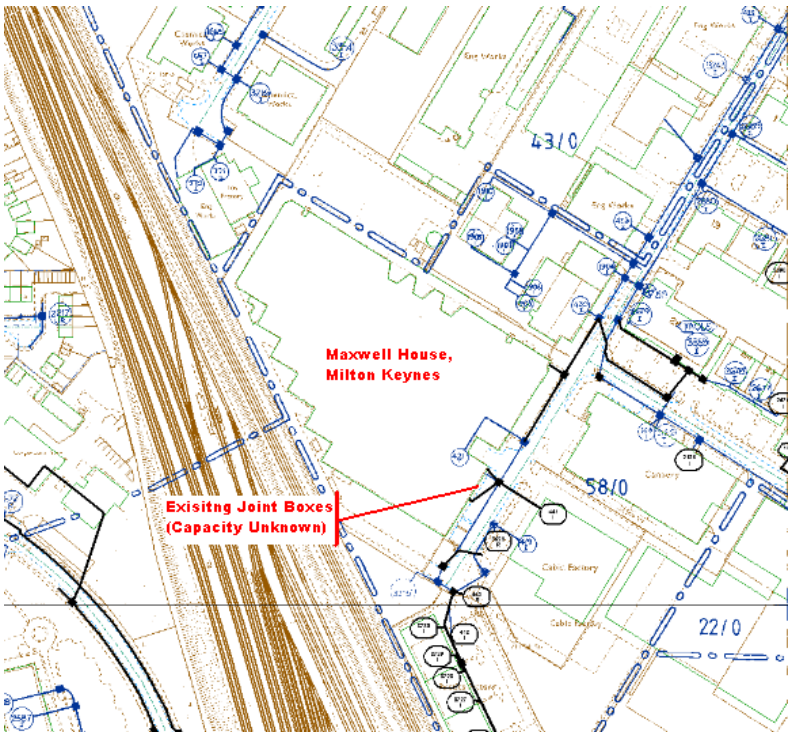


Figure 9 Existing BT infrastructure at Maxwell House Site

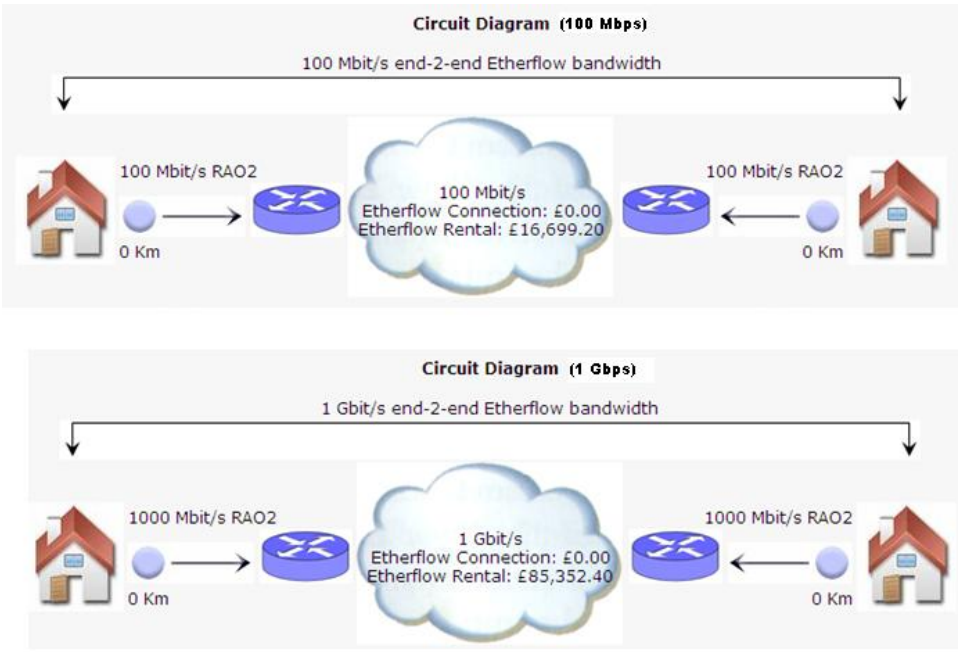


Figure 10 BT Proposed Infrastructure for 100Meg and 1Gig links

No pricing or route information has been received from BT Wholesale at this time for the provision of a Dual 10Gb fibre link service:

4.2.4. Cable & Wireless

Cable & Wireless (CW) have a point of presence within approximately 1.7 km of the proposed Maxwell House site and 40 metres away from the BoE site. CW cannot disclose detailed information on the PoP's without an NDA and knowledge of who the information will be shared with.

The fibre links will go through an aggregation point and the network belongs to CW. CW already have an existing connection into the BoE site but will require civil works Maxwell House. CW can provide further details subject to agreements and site surveys.

CW have indicated the cost for a 10Gb link with 1Gb back up as £150.5k for installation with an annual rent of £72k. The estimated cost for 1G link will be £100k for installation with an annual rent of £60k.

4.2.5. Virgin Media

Virgin Media has deployed a large fibre network and will be able to provide the diverse route services over their own network. The nearest major exchanges are understood to be Milton Keynes and Luton, which are approximately 1.5km and 28km away from Maxwell House respectively. The type and distance will vary depending on final services required.

Virgin Media have existing fibre network very close to the postcode, approximately 300 meters away. They can provide dual connected routes to building but will require full identification of the building to carry out a full feasibility survey to confirm access points to the building etc. They can cable diversely away from site to provide end to end and diverse routes as required to support a range of services.

Depending on the fibre solution required, they can either provide bandwidth over DWDM core or dedicated point to point fibre. They can provide two diverse routes to act in primary and back-up mode with no aggregation point.

Confirmation of existing services requires a full site survey.

It is estimated, that civil works will be required due to the requirement to provide dual links. Civil distances look to be relatively short at approximately 300 meters per link.

Lead time will be subject to final design, requirements and site survey. Virgin has advised a timeframe of approximately 65 working days for more detailed information.

	Distance	**Latency**
Primary Route (via Milton Keynes)	110km (estimated)	0.55ms
Secondary Route (via Luton)	110km (estimated)	0.55ms

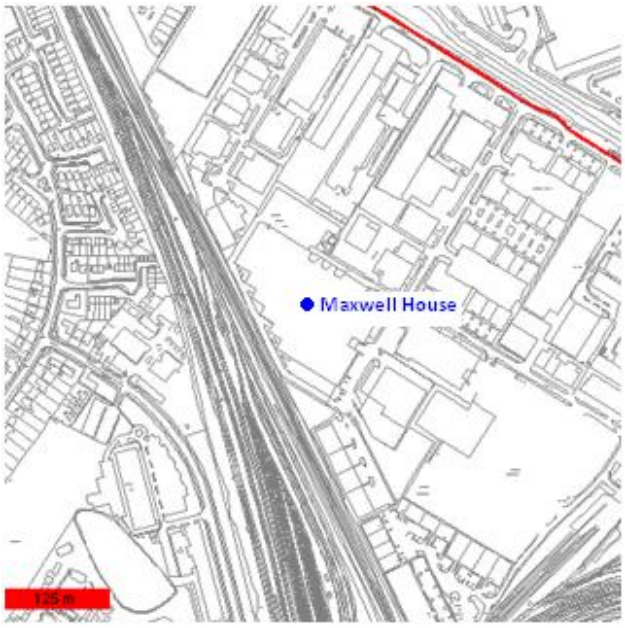


Figure 11 Existing Virgin Media Fibre Network close to Site

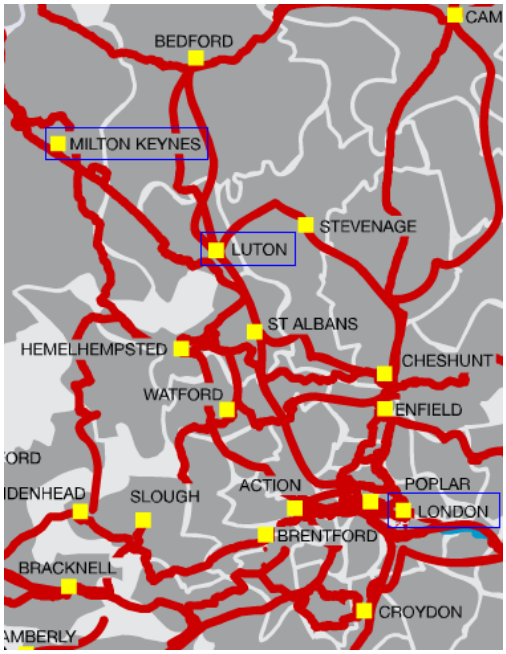


Figure 12 Virgin Media Core Network and Coverage

4.2.6. Global Crossing

For a two site diversely routed DWDM service, Global Crossing (GC) would look to have at least two of the four wavelengths directly connected to the customers site and the other delivered by third party tails (BT). However, both sites in this scenario would need civil engineering (Dig) and new fibre installation.

Milton Keynes

Global Crossing's desired service would be a single GC fibre, and a 2nd access via a 3rd party tail. Currently, there is no connection between the rail fibre that runs alongside the building and the customer site (these are on leased fibre) so Global Crossing will have to use 3rd party tails for one of the legs (BT). Another challenge they face is that one leg will likely go back to Milton Keynes PoP with the other going to the Northampton PoP. With Northampton PoP, it will head north and route to London via Leeds/Manchester/Birmingham. Milton Keynes circuit however will route south to Docklands via a BT wavelength.

Bank of England

The BoE services would be taken back to their Clerkenwell PoP/Waterloo PoP and their Docklands PoP. However, they don't have fibre into this site either and civils could require 12-24 working weeks for the given site location.

Hence, they have declined to investigate further as their offer will be uncompetitive.

4.2.7. EasyNet

EasyNet have exchanges close to site and will be able to deliver the required services. The primary connection at the Maxwell House site will be to the Milton Keynes PoP with the secondary to the Milton Keynes Data Centre. At the BoE site, the primary connection will be into Brick Lane PoP with the secondary to the Telehouse North PoP. The fibre links will be point to point for both the routes and will be leased from diverse providers. Requirement for any civil works will be subject to full site survey. Lead time to provide the services will be maximum of 75 days.

Figure 13 Estimated Easynet Network route

	Distance	Latency
Primary Route (via Milton Keynes to Brick Lane)	110km (estimated)	0.55ms
Secondary Route (via Milton Keynes Data Centre to Telehouse North)	110km (estimated)	0.55ms

4.2.8. Neos Networks

Neos Network (now part of SSE Telecoms) are unable to provide diverse wavelength services from the Milton Keynes area cost effectively due to only having one PoP in Milton Keynes. Their nearest PoP to the Maxwell House site is 1.25km away radially, while the nearest PoP to the BoE site is at Telehouse Metro, which is 0.95km away radially.

The fibre services would be dedicated point to point. 95% of the route would be a SSE Telecom owned asset while final connectivity into each site would be achieved using BT tails.

Estimated latency for a one way circuit is 0.8ms which is subject to detailed site survey and testing.

The estimated lead time is 65 days but is subject to project manager approval.

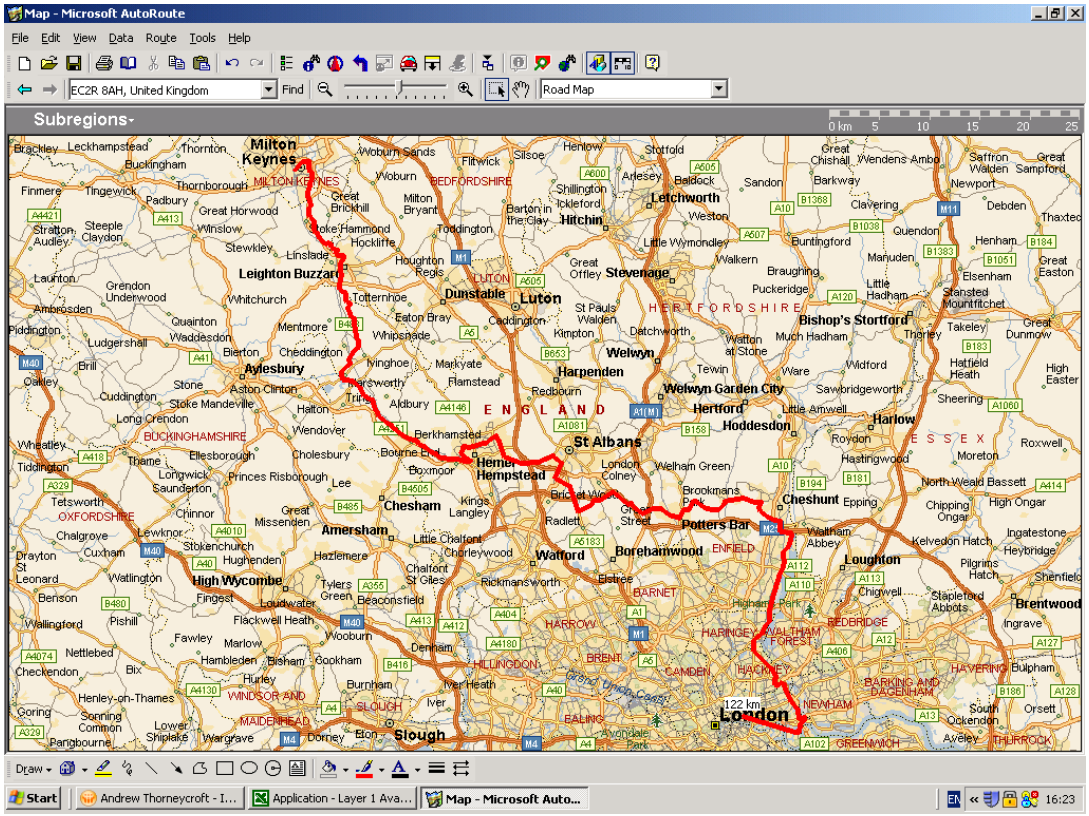


Figure 14 Estimated Neos Network primary route (BT circuits undetermined at this stage)

The lit and managed fibre installation cost for:

- 10G link with BT OSA Tails - based on a 3 year service contract is budgeted at £150k (£50k annual recurring cost) and £170k (£50k annual recurring cost) on a 1 year service contract.
- 1G link with BT WES Tails - based on a 1 or 3 year service contract is budgeted at £26k with £40k or £34k annual recurring cost, respectively.

The install fee is reflective of the dig cost Neos face to get their fibre to Maxwell House.

	Distance	**Latency**
Primary Route (via Milton Keynes to Telehouse Metro)	160km (estimated)	0.8ms
Secondary Route	-	-

4.2.9. Verizon Business

No response received.

5. ESTIMATIONS AND FINDINGS

5.1. Civil Works / Access Connection

Estimated connection distances to Maxwell House site are summarised in the table below:

Telco	No. Existing Site Connections [1]	Primary Route Distance to PoP	Civil Cost (est max)	Secondary Route Distance to PoP	Civil Cost (est max)
BT[2] [3]	-	100 m	£15k	100m	£15k
Cable and Wireless	-	-	N/A	-	-
COLT Telecom[3]	-	>3.5 km	>£350k	-	-
Geo[4]	-	1.2 km	N/A	-	-
Global Crossing	-	-	-	-	-
Virgin Media[3]	-	300 m	£45k	300 m	£45k
Neos Network[4]	-	-	N/A	-	-
EasyNet	-	-	-	-	-
Verizon	-	-	-	-	-

Figure 15 Estimated Distance to Point of Presence

[1] Capacity and access / way leaves to be confirmed following detailed survey.

[2] BT currently do not have 10Gb fibre links capacity on site. Estimates are based on information provided for 1Gb links.

[3] Civil costs are based on £100 per metre dig and information provided by carriers.

4 Civil costs included in service installation cost

Note. Information provided above is indicative and true figures are subject to detailed survey by individual carriers.

5.2. Provision of Service

Figures 16 and 17 summarise the overall estimated fibre distances and latency over the proposed links, as well as install and service pricing, as estimated by each provider.

Telco	Primary Route Distance (km) [1]	Est. Latency (ms)	Secondary Route Distance (km)[1]	Est. Latency (ms)
BT	110	0.55	120	0.55
Cable and Wireless	-	0.55 (or better)	-	0.55 (or better)
COLT Telecom	-	-	-	-
Geo	111.3	0.55	N/A	N/A

Global Crossing	-	-	-	-
Virgin Media	110	0.55	110	0.55
Neos Network	160	0.8	N/A	N/A
EasyNet	110	0.55	110	0.55
Verizon	-	-	-	-

Figure 16 Route Distances and Latency Times

[1] Routes are estimated from information provided by carriers. Actual routes to be confirmed following detailed survey

Note. Information provided above is indicative and true figures are subject to detailed survey by individual carriers.

Telco	Primary Route Install	Annual Fee	Secondary Route Install	Annual Fee
BT[1]	£15.65k	£135.7k	Incl.	Incl.
Cable and Wireless	£150.5k	£72k	Incl.	Incl.
COLT Telecom	-	-	-	-
Geo[2]	£130k	£97k	N/A	N/A
Global Crossing	-	-	-	-
Virgin Media	£60k	£38k	£60k	£38k
Neos Network[2]	£150k	£50k	N/A	N/A
EasyNet[2]	£82k	£80k	Incl.	Incl.
Verizon	-	-	-	-

Figure 17 Budgetary Costing

[1] BT currently do not have 10Gb fibre links capacity on site. Estimates are based on information provided for 1Gb links.

[2] Budgetary Pricing (based on 3 Year Term)

Note. All prices provided above are indicative and true amounts are subject to detailed survey by individual carriers.

6. CONCLUSION

Norman Disney & Young have been engaged to investigate the existing telecommunications infrastructure at Maxwell House, Third Avenue, Bletchley, Milton Keynes, MK1 1TG. For a preliminary review, the site is being considered for mirrored services from the Bank of England in Central London.

Carriers have been approached as part of this review to provide information on the proximity of the site to the carriers' fibre network, and budgetary pricing for diverse high capacity links. The services investigated are dual 10Gb fibre links on diverse routes and also, dual 1Gb fibre links on diverse routes.

Many carriers have fibre infrastructure in good proximity to the site, reducing installation costs and enabling diverse services to be provided.

Costs for civil works vary and it is anticipated that civil works will be required for most providers to connect to the access network.

The civil works cost for diverse 10Gb links to site is estimated at:

- £90k

The provision of a diverse 10Gb service is estimated at:

- £150k for installation of service, and
- £97k annually for a managed service.

The provision of a diverse 1Gb service is estimated at:

- £100k for installation of service, and
- £60k annually for a managed service.

Dark fibre can be provided and the annual service fee would be lower than the managed service.

Link latency across the dual 10Gb links is estimated at:

- Between 0.55 ms and 0.8 ms

To develop a finer resolution of costs and connectivity information it is considered that detailed site surveys by the respective carriers would need to be completed. The minimum period to obtain this information is estimated to be in the order of 30 working days to complete. Lead times for the provision of communications services vary, however a minimum of six (6) weeks can be expected.

Maxwell House presents a suitable site for a number of data centre services, both practically and in terms of providing flexibility for multiple carrier networks at the site.

APPENDIX A: CARRIER CONTACT DETAILS

Carrier	Contact Name	Contact Details	
		Email	Phone
BT	Wayne Kent Derrick sawyer	wayne.kent@bt.com derrick.sawyer@bt.com	0800 1218642 07739 196910
Cable & Wireless/Thus	Mandeep Gill	Mandeep.Gill@thus.net	0787 267 4947
COLT Telecom	Paul Young	paul.young@colt.net	020 7947 1748
EasyNet	Neil Williams	Neil.williams@easynet.co.uk	020 7032 5195
Geo	Justin Boreland	Justin.Boreland@geo-uk.net	020 3326 9584
Global Crossing	Nicole Cavalier	Nicole.Cavalier@globalcrossing.com	0330 060 7053
Interoute	Tim Cutts	Tim.Cutts@interoute.com	07969 362 241
Virgin Media	Trevor Goddard	Trevor.Goddard@virginmedia.co.uk	07785 387 068
Scottish & Southern Energy (Neos)	Robert Widley	robert.widley@sse.com	07825 015 155
Verizon Business	Timothy Carter	Timothy.carter@uk.verizonbusiness.com	07809 595 090

APPENDIX B: CARRIER INFORMATION

BT Private Circuits Technical Data Sheet

MegaStream Ethernet

This Technical Fact Sheet provides complimentary information to the Private Circuits MegaStream Ethernet Data Sheet [PHME 47790]. It explains a number of the technical characteristics of the service and provides network design guidelines to assist with optimising performance from your MegaStream Ethernet service.

Outline of Service

The MegaStream Ethernet service is a Point-to-Point or Point-to-Multipoint (Aggregate), flexible bandwidth, connection oriented Ethernet data service enabling customers to link two or more of their sites together across the UK for LAN/WAN data applications, at defined bandwidths from 2Mbit/s through to 100Mbit/s.

The service provides transparent, symmetrical, un-contended bandwidth between two Ethernet ports in multiples of 2Mbit/s, 5Mbit/s and 10Mbit/s to the maximum 100Mbit/s. No over-subscription/burst above the contracted circuit bandwidth is available with this service. The service is presented to the customer using 10Mbit/s, 100Mbit/s or 1Gbit/s Ethernet interfaces via a single compact NTE, meeting UK/International standards (IEEE802).

When Gigabit Ethernet (GbE) access is used VLAN tagging in accordance with IEEE 802.1Q will be used by BT.

Interfaces & delivery

- A Dedicated fibre delivered NTE will be provided at customer site locations delivering a copper or fibre Ethernet interface (dependant on speed). The NTE will be powered by standard 240V mains. Provision of a UPS is at the discretion of the customer.
- The NTE shall be configured to provide a copper 10BaseT or 100BaseT (RJ-45) interface or a fibre 1000BaseSX (SC) interface. All interfaces are available as full duplex only.
- BT do not support the use of auto-negotiation for this service, interface speeds will be pre-configured.
- A range of fibre access speeds are available and the following table illustrates the Interface options available for each fibre access speed.

Fibre access speed	Customer Interfaces Available	Notes
10Mbit/s	10BaseT, 100BaseT	Standard offer is 100BaseT with option of 10BaseT as an interface feature
30Mbit/s	100BaseT	
100Mbit/s Standard, Secure & Resilient Access Option 2	100BaseT	
1Gbit/s Standard, Secure & Resilient Access Option 2	1000BaseSX optical	

- Technical details of BT Ethernet interfaces can be found in SIN 360 available to view at: http://www.sinet.bt.com
- Standard access is defined as a single fibre/fibre pair connection between the NTE and the nearest BT Node.
- Secure access is defined as two fibre pairs between a single NTE and a single BT Node, which are routed diversely using reasonable endeavours. Secure access provides a single customer Ethernet interface presentation.
- Resilient access option 2 is defined as two standard access circuits routed between 2 different NTE and two different BT nodes.
- Each Circuit Bandwidth between customer sites will be symmetric at the end customer location, with Bandwidths available at:
  - 2, 4, 6, 8 and 10Mbit/s for 10BaseT.
  - 2, 4, 6, 8, 10, 15, 20, 25, 30, 35, 40, 50, 60, 70, 80, 90 and 100Mbit/s for 100BaseT and for 1000BaseSX.
  - Total bandwidth presented at any aggregate interface will be the sum of the aggregated circuit bandwidths from other sites connected in the network.
  - Upgrades to circuit bandwidths can be implemented within a few days provided the sum of all bandwidths on that interface does not exceed the access speed. Where the access speed is changed, timescales for upgrades will be longer and customers may incur a break in service.

Interfaces & delivery (cont)

- For Point-to-Point service and networks with up to 16 interconnected sites using 100BaseT access the MegaStream Ethernet service is transparent across the BT network to 802.1Q VLAN tags, STP BPDUs (IEEE802.1d, 802.1s, 802.1w) and 802.1p bits.
- No flow prioritisation is performed by the service. All traffic is treated equally.
- For 10/100 access, the Maximum Transmission Unit size (MTU) for MegaStream Ethernet service is 1534 bytes, enabling up to two VLAN headers plus two MPLS headers (or any combination thereof) to be supported.
- For GbE access, the MTU is 1534 bytes.

Using MegaStream Ethernet – Network design

In order to obtain the best results from your MegaStream Ethernet service the following network and service design parameters should be noted.

The MegaStream Ethernet service can be used to connect together a number of sites in a Point-to-Multipoint configuration or in a simpler Point-to-Point configuration to connect just two sites together to extend your LAN/WAN between sites in the UK.

10/100 Access

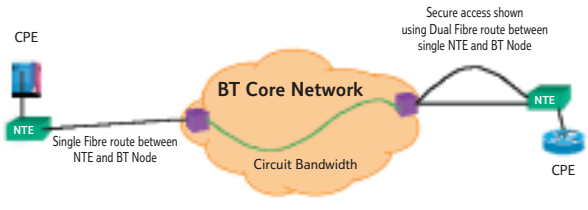
Point-to-Point Configuration

In the Point-to-Point configuration each of your business sites are connected to the BT node by any of the access options at the appropriate speed for your business requirements at that site. A MegaStream Ethernet circuit is then configured between these two sites at the circuit bandwidth you need for the applications you are using up to the maximum of 100Mbit/s.

The service is transparent to customers VLAN and prioritisation bits and uses MAC learning across the BT Core ATM network. The ATM PVCs are provisioned to allow for ATM overheads imposed within the network. To achieve optimal throughput on your MegaStream Ethernet service the average packet size must be at least 400 bytes. Persistent average packet sizes lower than this may not achieve the desired performance.

In order to maintain throughput performance it is suggested that the maximum number of MAC addresses used per MegaStream Ethernet circuit is limited to 200, or a limit of 8000 across each instance of the MegaStream Ethernet service.

The diagram below shows a Point-to-Point service architecture.



MegaStream Ethernet Point-to-Point Configuration

Point-to-Multipoint (Aggregate) Configuration

MegaStream Ethernet can also be used in a Point-to-Multipoint or aggregate service configuration.

The bandwidths at the 'Aggregate' end of the circuit are dependant on the bandwidths provisioned for the remote end customer sites. Bandwidth at the Aggregate site will therefore be equivalent to the sum of the remote end customer site bandwidths. Bandwidth will not be limited on a per VLAN basis, but will be implemented on a per End customer site basis. The sum of the End Customer bandwidths will not exceed the Aggregate site fibre access speed and interface bandwidth.

Service aggregation when using 30Mbit/s or 100Mbit/s (100BaseT interface) access will be achieved through MAC learning by provisioning ATM VCs between the end customer site and the 100BaseT Aggregate site. The connections to the customer equipment will therefore be a plain 100BaseT Ethernet connection.

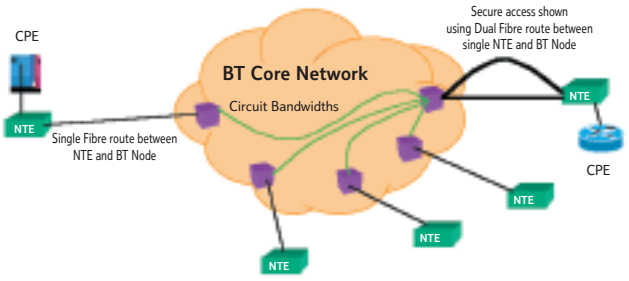
A maximum number of 16 customer sites can be connected together in this configuration. Multiple aggregate interfaces may terminate at the same site (using different fibre accesses), thereby allowing the customer to connect to more than 16 sites.

In order to maintain throughput performance it is suggested that the above MAC address limits are used.

It is the responsibility of the customer to ensure that a loop-free topology is used. BT will not police or enforce the chosen customer topology, nor will BT participate in the customer's Spanning Tree Protocol (STP).

When used in a Point-to-Multipoint configuration, such as a hub & spoke architecture as shown in the diagram below, the customer should note that there is no connectivity between the spoke sites, and thus the customer equipment must be carefully configured to ensure that problems are not caused by the use of Ethernet in a Non-Broadcast Multi Access (NBMA) network. The use of VLANs are one way to ensure correct operation. These would be used between the customer sites and are carried transparently by the BT network.

MegaStream Ethernet Point-to-Multipoint Configuration



Up to 16 sites can be connected in a single network when using 100bT at aggregation site.
When more than 16 sites are required in a single network then Gigabit Ethernet access must be used at the aggregation site with VLAN ID's

GbE Access

Gigabit Ethernet (GbE) Presentation

The MegaStream Ethernet service can also be delivered using a Gigabit Ethernet (GbE) presentation and there are two options for using GbE (1000BaseSX) within a MegaStream Ethernet network.

Due to complexities that can arise with addressing in large Ethernet networks it is important that the customer decides on their use of GbE with MegaStream Ethernet and choose the appropriate network architecture to meet their requirements when the service is first ordered from BT.

The first option maintains the 16 site limit on the number of sites within the network, but allows complete flexibility on the connectivity between sites. The GbE access used in this configuration will use VLAN tagging in accordance with IEEE802.1Q and the customer equipment must be able to support this feature on the GbE interface. Spoke sites are not required to use VLAN tagging to support the BT service. VLAN id's may be chosen by the customer or allocated by BT.

Use of a partial mesh topology by the customer may cause addressing problems and one way to overcome this is for the customer to use VLANs.

Alternatively, where more than 16 sites are required to be connected together in a single network configuration, a second option is to use a GbE (1000BaseSX) interface in a pure hub & spoke arrangement. This permits up to 400 spoke sites to connect to the GbE hub site. When GbE access is used in this configuration the MegaStream Ethernet service will use VLAN tagging in accordance with IEEE802.1Q and the customer equipment must be able to support this feature at the GbE interface (hub) end. Spoke sites will not use VLAN tagging. VLAN ids may be chosen by the customer or allocated by BT. It is acceptable to have more than one hub.

It is important to note that the above two GbE options are not interchangeable and should the customer wish to migrate from a 16-site GbE hub & spoke network (which includes options to partially mesh the network) to a 400 site GbE hub & spoke network there will be a service interruption during the migration.

The MegaStream Ethernet service is transparent to BPDUs, as a consequence it is the customers responsibility to ensure that a loop free topology is applied by use of either a layer two or layer three protocol. BT will not participate in the customers Spanning Tree Protocol.

Core network

MegaStream Ethernet uses an ATM core network for the secure transport of the data between customer sites. Connection between the customer site NTE and the BT Node is via optical fibre.

Core network Bandwidth is configured such that the ATM PVCs carrying the MegaStream Ethernet circuits ensure the bandwidth is guaranteed to the customer with the ATM PCR set to the same value as the SCR. The value of the ATM PVC bandwidth shall be greater than the chosen Ethernet circuit bandwidth to account for ATM overheads.

If customers traffic exceeds the ordered value of the MegaStream Ethernet circuit bandwidth then the frames will be stored in ingress buffers until they can be put to line or will be discarded if the buffers are full. This will cause increased latency and traffic discards, thus traffic shaping by the customers CPE is highly recommended.

The MegaStream Ethernet service has been designed such that the end-to-end latency will not exceed 30ms with some typical latencies shown below:

Route	Distance	Typical Latency
London - London	30km	12ms
London - Birmingham/Bristol	250km	17ms
London - Manchester	320km	17ms
London - Edinburgh	640km	19ms
London - Londonderry	750km	22ms
London - Inverness	940km	22ms

Application suitability

Being largely transparent to Ethernet frames the MegaStream Ethernet service is suitable for the transmission of frames from a variety of applications including E-mail, Internet and Intranet access, file transfer, VOIP or videoconferencing. The service does not employ traffic type prioritisation so where applications are particularly sensitive to delay, such that they may generate relatively small frames (below 400 bytes), it is recommended the customer shape their traffic such that the average throughput is a little below the contracted core bandwidth to avoid any impact on perceived quality of the end application. The degree of reduction is dependent on the mix of traffic - the proportion of small frames in the data stream and size of those frames - but where all traffic is expected to be small frames then a reduction to around 65% of contracted core bandwidth should be considered.

Glossary	
ATM	Asynchronous Transfer Mode
BPDU	Bridge Protocol Data Unit
BT	British Telecommunications plc
CPE	Customer Premises Equipment
GbE	Gigabit Ethernet
IEEE	Institute of Electronic and Electrical Engineers
LAN	Local Area Network
MAC	Medium Access Control
MPLS	Multi Protocol Label Switching
MTU	Maximum Transmission Unit
NTE	Network Terminating Equipment
PCR	Peak Cell Rate
PVC	Permanent Virtual Connection
SCR	Sustained Cell Rate
STP	Spanning Tree Protocol
UPS	Uninterruptible Power Supply
VBR	Variable Bit Rate
VLAN	Virtual LAN
VOIP	Voice Over Internet Protocol
WAN	Wide Area Network

Service information for MegaStream Ethernet can be obtained from the associated MegaStream Ethernet Service Description (PHME 47791).

To find out more about MegaStream Ethernet, please contact your BT Account Manager or Authorised Dealer, or call us on Freefone 0800 **800 977. You might also like to visit our website at** www.bt.com

Offices worldwide

PHME 47792/04/05

Printed on paper which meets international environmental standards.

a Cable&Wireless business

ETHERNET VPN

An economical and flexible way of connecting your sites via our secure high speed network infrastructure, delivering the benefits of Ethernet over a next-generation, national network

As businesses react to changing market conditions and customer requirements, they often need to rapidly change their communication and IT infrastructure. Changes in staff numbers and locations, new sites and new applications can drive significant changes within an organisation's Wide Area Network (WAN).

THUS's Ethernet Virtual Private Network (VPN), provides a WAN solution that delivers improved cost efficiency, flexibility and the opportunity to accommodate change at short notice. Like its sister product, Ethernet Wireline, it provides a layer 2 Ethernet Service over an Multi proocol label switch (MPLS) network, but with Ethernet VPN, any site can talk to any other site without having to go though a hub site. This can be very useful if you don't just have one"main site" or have important applications hosted in different places.

In contrast to legacy Leased Line, Frame or ATM technology - often used to connect multiple LANs together, Ethernet VPN provides a simple, seamless method of delivering connectivity between your sites with the flexibility of any-to-any networking.

FLEXIBILITY

One of the more difficult tasks organisations face is how to meet bandwidth and network performance requirements while minimising network complexity and lowering the cost of ownership of the corporate network.

Increasingly, the solution is seen as a single network that will allow all your WAN applications to run seamlessly and at high speed. Ethernet VPN provides organisations with a flexible solution to address these concerns by providing Ethernet access with flexible service options.

The bandwidth capability of each site connection can be increased or "flexed" at short notice. This change is permanent in nature until "flexed" again.

This gives the benefit of providing the bandwidth you need now, but with the facility to increase it in the future. It is often possible without the need for THUS to revisit a site or to change the terminating equipment.

This capability is highly granular in nature. Flexes can be made in increments of 1Mb to 1Gbit.

Further to being able to "flex" the service – you can also purchase a "Burst" service. This is ideal for organisations which require extra "head room" at peak traffic times for non-critical applications.

Ethernet VPN is also scalable; it can handle all traffic from all sites, whether they are small sites that would usually inter-connect via frame relay, or high bandwidth sites that would otherwise employ an ATM or SDH network.

RESILIENCE

The loss of WAN connectivity directly impacts an organisation in a big way. That's why Ethernet VPN service is provisioned across a highly resilient MPLS network.

In addition, we know that in the telecoms industry the majority of customer failures occur in the local connection. That's why THUS offers a range of options to minimise this risk which include offering dual access paths to sites and geographic diversity should it be required.

- **Scalable high-speed connectivity up to 1Gbps**
- **Highly granular flexible bandwidth options in increments of1Mbps to 1Gbps**
- **Optional Burst feature**
- **Flexible Any to Any configuration**
- **A layer 2 service allowing you to maintain control of your IP routing**
- **Supports 3 classes of service allowing prioritisation of different traffic types. Ideal when you want your network to support multiple applications including Voice**
- **Highly resilient service keeps your business running smoothly – provisioned over a highly resilient MPLS network with a range of dual local access options if required**
- **Delivered over a Multi-Service platform, enabling future total cost of ownership benefits when taking Ethernet Wireline and other future service options.**

In addition, the any-to-any nature of Ethernet VPN makes it easy for you to implement dual hub sites. That way, if one of your main sites is busy or suffers an outage, it is easy for your satellite sites to switch to the other main site.

CONTROL

Organisations may consider control over their network a paramount requirement and hence are averse to handing over that responsibility to a service provider. Ethernet VPN allows organisations to retain control of their network policies. The Service is completely transparent to IP and its control protocols, so the IP solution remains solely within an organisation's control in terms of visibility, configuration and management. This makes it particularly suitable for organisations that prefer to take a DIY approach to network build or are looking for a solution similar to that already employed.

Ethernet represents a natural migration path for existing leased circuits, ATM and Frame Relay customers.

Ethernet VPN provides more control over traffic prioritisation than traditional leased circuits or Frame Relay/ATM. Our Ethernet VPN service allows you to select from 3 Classes of Service so customers can choose the appropriate CoS for their traffic. This is ideal if you have a mix of traffic, some critical or latency intolerant and some not so critical. Customers can choose a single Class of Service for their bandwidth or take a mixture of all 3 classes. In the event of congestion THUS will transmit critical data first to ensure priority is given to an organisation's delay sensitive applications.

In addition, the MPLS technology we employ assures the same level of traffic segregation as in a traditional Frame Relay, ATM or traditional private circuit network.

IT CONSOLIDATION

(Ethernet access to centralised storage, servers, applications)

Many businesses now have networks in a hub and spoke configuration where the ability to centralise IT applications into a major data centre significantly reduces IT budgets, whilst improving processes and productivity. But what if your business doesn't lend itself to a hub & Spoke configuration? What if your business data is stored in more than one data centre or perhaps you want to use VoIP internally but have main switchboards in different parts of the country? This is where the any-to any nature of Ethernet VPN can be the solution you are looking for. You get a layer 2 VPN but any site can talk to any site without the need to go through a central hub

MULTIPLE APPLICATIONS

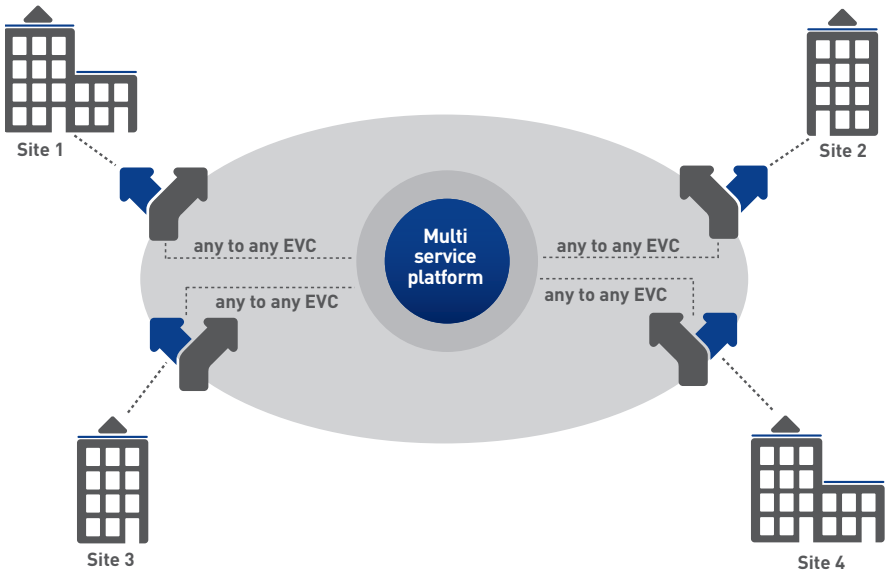
You are probably planning to use your network for many different applications but need to be sure that all your varied applications will work without having to spend a fortune on bandwidth. Ethernet VPN runs on our next- generation network, specifically built to meet the needs of business customers who want to buy one network that will support all their applications whether they be high priority voice an video conferencing, medium priority data, or lower priority email and internet access. The ability to prioritise your important applications means that they will work even when the network is busy, without you having to buy peak levels of bandwidth. When you add an application you can just buy extra bandwidth at the appropriate CoS and just for the sites that need it. As well as extending LANs between sites, all your applications can be consolidated on the same Ethernet network, reducing total cost of ownership and improving return on investment.

TECHNICAL SPECIFICATIONS IN SUMMARY FOR CABLE&WIRELESS ETHERNET WIRELINE

EVC topology supported	• Virtual Private LAN Service (VPLS). Point to point EVC (permitting point to point, point to multipoint network or any-to-any topologies to be supported)
Underlying network technology	• Multi Protocol Label Switching (MPLS) using PWE3 pseudo wires and RVSP-TE
Multi Service Access Bearer options	• Choice of 10mb,100mb or 1000mb access using Ethernet over Fibre, Ethernet over SDH/WDM, or OLO tails such as BT WES • Presentation -10 Base TX, 100 Base TX/FX or 1000 Base TX/FX
Ethernet Virtual Circuit (EVC) options	• Bandwidth range from 1Mbps to 1000Mbps • Class of Service options of Premium, Enhanced and Standard • Burst capability available on Enhanced and Standard bandwidth • VLAN tagging supported (802.1q)
MAC Address Support	• 250 MAC addresses are available per EVC (VPLS instance). Additional MAC addresses are available upon request at additional charge. • Maximum number of MAC addresses per VPLS instance is 2500.
NTE power support	• NTE can be equipped with dual power supplies on request (AC and DC)

Ethernet VPN network

- Customer sites are first connected to our network
- 10Mbps, 100Mbps,1000Mbps
- Customers buy Ethernet network bandwidth and CoS as required
- Any site can communicate seamlessly with any other site.



COMPREHENSIVE SUPPORT

We realise how important it is to have a reliable network connecting your sites. Not only do we design our services with this in mind but all our services come with 24/7 customer support and stringent Standards of Service. In the unlikely event that a circuit fails, our technical teams are there to resolve the fault. We offer a five-hour fix time for critical faults and back that with a service credit regime that provides total 'peace of mind'.

PART OF A TOTAL SOLUTION

THUS Ethernet VPN is just part of our comprehensive portfolio of Connectivity services. These provide the connectivity method for all voice, internet and data business critical services.

If required, Ethernet VPN can be combined with its sister product Ethernet Wireline, allowing two networks to run over the same site connection and combining the flexibility of an any-to-any network with dedicated point to point bandwidth where required.

Datasheet
Site to Site Connectivity

Ethernet Services

Here, there and everywhere

You already know how challenging it can be to keep everyone in touch when they're in different geographical locations. Especially when it comes to moving and sharing huge amounts of data.

What you may not realise is how easily Virgin Media Business can help you keep everyone connected – linking people along a corridor, across a business park, or the length and breadth of the country. We can enable your staff to be even more productive, with access to all the data and information they need, wherever they work. And you have a more cost-effective way of ensuring a constant flow of information across your business.

Our Ethernet portfolio of products helps you connect existing LANs and WANs into one seamless network that's more effective, more efficient and much easier to manage. Here's an introduction to just three of the options within our Ethernet portfolio – Ethernet Extensions, Ethernet Extensions+ and National Ethernet.

1. Close local gaps: Ethernet Extensions

Need to transfer data quickly and securely within a 25km radius? Connecting various buildings in a town or over one large sprawling site? Then Ethernet Extensions are your first step.

They give you a dedicated fibre path that links together two or more sites to create a single high-speed network, giving you:

- A highly secure, low-cost alternative to Leased Lines.
- A flat rate pricing structure – regardless of usage – for more predictable budgeting.
- The bandwidth you need to exploit next generation applications like Voice and Video over Internet Protocol (IP), plus IP CCTV.
- A choice of bandwidths to ensure you have the most suitable service for your organisation, and you can respond to changing business needs faster.

2. Drive up service: Ethernet Extensions+

Now let's look at Ethernet Extensions+. These use switched Ethernet technology (as opposed to the dedicated fibre connections of Ethernet Extensions), again up to a distance of 25km.

As well as all the benefits of Ethernet Extensions, you also get a choice of seven Classes of Service so you can prioritise the different types of data you want to transmit. Plus you have access to useful online performance reporting, so you can continually monitor the demands placed on your network – and how it responds.

We have strict latency, jitter and packet loss targets too, and your service is proactively managed around the clock, to help resolve issues before they cause any problems.

3. Go nationwide: National Ethernet

With Ethernet Extensions and Extensions+, speed and reliability is no object – and with our National Ethernet, neither is distance.

All your separate networks can now work together across the UK as one powerful seamless whole. It's like having your entire nationwide organisation under one roof.

We raise the functionality and performance of your WAN to ensure you can enjoy all the LAN-based features you find invaluable; like high-res video conferencing, VoIP and media-rich applications. Latency, jitter and packet loss targets are included too, along with the same effective proactive management as with Ethernet Extensions+.

Remote upgrades also enable you to add more bandwidth without needing site visits. Not to mention providing secure links to your existing data storage sites, to help you meet the requirements of your business continuity strategy.

Service guaranteed

All our Ethernet solutions include watertight Service Level Agreements that give you complete peace of mind. Including:

- Service delivery and availability.
- Continuous 24/7 network monitoring with fault restoration.
- Absolute confidence in our ability to meet these levels, which we demonstrate by building service credits into these agreements.

Quick product comparisons

	Ethernet Extensions	Ethernet Extensions+	National Ethernet
Configuration	Dedicated fibre; point-to-point (or multiples thereof); hub and spoke	Point-to-point (or multiples thereof); hub and spoke	Point-to-point (or multiples thereof); hub and spoke
Available in increments from	Access bearers of 10Mbit/s, 100Mbit/s, 1Gbit/s and 10Gbit/s	Access bearers of 10Mbit/s, 100Mbit/s and 1Gbit/s, available in increments from 10Mbit/s to 1Gbit/s	Access bearers of 10Mbit/s, 100Mbit/s and 1Gbit/s, available in increments from 2Mbit/s to 1Gbit/s
Scalability	Bandwidths can be upgraded	Bandwidths can be upgraded	Bandwidths can be upgraded
Remote upgrades	N/A	Available in most cases	Available in most cases
Resilience	Available as an optional extra	Available as an optional extra	Available as an optional extra
Availability	Metro (<25km)	Metro (<25km)	National
Protocols supported	Multiple	Multiple	Multiple
Performance	N/A	As per SLA	As per SLA
Special features	Dedicated solution	Online performance reporting available	Online performance reporting available
Quality of Service	N/A	7 Classes of Service available	7 Classes of Service available
Managed Service	Reactively managed for 10Mbit/s and 100Mbit/s and proactively managed for 1Gbit/s and 10Gbit/s	Proactively managed	Proactively managed

For more information about how our Ethernet portfolio can help your business get better connected, call 0800 052 0845 or visit www.virginmediabusiness.co.uk

Point to Point Services

Service Level Agreement (SLA)

How we'll look after you

Thank you for your business. We'll never take it for granted. That's why we've put together this Service Level Agreement (SLA). It lets you know exactly what we promise to deliver as part of the Point to Point Services you've ordered from us. Our Point to Point Services include Ethernet Extension, Ethernet Extensions+, High Capacity Services, Leased Line and National Ethernet Services. This SLA forms part of the Agreement between You and Us, so naturally We'll fulfil what's laid out here.

Getting You up and running

When We've taken your order and finished planning, We'll give you a Customer Promise Date (CPD).

Threshold Missed	Service Credit Scheme
1-7 Days past CPD	5% of impacted Circuit Connection Charge
8-14 Days past CPD	15% of impacted Circuit Connection Charge
15-30 Days past CPD	25% of impacted Circuit Connection Charge
>30 Days past CPD	50% of impacted Circuit Connection Charge

We're big on quality

We provide some of the highest quality services in the industry. But to give You the complete picture about our Ethernet services, here are the key service parameters We operate to.

Measurement	Target
Round Trip Delay	30ms
Jitter	8ms
Packet Loss	0.1%

Keeping you connected

We promise to give You an annual Service availability level of 99.99% for protected and 99.9% for unprotected Type 1 services (delivered on our network). For Type 2 services, which are third party delivered, We promise 99.85% availability.

We calculate Service availability for the previous year. Here's how.

Actual Circuit availability divided by total potential availability to give a percentage availability per Circuit:

$$\frac{\text{Measurement period} - \text{Outage Time}}{\text{24hrs x days in Service Year}} \times 100$$

The good news is, if We fail to achieve these Service Levels, We'll give You the opportunity to claim back Service Credits for the affected Circuits, as set out below.

For Type 1 Circuits

Protected Thresholds	Unprotected Thresholds	Service Credit Scheme
<99.99%-99.9%	<99.9%-99.4%	5% of annual Circuit Rental
<99.9%-99.4%	<99.4%-98.9%	10% of annual Circuit Rental
<99.4%-98.9%	<98.9%-97.9%	15% of annual Circuit Rental
<98.9%	<97.9%	20% of annual Circuit Rental

For Type 2 Circuits

Thresholds	Service Credit Scheme
<99.85%-99.35%	5% of annual Circuit Rental
<99.35%-98.85%	10% of annual Circuit Rental
<98.85%	15% of annual Circuit Rental

Bringing You back online

If there's a problem, We'll aim to fix it within six hours of You telling us about it. If We let You down We'll hold Our hands up and give You the opportunity to claim Service Credits as set out below as a way of saying 'sorry'.

Thresholds	Service Credit Scheme
0-1 Hours past	5% of monthly Circuit Rental
1-2 Hours past	7% of monthly Circuit Rental
2-4 Hours past	10% of monthly Circuit Rental
>5 Hours past	15% of monthly Circuit Rental

Who's in charge of getting problems sorted?

If a problem isn't sorted within six hours, then We escalate it as You can see from the table below.

Our Commitment to Fix

Internal Escalation	Escalation Level
Team Manager	Level 1
Fault Centre Manager	Level 2
Head of Business Assure	Level 3

The next bit is the full agreement. It spells out exactly where we both stand so that there is no confusion.

Point to Point Services Service Level Agreement (SLA)

What Do the Terms Mean, What is Not Covered by This SLA, Claiming Service Credits and our Liability to You, Planned Outages and How to Report a Fault.

Definitions of Terms Used

1 **Circuit** means the physical connection over which the Service is provided.

2 **Customer Promise Date** means the agreed target date by which We aim to have completed installation of the Service as notified to You in writing.

3 **Days** means Monday to Friday excluding Bank and Public Holidays.

4 **Excused Outage** means any Fault caused by:

(a) Your network or system, or any part of it; or

(b) a fault in, or any problem associated with, equipment connected on Your side of the Virgin Media Business network termination point; or

(c) Your acts or omissions; or

(d) Your breach of the Agreement; or

(e) Your failure or delay in complying with Our reasonable instructions; or

(f) any refusal to allow Us, Our employees, agents or subcontractors to enter into the relevant premises to diagnose or remedy any Fault; or

(g) a force majeure event as set out in the Agreement; or

(h) a Planned Outage; or

(i) an act or omission of any third party which is beyond Our reasonable control which shall include, without limitation, a fibre cut.

For the avoidance of doubt, 'You' and 'Your' shall include Your employees, subcontractors and agents.

5 **Fault** means a fault, outage or Service downtime (other than a Planned Outage or an Excused Outage) resulting in a total loss of Service on a Circuit where it is not possible to transmit signals in one or both directions, which has been reported to Us in accordance with standard fault reporting procedures.

6 **Fault Report** means the report of a Fault either by You or Us that has been recorded on the call record at Our Business Technical Support Centre in accordance with standard fault reporting procedures.

7 **Outage Time** means the sum total time of all Faults during the relevant 12-month period for a Circuit.

8 **Planned Outage** means any Service downtime:

(a) scheduled by Us to carry out any preventative maintenance services; or

(b) caused by any upgrade services in relation to the Service or Our Communications Network; or

(c) caused by any services You request or authorise including without limitation, network redesign or reconfiguration.

9 **Service** means the service that We provide to You as set out in the Agreement.

10 **Service Levels** means the service levels set out in this SLA.

11 **Service Credit** is the amount We credit or pay to You for failing to meet Service Levels set out in the appropriate sections above.

Exclusions:

Service Delivery

We will not be liable to pay Service Credits for Service Delivery failure where such failure results from:

(a) Your network or system, or any part of it; or

(b) a fault in, or any problem associated with, equipment connected on Your side of the Virgin Media Business network termination point; or

(c) Your acts or omissions; or

(d) Your breach of the Agreement; or

(e) Your failure or delay in complying with Our reasonable instructions; or

(f) any refusal to allow Us, Our employees, agents or subcontractors to enter into the relevant sites; or

(g) a force majeure event as set out in the Agreement; or

(h) Your failure to obtain the necessary wayleaves.

Service Availability

Unavailability of the Service as a result of any of the following events shall not count as Outage Time:

(a) an Excused Outage; or

(b) a Planned Outage.

Where You have resilience built into the Service a Fault on a Circuit will not be counted for the purposes of Service Availability if Service is still available at that Site.

Service Restoration

Time spent in repairing a Fault or restoring the Service as a result of any of the following events will not be counted as part of restoration time when calculating Service Credits:

(a) Your failure or delay in providing the necessary co-operation required by Us including, without limitation:

(I) supply of the necessary information; or

(II) access to the relevant sites; or

(III) supply of the necessary power or facilities; or

(b) Your relevant personnel cannot be contacted to assist Us or to confirm the Service is restored; or

(c) a Planned Outage; or

(d) an Excused Outage.

The time taken to restore a Fault is measured from the time the Fault Report is recorded on Our fault management system until the time We notify You that Service has been restored or in the event that We are unable to contact You, the time recorded on Our fault management system that Service has been restored.

General

The SLA does not apply to non-standard solutions or customised services unless expressly agreed in writing.

If an on-site visit reveals that there is no fault with the Service or the Fault is an Excused Outage, We may charge You and You shall pay Us an engineer call-out fee at Our standard charges at that time.

Claiming Service Credits and Our Liability to You

To request Service Credits, You must claim in writing via Your Virgin Media Business account manager within three months of the Fault Report or in the case of Service Availability within 30 calendar days of each annual period. If You do not claim Service Credits within such period You will be deemed to have waived the applicable Service Credits.

You agree that Service Credits shall be Your sole and exclusive financial remedy for Our failure to meet Service Levels. Service Credits payable shall relate to the Connection Charge or monthly or annual Rental of the Circuit that is the subject of the Fault or failure in Service Delivery as applicable.

Notwithstanding any provisions in the Agreement to the contrary in no event shall the total amount of Service Credits payable to You in any calendar year for the affected Circuit exceed the total of the annual Rental for that affected Circuit nor shall the amount of Service Credits payable to You in any month exceed the total of that month's Rental for the affected Circuit.

Planned Outage

Except in an emergency or in circumstances beyond Our control, We will endeavour to give You at least 10 working days' notice of any maintenance or upgrade work on Our network which will affect the availability of Service to Your site. Such notice will include:

(a) a brief description of the Planned Outage;

(b) date and time of the Planned Outage; and

(c) estimated duration of the Planned Outage.

Such notice will be given by way of letter or via email. However, in the case of an emergency, We may give You a shorter notice by way of a telephone call.

Reporting a Fault

You must comply with any fault reporting format as advised by Us from time to time for the reporting of faults.

For the avoidance of doubt, if there is a dispute on any Fault commencement or duration, the records of the fault management system at Our Technical Support Centre shall be final.

Any faults or suspected faults on the Services must be reported to Our Technical Support Centre on **0800 052 0800** (followed by your PIN, if supplied).

You shall identify to Us the individuals who shall have authority to report faults ('**Authorised Individuals**'). Any replacement Authorised Individuals must be notified to Us in writing.

In Our Commitment to Fix, Our internal escalation procedure is for information only and You will not have any direct contact with any of such personnel.

Thank you for your business – we're looking forward to working with you. If you have any questions, we'd love to hear from you. Please call our Customer Services team on 0800 052 0800.

colt
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1 Overview

The Colt LANLink portfolio enables you to interconnect your Ethernet or ATM LANs. Ethernet is the most widely installed Local Area Network (LAN) technology and is standardised via IEEE 802.3. A range of interfaces is available and can be confirmed on request.

Colt LANLink Metro, National and International

Colt LANLink is a point-to-point LAN-interconnect service supporting the transparent delivery of Ethernet frames over a dedicated connection between any two sites. The Service is full duplex, which means that the full bandwidth of the Service can be used for traffic in both directions. Ethernet interfaces available are:

- 10BASE-T
- 100BASE-T
- 1000BASE-T
- 1000BASE-LX/SX
- 10GBASE-ER/LR/SR

Multi-port access – point to point

Where multi-port access is requested, point-to-point services will remain transparent, but individual ports will be linked together so that traffic arriving at port 1 at the circuit A end will be carried to port 1 at the B end.

Multi-port access – hub and spoke

Hub sites with multi-port access can have ports configured to act as 802.1Q trunks or as ports in a single VLAN. Spoke sites can have up to four Fast Ethernet 10/100 ports enabled or two 1Gbps ports enabled. These ports can be placed in different VLANs or in the same VLAN, or in a combination. Spoke sites are not transparent to 802.1Q tagged frames and can receive only untagged 802.3-compliant Ethernet frames.

Colt LANLink Hub and Spoke

Colt LANLink Hub and Spoke allows you to aggregate Ethernet services onto an Ethernet interface at a single site. This Service can be made up from Metro, National and International services all terminated at a hub site.

The Colt LANLink Hub and Spoke service is a Layer 2 private network service composed of several Ethernet Virtual Private Line (EVPL) links between one hub site and several spoke sites.

The multiplexing of the spoke services is done at the hub site over a single Ethernet interface. You can choose between two hub options:

- Fast Ethernet presentation
- Gigabit Ethernet presentation

The IEEE standard 802.1Q VLAN Tagging is used for service segregation between the spoke sites on the single hub interface. There are limitations to the number of spokes and the bandwidth that can be supported on a hub site.

Each spoke site is allocated a VLAN tag by you included on the order form. When a spoke is added to the network, a physical point-to-point link is configured on our protected network between the hub site and the new spoke site.

Link aggregation

Link aggregation enables you to benefit from extra resilience at the hub site. Based on Link Aggregation Standard (IEEE 802.3ad-2002), link aggregation lets you implement an interface speed of up to 2Gbps at the hub location.

2 Technology platform

We use a number of technologies to deliver Colt LANLink Services.

LANLink Metro Ethernet over Fibre (EoF) services are delivered using dedicated fibre and on-site optical devices. EoF services are available at high bandwidths but are not able to offer features such as Class of Service (CoS), bandwidth flexibility and multi-port access.

LANLink Services are also delivered over Colt's Ethernet based Multi Service Platform (MSP).

All other LANLink Services are delivered over our European-wide SDH network.

3 Network access

Colt LANLink Services can be provided:

- On-Net using our fibre end-to-end (for premises directly connected to our network); or
- Off-Net using third-party other licensed operator tails, or DSL

4 Options

The following options are available:

Class of Service (CoS)	For all Ethernet Services two CoS are available that give the ability to prioritise business-critical or time-sensitive traffic. The classes available are: • Standard • Premium (the Premium maximum is set at 60% of the total WAN bandwidth)
Resilience options (options depend on type of Services taken)	Unprotected – no service resilience provided
	Standard resilience – protection provided by a dedicated failover path
	Gold resilience – incorporates dual CPE (multiplexers) onto the same access ring at both the A and B end of the service, adding full 1+1 CPE resilience
	Platinum resilience – places each multiplexer on a different fibre pair and utilises two header multiplexers, ensuring a maximum of 1+1 end-to-end redundancy across the whole of your solution
Dual Entry	Dual diverse entries into your premises
Performance Reporting	Service performance management reporting is available on a per site basis