# SIN 385

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**Suppliers' Information Note**

*For The BT Network*

# IP Connect UK
## Service Description



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**TABLES**

# 1. Introduction

This Suppliers' Information Note (SIN) describes BT's IP Connect UK service, which utilises MPLS technology to provide an IP Virtual Private Network capability. The service offers access options using Leased Line, Ethernet or xDSL with various rates depending on the access mechanism. This document provides information about the service for use by Customer Premises Equipment (CPE) manufacturers and developers.

# 2. Service Availability

The BT IP Connect UK service will cover mainland Britain and Northern Ireland (the UK Licenced area), subject to available network capacity.

Ethernet access availability is restricted to be within a given distance from the Network Point of Presence and also depends upon the required resilience. Further detail is specified in the IP Connect UK Product Description.

Geographic availability of xDSL access will be made available using BT's broadband checker tools. xDSL access to IP Connect UK will only be provided over BT-provided direct exchange lines. There are also technical limitations depending on factors such as the length of the local loop that may restrict ADSL delivery to some users.

For further information please refer to http://www.btplc.com/sinet/

If you have enquiries relating to this document, then please contact : sinet.helpdesk@bt.com

# 3. BT IP Connect UK Service Description

## 3.1. General Service Characteristics

The BT IP Connect UK Service provides both a physical access and a logical connection to a defined IP VPN hosted on BT's Multi–Protocol Label Switching (MPLS) platform. Logical access to single and/or multiple VPNs is supported per physical access using individual Frame Relay encapsulated Permanent Virtual Circuits, Ethernet VLAN accesses or PPP tunnels for xDSL. The service is designed to provide any-to-any IP connectivity within a customer defined VPN and supports a combination of IP version 4 and version 6 traffic. The IP Connect UK service offers a range of available access rates.

The access speeds currently supported are listed in Table 1. Note that for Ethernet accesses the Port/Contracted Data Rate (CDR) may be below the access rate; in this case traffic should be shaped on egress at the CPE, and will be policed on ingress to the network.

| IP Connect UK Access Rates | | IP Connect UK interfaces |
|---|---|---|
| 128 kbit/s | | X.21 |
| 256 kbit/s | | X.21 |
| 512 kbit/s | | X.21 |
| 1024 kbit/s # | | X.21 |
| 2048 kbit/s ## | | X.21 or G.703 |
| 34 Mbit/s | | G.703 |
| 155 Mbit/s | | G.957 optical |
| 10 Mbit/s | | 10BaseT electrical |
| 100 Mbit/s | | 100BaseT electrical |
| 1000 Mbit/s | | 1000Base-SX optical |
| ADSL1 | | |
| Downstream < 8 Mbit/s | Upstream (uncapped or 448kbit/s fixed) | ADSL |
| ADSL2+ | | |
| Downstream (< 24 Mbit/s) | Upstream (uncapped or 448kbit/s fixed) | ADSL |
| Downstream (fixed rates at 512kbit/s:1Mbit/s or 2Mbit/s) | Upstream (256kbit/s fixed) | ADSL |
| Super-Fast FTTC | | |
| ###Downstream 40/80/100Mbit/s | Upstream 2/10/20Mbit/s | 10/100BaseT |
| Super-Fast FTTP | | |
| Downstream 40/80/100Mbit/s | Upstream 2/10/20Mbit/s | 10/100BaseT |

*# not available for new supply.*

*## using X.21 interface. Where X.21 is not available, a framed G.703 interface may be offered providing a useable bit rate of 1984 kbit/s)*

*### see section 3.2.5 as this interface will change in Q4 2015-16*

**Table 1. IP Connect UK access rates**

## 3.2. Access

### 3.2.1. Leased Line access

For leased line accesses this service supports the encapsulation of IP v.4 and v.6 data packets using a Frame Relay framing structure that conforms with the Frame Relay Forum User–to–Network Interface (UNI) specification FRF 1.2 [1] the ITU–T Recommendation I.233 [2] and the IETF specification RFC 2427 [3] for multi–protocol encapsulation over Frame Relay.

The service employs unnumbered IP interfaces within the BT domain, such that all IP addressing relating to a Customer's IP–VPN is associated with the Customer's equipment and network domains.

The IP Maximum Transmission Unit (MTU) value supported by the service is 1500 bytes. Any IP packet forwarded to the service larger than 1500 bytes will be fragmented unless the D/F bit is set within the IP header, in which case the packet will be discarded.

Leased line accesses support a Frame Relay Local Management Interface (LMI) capability per physical access that complies with either ITU–T Q.933 Annex A [4] or ANSI T1.617 Annex D [5] (as selected by the Customer at time of order).

Access to individual VPNs from an IP Connect UK access is achieved by the use of Frame Relay PVCs. Multiple VPN connections are supported from an IP Connect UK access, with each connection using an individual PVC with an associated Data Link Connection Identifier (DLCI). The DLCI allocated to each VPN connection is allocated at time of subscription and is assigned by default to "101" for the first connection and "10n" for nth DLCI connection provided, per single physical access.

Alternatively DLCI values can be specified by the Customer from the value range detailed in Table 2.

| IP Connect UK DLCI values | |
|---|---|
| 0 | Reserved for channel signalling |
| 1 - 15 | These numbers are reserved |
| 16 - 979 | Admissible values for Customer DLCIs |
| 980 - 991 | Reserved for management connections |
| 992 - 1023 | These numbers are reserved |

**Table 2. Admissible DLCI values**

### 3.2.2. Fibre Ethernet access

For Ethernet accesses the service supports the encapsulation of IP v4 and v6 data packets using IEEE 802.3 [24] Ethernet framing, with 802.1q [25] VLAN trunking protocol for accesses with multiple VPNs.

Where a single VPN connection is provided on an Ethernet access, data will be sent without the VLAN Id field being set in the Ethernet header, i.e. the link will not be configured as an IEEE 802.1q [25] VLAN trunk.

Multiple VPN connections are supported on an Ethernet access by configuring the access as an IEEE 802.1q VLAN trunk with each VPN using an individual VLAN associated with a VLAN ID. The VLAN ID associated with each VPN connection will be allocated by BT at the time of subscription. VLAN IDs cannot be specified by the customer.

The IP Connect UK service supports Ethernet access with the following interfaces (see SIN360 [27]):

- # Ethernet: IEE 802.3 [24] at 10Mbit/s.
- Fast Ethernet: IEE 802.3 at 100Mbit/s.
- Gigabit Ethernet: IEEE 802.3 at 1000Mbit/s.

The access data rate of each Ethernet access will be 10, 100 or 1000Mbit/s as per the IEEE 802.3 [24] standard. However, the customer will subscribe to a Port/Committed Data Rate (CDR) for each access that defines the maximum rate at which the customer may send or receive data packets to/from the network. The customer will not be able to burst above the CDR defined for each access.

The service employs numbered IP interfaces between the BT domain and the CPE router equipment. These addresses will be provided by the customer, and require a point-to-point IP subnet with a mask of /30 for v4 and /127 for v6. The higher (even) IP address will be used for the CPE equipment and the lower (odd) for the network.

*# no longer available for new supply*.

The IP Maximum Transmission Unit (MTU) value supported by the service is 1500 bytes, any IP packet forwarded to the service larger than 1500 bytes will be discarded.

The customer equipment connected to the service should appear to BT's network as a layer 3 IP router and should present a single 802.3 MAC address. Traffic to all other devices within the customer site should be routed via this device.

No spanning tree mechanism is used on the access link. Customers should not configure their equipment to send spanning tree packets (or other 802.x control packets) on the access circuit.

DiffServ Code Point (DSCP) Class of Service is supported on 10Mbit/s, 100Mbit/s and 1000Mbit/s (1Gbit/s) Ethernet Access. Previously 100Mbit/s Ethernet Access did not support Class of Service for IP Precedence based IP VPNs (ie all traffic will be marked as Class 3 on ingress to the network), although IP Precedence based CoS is supported on Gigabit Ethernet accesses.

### 3.2.3. Ethernet in the First Mile (EFM)

The IEEE 802.3ah-2004 Ethernet in the First Mile (EFM) standard defines additional specifications for Ethernet broadband technologies supporting speeds from 2Mbit/s to 1Gbits/ using physical layers of either twisted-pair copper cabling or single-mode optical fibre.

IP Connect UK delivers Ethernet-over-copper, offering symmetrical bandwidths over single to multiple bonded voice grade copper pairs, otherwise referred to as a Metallic Path Facility (MPF), using standards based 2BASE-TL technology,

- The installed number of MPFs varies according to the required bandwidth, the distance from the local serving exchange and line characteristics.
- Policing & shaping of traffic to a contracted bandwidth will be performed at points of ingress and egress throughout the network.
- IEEE 802.3 [24] Ethernet framing, with 802.1q [25] VLAN trunking protocol for EFM access with single or multiple VPNs.
- CoS Policy per Access (CPPA) applies to EFM access whether supporting single or multiple VPNs . CPPA means a single CoS policy will be applied across the whole access.
- EFM access provides an uncontended access bandwidth to the customer VPN.
- EFM access is available on IP VPNs configured for DSCP CoS and supports EF, AF & DE traffic class types.

The EFM access data rate and a requisite number of MPF pairs are delivered to meet the customer subscribed Committed Data Rate (CDR) . The CDR defines the maximum rate at which the customer may send or receive data packets to/from the network. The customer will not be able to burst above the CDR defined for each access.

The service employs numbered IP interfaces between the BT domain and the CPE router equipment. These addresses will be provided by the customer and require a point-to-point IP subnet with a mask of /30 for v4 and /127 for v6. The higher (even) IP address will be used for the CPE equipment and the lower (odd) for the network.

For further information on Ethernet Access, please refer to:

SIN 476 - BT Downstream 21CN Ethernet Services, Service Description

SIN 492 - Ethernet Access Direct (EAD) and Ethernet Access Direct Local Access, Service & Interface Description

### 3.2.4. ADSL1, ADSL2/2 +

ADSL can be provided using ADSL1 or ADSL 2+ technology with upstream speeds of up to 1Mbit/s and up to 24Mbit/s downstream.

ADSL1, ADSL2/2+ access variants are mostly rate adaptive and delivered at optimal speed by a line technology termed Dynamic Line Management (DLM).

DLM analyses network performance information to then determine the overall performance of each individual line through a balance of the maximum achievable line rate against the stability of the line.

If a line is unstable or performing poorly then it is re-configured automatically to try and address this without any manual intervention.

Customer sites connect via a BT Public Switched Telephone Network (PSTN) line to a local ADSL Copper Multi Service Access Node (CMSAN). A single ATM VC (VPI/VCI 0/38) is provided across the physical access between the CMSAN and the customer premises. Point to Point Protocol (PPP) is operating above the ATM layer to provide an end to end layer 2 connection between the customer CE router and the serving MPLS PE router.

For most ADSL options static and dynamic routing is supported. The underlying PPP session established between the customer CE router and serving MPLS PE router is authenticated using a user/domain name and CHAP password. The user/domain name is allocated by BT and consists of the end user access ID (unique to the customer circuit) and the domain name unique to IP VPN. The format is BBEU12345678@adslconnect.bt.com. The password is also BT defined (end user access ID in the format BBEU12345678).

### 3.2.5. Fibre to the Cabinet (FTTC)

FTTC offers an EU Access option based on VDSL 2 technology, rather than ADSL 1 and ADSL 2/2+ on WBC. This type of EU Access provides a higher line rate of up to 80Mbps downstream and up to 20 Mbps upstream.

The main difference between FTTC and ADSL1/2/2+ Service is that the DSLAM (Digital Subscriber Line Access Module) for the ADSL1/2/2+ Service is situated in an exchange building whereas for FTTC the DSLAM is situated in a street cabinet ("Street DSLAM").
The Street DSLAM is served with a fibre back to the exchange to carry the Broadband signals.

The 'Street DSLAM' is connected to the Street Cabinet using tie pair cables. VDSL 2 is used to carry the Broadband over the copper pair from the Street Cabinet to the End User's premises.
The Public Switched Telephony Service (PSTN) is unaffected by this technology and continues to be supplied over the copper pair between the Exchange and EU's premises.
FTTC accesses use the PPP (Point-to-Point Protocol) session establishment to inform the BRAS of the Openreach line rate. It is therefore essential that the PPP session is re-started every time the VDSL line retrains. To ensure this, the PPP / L2TP timeout values must be set to less than 20 seconds.

FTTC requires a Service Specific Front Plate to the existing metallic line box, the Network Terminating Equipment, (NTE5). The VSDL2 modem connects to the data port on the Service Specific Front Plate , the modem then presents a logical Ethernet Interface for the EU. Refer to SIN 498 [43]

The Service Specific Front Plate includes the VDSL2 filter that separates PSTN and VDSL2 signals carried over the PSTN line, it also prevents VDSL2 signalling from reaching other telephone extension sockets.

A VDSL2 modem will be supplied and connected to the data port of the service specific front plate. This is an active device that BT uses to monitor and test the service provided. The VDSL2 modem must be within reach of a power supply, remain powered and connected to the data port of the service specific front plate at all times. It should be noted that the VDSL2 modem is being withdrawn for new services in Q4 2015-16. After this point the CPE is required to fulfil the modem functionality and the service interface will be VDSL2.

Separate ADSL filters are not required in the End User's premise.

For more detail, please refer to;

SIN 360 - Ethernet Customer Interfaces - Interface Characteristics

SIN 498 – Fibre to the Cabinet (FTTC) Generic Ethernet Access Service and Interface Description

### 3.2.6. Fibre to the Premise (FTTP)

The FTTP product will use an overlay of fibre infrastructure to sites with existing copper infrastructure and provides an alternate access solution other than Fibre to the Cabinet (FTTC).

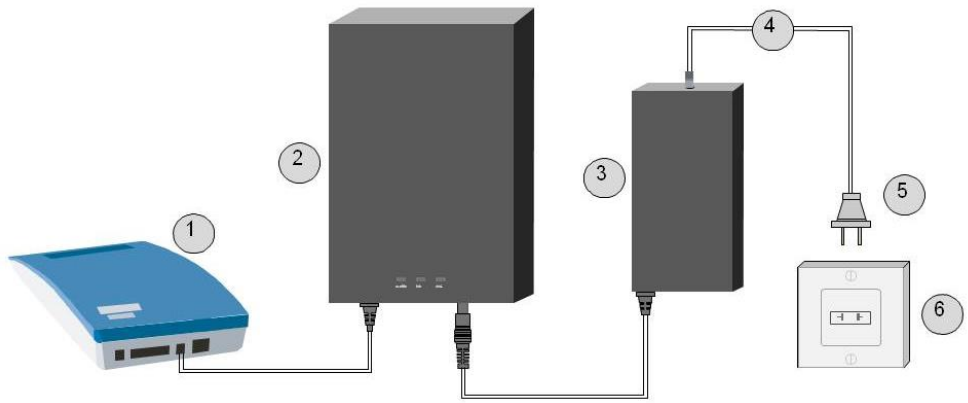
The fibre is installed between Optical Line Termination equipment within a 'Next Generation Access' Exchange building to an Optical Network Termination (ONT) device located at the EU premise. Note that there is no requirement for Dynamic Line Management with a FTTP service.

An FTTP installation comprises of two main deliverables.

I. A Fibre connection between NGA exchange and EU site, where the fibre terminates within an external Customer Splicing Point (CSP) at the EU premise.

II. An EU site installation between the external CSP and an internal Optical Network Termination device; the ONT presents an Ethernet interface for EU CPE equipment.

Note. The ONT is an active device, therefore needs to be located within reach of a power supply and should remain powered at all times; the ONT will provide four Ethernet data ports.




**Legend**: 1-ONT; 2–BBU; 3–Charger/Adaptor; 4/5 - AC Power Cable & Plug; 6-Power Socket

BBU – Battery Backup Unit

ONT – Optical Network Termination

## 3.3. Routing Options

Both Static Routing and Dynamic Routing (eBGP) options are supported for exchanging routing information between the PE and CE.

A number of enhanced service reliability options for IP Connect UK are offered between the customer NTE and BT's IP Connect UK.

The dynamic routing option requires the CPE to run an external BGP session across a *multihop* link in accordance to RFC 1771 A Border Gateway Protocol 4 (BGP-4) [22]. For Ethernet access all resilient sites use dynamic resilience in accordance with the above RFC. This requires the CPE to run an external BGP session between LAN interfaces, not using *multihop*.

This external BGP session supports the end to end transparency of BGP standard communities. The following communities are carried transparently by IP Connect UK.

- Any AS in the first 2 bytes of the community attribute
- Excluding core ASNs (2856, 12641)

That is, the following are allowed

- 0:0 to 2855:65535
- 2857:0 to 12640:65535
- 12642:0 to 65535:65535

Two accesses forming a resilient connection can be in different BGP AS (Autonomous System). Each BGP connected site within a VPN should use a different AS number. IP Connect UK uses both "Deterministic MED" and "Always Compare MED". BT can recommend the AS numbering plan for customer sites or the customer may select their own. Any AS number selected by the customer must either be in the Private AS number range [64521 - 65535][1] or is registered to them by a Regional Internet Registry e.g. ARIN (Canada, United States, islands in the Caribbean Sea and North Atlantic Ocean) or RIPE NCC (Europe, the Middle East, Central Asia) and must be unique for each site within a VPN.

The dynamic resilience options do not support true load sharing. As such the BGP configuration on the CPE should set MED (Multi-Exit Discriminator) values for all route prefixes which are announced to the IP Connect UK network. This enables the customer to control which connection will be used to send traffic from BT's IP Connect UK platform to them for each individual prefix that they advertise.

iBGP Multipath will be configured as default on all accesses. Customers with more than one access advertising the same routes would receive flow based load-sharing of inbound traffic across up to 4 paths (accesses). To be able to use iBGP Multipath the following must be true:

- Weights are equal
- Local-preference is equal
- AS-PATH is same. Note that entire AS-PATH should be identical
- Origin is same
- MEDs are equal

Any of the foregoing can be used to override iBGP Multipath. The use of unequal path load sharing allows accesses, which are parented on different PoPs thereby possible having different path lengths, to have approximately equal distribution of sessions.

It must be noted that "loadsharing" is session based and depends upon the source and destination IP addresses as to which path is taken; it does not take session bandwidth into consideration. "Loadsharing" will work optimally if there are large numbers of sessions; there is a risk that with traffic will be unequally routed if very small numbers of sessions are present. Access should always be of equal bandwidth.

Note that iBGP Multipath will only control inbound sessions to the multi access site. The Customer must control outbound traffic by configuration on their site

The BGP timer parameters supported by the BT network are given in Table 3. These timers may be negotiated between the network and the CPE equipment if the CPE supports this. The minimum values that should be set in the CPE are defined below. If the CPE does not support negotiation then the service defaults should be used.

| Timer | BT Service Default | Minimum Value Permitted |
|---|---|---|
| BGP neighbour keepalive timer | 60 seconds | 10 seconds |
| BGP neighbour hold timer | 180 seconds | 3 × keepalive timer |

**Table 3. BGP timer values supported by IP Connect UK**

When using BGP to advertise routing information to the network, each site will be subject to a pre-agreed maximum number of routes that it can advertise. This number of routes should not be exceeded; the network will disconnect sites that advertise more than the agreed number.

## 3.4. Class of Service not Enabled: IP Precedence and DSCP Model

Where CoS features are not enabled, IP Connect UK accesses do not support by default the use of IP Precedence bits in the headers of Customers' IP packets. Any IP Precedence bit values that are set will be reset to BT's Class 3 (Default) precedence marking for transport across the network. By default the network will not re-instate the original precedence bit value.

## 3.5. Class of Service Enabled: IP Precedence Model

Where CoS features are enabled under the IP Precedence CoS model, IP Connect UK accesses support the use of IP Precedence bits in the headers of Customers' IP packets in order to provide prioritisation of Customer data according to the values employed in the Precedence bit.

IP Connect UK supports prioritisation into 3 discrete IP Classes of Service:

- Class One
  used for low–jitter, low–delay application requirements such as Voice over IP
- Class Two
  used for data prioritised over 'general' traffic or data with underlying application performance requirements such as video
- Class Three
  used for general data

In order for IP Connect UK to handle Customer traffic according to its appropriate Class setting, the Precedence bit in the IP headers of Customer data should be set according to the following scheme:

| IP Precedence | | IP VPN Class of Service | In/Out of Contract Marking |
|---|---|---|---|
| Value | Binary | | |
| 6 | 110 | 2 | In |
| 5 | 101 | 3 | In |
| 4 | 100 | 1 | In |

**Table 4. IP Precedence Marking scheme**

The precedence value of Customer traffic submitted to IP Connect UK will be set to the same value on egress from the network. Any received precedence value settings that are not in accordance with the above Precedence Marking scheme will be re–marked to Class 3 on egress.

On an Ethernet access, bits 4-6 of the ToS field (the last 3 bits of the DSCP) must be set to zero on the CPE for Class 1 and Class 2 traffic; these bits will be set to zero for all traffic on egress.

## 3.6. Class of Service Enabled: DSCP Model

Where CoS features are enabled under the DSCP (DiffServ Code Point) CoS model, IP Connect UK accesses support the use DSCP bits in the headers of Customers' IP packets in order to provide prioritisation of Customer data according to the values employed in the Precedence bit.

The IP Connect UK network supports prioritisation into 3 discrete IP Classes of Service:

- Class One/Expedited Forwarding
  used for low-jitter, low-delay application requirements such as Voice over IP
- Class Two/Assured Forwarding
  used for data prioritised over 'general' traffic or data with underlying application performance requirements such as video. Up to four discrete AF classes are available to segregate Customers' prioritised or performance-sensitive data traffic
- Class Three/Default (or "Best Efforts")
  used for general un-prioritised data

When supporting EF on a DSL access the CPE must be configured for MLPPP and fragmentation will be applied to IP packet.

In order for IP Connect UK to handle Customer traffic according to its appropriate Class setting, the DSCP bit in the IP headers of Customer data will be processed according to the following precedence marking scheme:

| Marking on BT Network | | | Classification | |
|---|---|---|---|---|
| Binary | Octal | Ingress/Egress treatment (In/Out of Contract) | DiffServ Code Point | Class |
| 101000 | 5-0 | In | EF | Class 1 |
| 101110 | 5-6 | In | EF | Class 1 |
| 100000* | 4-0* | In | | Class 2/AF4 |
| 100010 | 4-2 | In | AF41 | Class 2/AF4 |
| 100100 | 4-4 | Out | AF42 | Class 2/AF4 |
| 100110 | 4-6 | Out | AF43 | Class 2/AF4 |
| 011000* | 3-0* | In | | Class 2/AF3 |
| 011010 | 3-2 | In | AF31 | Class 2/AF3 |
| 011100 | 3-4 | Out | AF32 | Class 2/AF3 |
| 011110 | 3-6 | Out | AF33 | Class 2/AF3 |

| | | | | |
|---|---|---|---|---|
| 010000* | 2-0* | In | | Class 2/AF2 |
| 010010 | 2-2 | In | AF21 | Class 2/AF2 |
| 010100 | 2-4 | Out | AF22 | Class 2/AF2 |
| 010110 | 2-6 | Out | AF23 | Class 2/AF2 |
| 001000* | 1-0* | In | | Class 2/AF1 |
| 001010 | 1-2 | In | AF11 | Class 2/AF1 |
| 001100 | 1-4 | Out | AF12 | Class 2/AF1 |
| 001110 | 1-6 | Out | AF13 | Class 2/AF1 |
| 000000 | 0 | In | DE | Class 3 |

*= DSCP Class Selector/Truncated DSCP value

**Table 5. DSCP Precedence Marking Scheme (based on RFC2597 [37])**

The precedence value of Customer traffic submitted to IP Connect UK will be set to the same value on egress from the network. By default, any received precedence value settings that are outside of the DSCP framework will be re–marked to Class 3/Default on egress.

## 3.7. Class of Service and Interface Fragmentation (FRF.12)

Where an IP Connect UK service is ordered in conjunction with Class of Service (CoS) that includes Class 1, FRF.12 fragmentation will be enabled in order to support Class 1 effectively at access bandwidths of below 2Mbit/s (X.21 interface) or 1984 kbit/s (G.703 interface). The fragment sizes defined in the configuration of FRF.12 settings will vary according to the bit rate of the Access. FRF.12 settings will need to be configured on the Customer CE Router to match those configured on the BT network.

| IP Connect UK Access speed | FRF.12 Fragment size (bytes) |
|---|---|
| 256 kbit/s | 300 |
| 512 kbit/s | 400 |
| 1024 kbit/s | 800 |

**Table 6. FRF.12 fragment size settings for IP Connect UK accesses**

## 3.8. IP Connect UK Flex (2Mbit/s and below)

A variant of IP Connect UK is available (based on a 2Mbit/s physical delivery) that offers flexible bandwidth to the Customer. This service employs the use of a 2Mbit/s service with G.703 interface only (i.e. the IP Connect UK X.21 interface is not supported for Flex).

Bandwidth is delivered to Customer sites at rates of below 2Mbit/s through the use of specific TDM time slot combinations, configured on the Network Terminating Equipment (NTE) of the IP Connect UK service. Each time slot is equivalent to 64kbit/s of bandwidth, with 31 time slots supported on the 2Mbit/s service providing a maximum of 1984 kbit/s.

Customer Routers connected to the IP Connect UK Flex service typically require configuration to take account of TDM time slot configuration (and its configured bandwidth) on the IP Connect UK Flex service.

Specific time slots are used to deliver flexible bandwidth at intermediate steps between 256bit/s and 1984 kbit/s. The range of possible bandwidths, and their mapping to time slot values as supported by IP Connect UK, is as described in Table 7. Please note that not all bandwidth options are commercially available, please consult the IP Connect UK Production Description.

| Time Slots (G703 2Mb Flex service) | Delivered Flex Access Bandwidth | FRF.12 Fragment size (bytes) | Time Slots (G703 2Mb Flex service) | Delivered Flex Access Bandwidth | FRF.12 Fragment size (bytes) |
|---|---|---|---|---|---|
| 1 to 4 | 256 kbit/s | 300 | 1 to 18 | 1152 kbit/s | 900 |
| 1 to 5 | 320 kbit/s | 300 | 1 to 19 | 1216 kbit/s | 900 |
| 1 to 6 | 384 kbit/s | 300 | 1 to 20 | 1280 kbit/s | 1000 |
| 1 to 7 | 448 kbit/s | 300 | 1 to 21 | 1344 kbit/s | 1000 |
| 1 to 8 | 512 kbit/s | 400 | 1 to 22 | 1408 kbit/s | 1100 |
| 1 to 9 | 576 kbit/s | 400 | 1 to 23 | 1472 kbit/s | 1100 |
| 1 to 10 | 640 kbit/s | 500 | 1 to 24 | 1536 kbit/s | 1200 |
| 1 to 11 | 704 kbit/s | 500 | 1 to 25 | 1600 kbit/s | 1200 |
| 1 to 12 | 768 kbit/s | 600 | 1 to 26 | 1664 kbit/s | 1200 |
| 1 to 13 | 832 kbit/s | 600 | 1 to 27 | 1728 kbit/s | 1200 |
| 1 to 14 | 896 kbit/s | 700 | 1 to 28 | 1792 kbit/s | 1200 |
| 1 to 15 | 960 kbit/s | 700 | 1 to 29 | 1856 kbit/s | 1200 |
| 1 to 16 | 1024 kbit/s | 800 | 1 to 30 | 1920 kbit/s | 1200 |
| 1 to 17 | 1088 kbit/s | 800 | 1 to 31 | 1984 kbit/s | N/A |

**Table 7. TDM time slots to delivered bandwidth on IP Connect UK Flex (2Mbit/s and below)**

Where a Flex service is ordered in conjunction with Class of Service (CoS) that includes Class 1, FRF.12 fragmentation will be enabled in order to support Class 1 effectively at configured access bandwidths of below 1984 kbit/s. The fragment sizes defined in the configuration of FRF.12 settings will vary according to the configured bit rate of the service. FRF.12 settings will need to be configured on the Customer CE Router as well as on the BT network. Note that FRF.12 fragmentation is not required at the full line rate to support Class 1. Fragment sizes are shown in Table 7. Where a value is shown then fragmentation must be configured; these are recommended upstream fragment sizes.

## 4. Interface Descriptions

IP Connect UK access connections support the following types of customer interface:

1. 128, 256, 512, 1024 & 2048 kbit/s
   X.21 [6] electrical presentation.

2. 2048 kbit/s (G.703 [9])
   Where X.21 [6] is not available from BT due to geographical coverage an alternative G.703 [9] presentation may be offered with G.704 [14] framing, providing a data path with 1984 kbit/s of usable bandwidth.

3. 34 Mbit/s
   G.703 [9] presentation with G.751 [13] framing.

4. 155 Mbit/s
   G.957 [12] optical presentation with G.707 [14] framing.

5. 10/100 Mbit/s
   RJ-45 connection with IEEE 802.3 [24] Ethernet at 10 or 100Mb/s, in half or full duplex mode.

6. 1000 Mbit/s
   1000Base SX optical presentation with IEEE 802.3 [24] Gigabit Ethernet framing.

7. DSL
   Analogue BT-provided PSTN direct exchange line.

## 4.1. 128, 256, 512, 1024 & 2048 kbit/s

The service supports customer access at 128, 256, 512, 1024 and 2048 kbit/s which conform to ITU–T Recommendation X.21 [6]. Electrical characteristics for this interface are specified in ITU–T Recommendation X.27 [7], and ISO4903 [8] defines the mechanical connector arrangements.

Frame Relay encapsulation is as described in IETF RFC 2427 ("Multiprotocol interconnect over Frame Relay") [3]. Cyclic redundancy checking (CRC) must be disabled.

## 4.2. 2048 kbit/s (G.703 interface)

The service supports customer access at 2048 kbit/s using an ITU–T Recommendation G.703 [9] electrical presentation (where X.21 [6] is not otherwise available from BT). The Layer 2 framing structure employed over this interface conforms with ITU–T Recommendation G.704 [10] and provides a useable 1984 kbit/s of bandwidth.

HDB3 line coding is used as defined in ITU–T Recommendation G.703 [9].

Frame Relay encapsulation is as described in IETF RFC 2427 ("Multi–protocol interconnect over Frame Relay") [3]. Cyclic redundancy checking must be disabled.

The physical presentation of this service is via a pair of unbalanced BNC 75 Ohm female BNC coaxial connectors, one for each direction of transmission. The connectors conform to the general requirements of BS 9210 N0001 : Part 2 : 1982 [11].

## 4.3. 34.368 Mbit/s

The service supports customer access at 34 Mbit/s whose electrical characteristics conform to ITU–T Recommendation G.703 [9]. Frame structure is as defined in ITU–T Recommendation G.751 [13].

Frame Relay encapsulation is as described in IETF RFC 2427 ("Multi–protocol interconnect over Frame Relay") [3].

The physical presentation of the service is via a pair of unbalanced 75 Ohm female BNC coaxial connector's one for each direction of transmission [11]. HDB3 line coding is used as defined in ITU–T Recommendation G.703 [9].

The CPE E3 Serial card must support 16-bit cyclic redundancy checking.

## 4.4. 155.520 Mbit/s

The service supports customer access at 155.520 Mbit/s using an optical interface conforming to ITU–T Recommendation G.707 [14] for the SDH Network Node Interface. This interface is presented via an optical single–mode fibre connection as described in SIN 333 [29] conforming to ITU-T Recommendation G.957 [12] for SDH optical requirements. The optical fibre presentation at the UNI conforms with BS EN 60825-1 [17] and BS EN 60825-2 [18] as a class 1 laser product.

The interface operates over Single-Mode optical fibre conforming to ITU-T Recommendation G.652 [19] and presents an SDH based frame structure as described in SIN333 [29], "SDH Customer Interfaces at the STM n level", conforming with ITU-T Recommendation G.707 [14].

The optical connector is FC type conforming to BS EN 186110 : 1994 [20]. The connector is Physical Contact (PC) polished. This combination is commonly known as an FC/PC connector. Non Return to Zero (NRZ) line coding is used as specified in ITU-T Recommendation G.957 [12].

The signal at the UNI is derived from a 1310nm-wavelength long haul SDH class laser (L-1.1) as specified in ITU-T Recommendation G.957 [12]. The NTE optical transmitter provides a signal power level of between –10dBm and –15dBm to interface with the attached CPE receiver. The NTE optical receiver has a sensitivity in the range –10dBm and –34dBm.

In order to operate the IP–VPN service, the Customer must install a Packet Over SONET /SDH (POS) card in their CPE Router configured to support SDH framing and connect it to the optical presentation at the User–Network Interface (UNI).

The CPE POS card must be configured to support 32 bit cyclic redundancy checking and should support G.707 – compliant SDH framing and the Frame Relay encapsulation mechanism defined in IETF RFC 1662 [15]. The Path Trace setting should not be enabled.

The CPE POS card connected to the IP Connect UK service at 155.520 Mbit/s must support Payload Scrambling as defined in Section 6.5 of ITU–T Recommendation G.707 [14] and RFC 2615 [21].

## 4.5. 10/100 Mbit/s

The interface is the Network Termination Point (NTP), i.e. the point of connection between the BT Network Terminating Equipment (NTE) and the CPE interface. The Customer Interface consists of an RJ-45 type socket. The customer provides the category 5 connecting cords between the NTE and their own CPE. The maximum cable length is 100m.

The RJ-45 type connector is as specified in the 10BaseT and 100BaseT IEEE 802.3u/x [30] [31] specifications. Attention is drawn to the Intellectual Property Rights (IPRs) set out in the preface of this agreed International standard. It is the responsibility of the CPE supplier to ensure that they have the necessary rights from the owner of the IPR. The IPR owner has stated that they are willing to negotiate licences under reasonable and non-discriminatory terms and conditions with applicants throughout the world.

Ethernet Access will be provided using BT Downstream 21CN Ethernet Services (SIN 476) , , The customer's equipment will need to be set to Auto-negotiate "on" in order to work correctly, the NTE will then negotiate interface speed.

## 4.6. 1000 Mbit/s

1000Mbit/s (Gigabit Ethernet) conforms to the IEEE 802.3 [24] standard.

The interface is the Network Termination Point (NTP), i.e. the point of connection between the BT Network Terminating Equipment (NTE) and the CPE interface. The Customer Interface consists of a Dual SC type 1000Base SX fibre interface. The customer provides the fibre patch connectors between the NTE and CPE, the maximum fibre length is 550m.

The SX type connector is as specified in the Gigabit Ethernet IEEE802.3z [32] specification. Attention is drawn to the Intellectual Property Rights (IPRs) set out in the preface of this agreed International standard. It is the responsibility of the CPE supplier to ensure that they have the necessary rights from the owner of the IPR. The IPR owner has stated that they are willing to negotiate licences under reasonable and non-discriminatory terms and conditions with applicants throughout the world.

| | |
|---|---|
| **Protocol** | Gigabit Ethernet IEEE 802.3z [32] |
| **Line Rate** | 1.25 Gbit/s |
| **Maximum Bit Error Rate** | $10^{-12}$ |
| **Power Requirement** | Mains voltage 50 Hz AC input, 50 watt |
| **Customer Fibre Connector** | SC type |
| **SX Fibre *(Customer provided)*** | Multi-mode 850nm, 50/125 or 62.5/125 micron |
| **SX Fibre Maximum Delivery Distance** | 550 m from NTE's SX port |
| **Operating Temperature** | 0° to 40° C |
| **Laser Safety** | Class 1 under all conditions as per IEC 825-1 [33] |
| **AUTONEGOTIATION** | ON |

**Table 8. 1000Mbit/s Ethernet NTE technical specification**

## 4.7. EFM

The EFM Network Terminating Equipment operates to Standard IEEE 802.3ah. Each MPF pair will terminate on a standard NTE5 faceplate and a separate cable assembly will connect each NTE5 to the supplied EFM NTE.

The customer interface is a 10/100BASE-TX port presented via a RJ45 type connector.
The customer will require an RJ45 category 5 cable to connect EFM NTE to their own CPE, where the maximum cable length is 100m.

For further detail: SIN 476.[40]

## 4.8. ADSL1/ADSL2/2 +

Customer ADSL CPE requires an ADSL port to provide a connection, noting that the ADSL connection supports a single VC.

The ADSL interface will utilise an ADSL/ CPE filter which is not supplied as part of the service.

## 4.9. Fibre to the Cabinet (FTTC)

Fibre to the Cabinet utilises VDSL2 signalling delivered via MPF pairs to the EU premise. The metallic path terminates on the NTE5 at EU premise.

The NTE Special Service faceplate includes an integral VDSL2 filter that separates analogue voice from VDSL2 signalling; a VDSL2 modem then connects to the VDSL2 filter outlet port.

The VDSL2 modem in turn presents a logical Ethernet interface for EU CPE connection.

The VDSL2 modem should remain powered at all times.

For further detail: SIN 498[43]

## 4.10. Fibre to the Premise (FTTP)

Fibre to the Premise utilises Openreach Generic Ethernet Access between End User Access up to a enabled exchange, The FTTP service delivers a single Virtual Local Area Network (VLAN) to the EU premise.

An Optical Network Termination device (ONT) installed at the EU premise terminates the optical path and presents 4 logical Ethernet interfaces as EU connection.

For general information regarding this service, please refer to SIN509[45] and SIN506[44].

# 5. Physical arrangements

## 5.1. Physical Location of Connectors

The User–Network Interface (UNI) is located at the connector on the BT Network Terminating Equipment (NTE) with a connector on the Customer side as described in the relevant part of Section 4 of this document.

## 5.2. NTE Power Supply Requirements

The NTE is locally powered and will require either a single or dual local mains 50Hz AC supplies (dependant on access rate).

The NTE will be installed in accordance with standard BT practises in agreement with the Customer.

### 5.2.1. 128, 256, 512, 1024 and 2048 kbit/s

Various types of NTE may be installed, some of which require an A.C. mains power source and others a –50V D.C. power supply. Power consumption varies, dependent on the type of NTE, from 5 Watts and 20 Watts. The –50V D.C. supply can be provided by BT, or by the Customer. A Customer supplied A.C. mains power source will be required close to the installation to operate the –50V D.C. power supply, or to power the NTE directly, dependent on NTE type.

Where the NTE is powered by a Customer provided –50V D.C. power supply, the NTE will be supplied with a connection lead which will be presented as wires–only. As power supplies can vary slightly in output voltage and other electrical characteristics, the NTE should be connected to power supplies conforming with British Telecommunications Network Requirements (BTNR) 2511 [16].

Customer supplied power supplies for connection to this service shall conform with the relevant safety standards in force.

### 5.2.2. 34 and 155 Mbit/s

The NTE is locally powered and will require at least one A.C. mains supply. For certain NTE types, the Customer can be supplied with a battery back–up option.

### 5.2.3. 10/100 and 1000 Mbit/s

The NTE is powered from the normal domestic mains supply, standard CEE 22 (IEC 320 [36]) inlets which are fitted to the rear panel of the NTE. The appropriate mains cord is supplied.

The power consumption of the BT NTE is typically 50 watts.

### 5.2.4. EFM

The EFM NTE is DC powered (12V) and supplied with an external power supply , power consumption typically 20 watts.

For further information: SIN 476[40]; SIN 492[41].

### 5.2.5. ADSL1 and ADSL2/2+

The service boundary only extends to the Master Telephone Socket and does not include internal wiring. Thus no additional power is required for an NTE.

[Note]: It is advised that Broadband routers do not share power outlets with other electrical devices that demand high power and switching current as this may cause electrical interference via the power supply. If the sharing of power outlets is unavoidable, the EU may need to deploy a mains conditioner or UPS system to help remove any causes of electrical interference.

### 5.2.6. Fibre to the Cabinet (FTTC)

The Openreach supplied VDSL2 modem is an active device and must remain powered and connected at all times.

The power supply unit (PSU) to the Openreach VDSL2 modem will be a single, low voltage power interface. [Note]

For NTE dimension detail: SIN 498[43]

### 5.2.7. Fibre to the Premise (FTTP)

The Optical Termination Device serves as the service point of End User connection.

The ONT will be fixed to a wall within 1m of a fixed power socket.

The power supply to the ONT will be a single, low voltage power interface including the capability for battery backup when available. The PSU will be suitable for use with standard domestic UK supplied 230V (AC). The power consumption is <12 W. [Note]
• ONT Power supply 11 – 14 V DC, 1 A
• Power adapter input 100 – 240 V AC, 50 – 60 Hz

Power consumption Minimum: 6 W, Maximum: 12 W, Average: 7.5 W

For further detail: SIN 506[44].

## 6. References


| | |
|---|---|
| [1] | Frame Relay Forum implementation agreement 1.2, "User–to–Network (UNI) Implementation Agreement", April 2000 |
| [2] | ITU–T Recommendation I.233, "Frame Mode Bearer Services", March 1993 |
| [3] | IETF RFC 2427, "Multiprotocol Interconnect over Frame Relay", September 1998 (replaced RFC 1490) |
| [4] | ITU–T Q.933 Annex A, "Digital subscriber signalling system No. 1 (DSS 1) – Signalling specifications for frame mode switched and permanent virtual connection control and status monitoring", October 1995 |
| [5] | ANSI T1.617 Annex D, "Digital Subscriber System No. 1 DSS1 Signalling Specification for Frame Relay Bearer Service", Revised 1997 |
| [6] | ITU–T Recommendation X.21, "Interface between Data Terminal Equipment and Data Circuit–terminating Equipment for synchronous operation on public data networks", September 1992 |
| [7] | ITU–T Recommendation X.27, "Electrical characteristics for balanced double–current interchange circuits operating at data signalling rates up to 10 Mbit/s", October 1996 |
| [8] | ISO 4903 15 Pole DTE/DCE Interface Connector and Contact Number Assignments, 1989 |
| [9] | ITU–T Recommendation G.703, "Physical/electrical characteristics of hierarchical digital interfaces", October 1998 |
| [10] | ITU–T Recommendation G.704, "Synchronous frame structures used at 1544, 6312, 2048, 8448 and 44 736 kbit/s hierarchical levels", October 1998 |
| [11] | BNC Connector complying with Figure 2 of BS 9210 N0001:Part2:1982 |
| [12] | ITU–T Recommendation G.957, "Optical interfaces for equipments and systems relating to the synchronous digital hierarchy", July 1999 |
| [13] | ITU–T Recommendation G.751, "Digital multiplex equipments operating at the third order bit rate of 34 368 kbit/s and the fourth order bit rate of 139 264 kbit/s and using positive justification", November 1998 |
| [14] | ITU–T Recommendation G.707, "Network node interface for the synchronous digital hierarchy (SDH)", October 2000 |
| [15] | IETF RFC 1662, "PPP in HDLC–like Framing", July 1994 |
| [16] | BTNR 2511 Interface of Telecommunications Equipment – nominal 48 volt negative D.C. power supply, latest issue |
| [17] | BS EN 60825 – 1 : 1994 Safety of Laser Products Part 1 Equipment Classification |
| [18] | BS EN 60825 – 2 : 1995 Safety of Laser Products Part 2 Safety of Optical Fibre Communications Systems |
| [19] | ITU-T Recommendation G.652 – Characteristics of a single-mode optical fibre cable. March 1993 |
| [20] | BS EN 186110 : 1994 Sectional specification. Connector sets for optical fibre and cables type FC. |
| [21] | IETF RFC2615, "PPP over SONET/SDH", June 1999 (obsoletes RFC1619) |
| [22] | IETF RFC 1771 "A Border Gateway Protocol 4 (BGP-4)", March 1995 |
| [23] | IETF RFC 1483, "Multiprotocol Encapsulation over ATM Adaptation Layer 5", July 1993 |
| [24] | IEEE 802.3, Standards for Local Area Networks: CSMA/CD Access Method |

| | |
|---|---|
| [25] | IEEE 802.1q, Recommendations for Virtual LANs |
| [26] | SIN 311, BT LAN Extension Service 100 – Service Description |
| [27] | SIN 360, Ethernet Customer Interfaces – Interface Characteristics |
| [28] | SIN 347, BT DataStream Office & BT DataStream Home |
| [29] | SIN 333, SDH Customer Interfaces at the STM-N Level (where N =1,4,16) |
| [30] | IEEE 802.3u, Standards for Local & Metropolitan Area Networks – Supplement: Media Access Control (MAC) Parameters, Physical Layer, Medium Attachment Units and Repeater for 100Mbit/s Operation, Type 100Base-T |
| [31] | IEEE 802.3x, Standards for Local and Metropolitan Area Networks: Specification for 802.3 Full Duplex |
| [32] | IEEE 802.3z, IEEE standards for Gigabit Ethernet in the LAN/WAN, 1998 |
| [33] | IEC 825-1, International Electrotechnical Commission (IEC) Standard – Safety of Laser Products Part 1 |
| [34] | SIN 346, BT ADSL Interface Description |
| [35] | ITU–T Recommendation G.992.1, Asymmetrical Digital Subscriber Line (ADSL) transceivers |
| [36] | IEC 320, International Standardized Appliance Connectors |
| [37] | IETF RFC 2597 “Assured Forwarding PHB Group”, June 1999. |
| [38] | IETF RFC 2364 "PPP Over AAL5" |
| [39] | SIN 472 - BT Wholesale Broadband Connect (WBC) Products, Service Description |
| [40] | SIN 476 - BT Downstream 21CN Ethernet Services, Service Description |
| [41] | SIN 492 - Ethernet Access Direct (EAD) and Ethernet Access Direct Local Access, Service & Interface Description |
| [42] | SIN 495 – BT Wholesale Broadband Connect Fibre to the Cabinet Service, Service Description |
| [43] | SIN 498 – Fibre to the Cabinet (FTTC) Generic Ethernet Access Service and Interface Description |
| [44] | SIN 506 – Fibre to the Premise (FTTP) Generic Ethernet Access . |
| [45] | SIN 509 – BT Wholesale Broadband Connect (WBC) Fibre to the Premise (FTTP) |

For information on where to obtain these referenced documents, please see the document sources list at http://www.btplc.com/sinet/

## 7. Abbreviations

| | |
|---|---|
| AAL5 | ATM Adaptation Layer 5 |
| ADSL | Asymmetric Digital Subscriber Line |
| AF | Assured Forwarding |
| ANSI | American National Standards Institute |
| AS | Autonomous System |
| ATM | Asynchronous Transfer Mode |
| BGP | Border Gateway Protocol |
| BTNR | British Telecommunications Network Requirements |
| CE | Customer Edge |
| CoS | Class of Service |

| | |
|---|---|
| CPE | Customer Premises Equipment |
| DF | Do not Fragment bit |
| DLCI | Data Link Connection Identifier |
| DSCP | DiffServ Code Point |
| DSL | Digital Subscriber Line |
| DSLAM | Digital Subscriber Line Access Multiplexer |
| EUDP | End User Data Path |
| FRF | Frame Relay Forum |
| HDB3 | High Density Bi–polar 3 |
| IETF | Internet Engineering Task Force |
| iBGP | internal Border Gateway Protocol |
| IP | Internet Protocol |
| IPR | Intellectual Property Rights |
| ITU–T | International Telecommunication Union |
| LMI | Local Management Interface |
| MAC | Medium Access Control |
| MED | Multi-Exit Discriminator |
| MPLS | Multi–Protocol Label Switching |
| MPF | Metallic Path Facility |
| MTU | Maximum Transmission Unit |
| NRZ | Non-Return to Zero |
| NTE | Network Terminating Equipment |
| PC | Physical Contact |
| PE | Provider Edge |
| PHB | Pre-Hop-Behaviour |
| POS | Packet Over SONET/SDH |
| PPP | Point-to-Point Protocol |
| PSTN | Public Switched Telephone Network |
| PVC | Permanent Virtual Circuit |
| RFC | Request For Comment |
| SDH | Synchronous Digital Hierarchy |
| SIN | Suppliers' Information Note |
| SONET | Synchronous Optical NETwork |
| TDM | Time Division Multiplexing |
| ToS | Type of Service |
| UNI | User/Network Interface |
| VC | Virtual Channel |
| VCI | Virtual Connection Identifier |
| VLAN | Virtual Local Area Network |
| VP | Virtual Path |
| VPI | Virtual Path Identifier |
| VPN | Virtual Private Network |

## 8. History

| Issue | Date | Revision changes |
|---|---|---|
| Issue 1.0 | 19 September, 2001 | First Issue |
| Issue 1.1 | 08 October 2001 | Correction to quoted standard in section 4 item 3 |
| Issue 1.2 | 08 November 2001 | Addition of 512 kbit/s rate on X.21 interface. |
| Issue 1.3 | 06 February 2002 | Addition of 64 & 128 kbit/s rates on X.21 interface. |
| Issue 1. | 27 February 2002 | Addition of 3.3 to clarify use of dynamic resilience option. |
| Issue 2.0 | 12 July 2002 | Addition of the Flex service section 3.6 refers<br>Clarification of the use of IP Precedence bits section 3.4 & 3.5 refer |
| Issue 2.1 | 07 May 2003 | Addition of Ethernet and DSL access options.<br>Modified FRF.12 fragment sizes for IP Connect UK Flex.<br>Approval Requirements statement removed, information available via SINet Useful Contacts page. |
| Issue 2.2 | 05 August 2003 | Text and title format changes Section 3.4 to 3.8.<br>Detail added to reflect support of DSCP Class of Service model (Section 3.6). |
| Issue 2.3 | 26 October 2004 | CoS Enabled, DSCP Model description clarified. |
| Issue 2.4 | 02 December 2004 | Addition of BGP Standard Community Attributes transparency, iBGP Multipath, "Always Compare MED" |
| Issue 2.5 | 06 May 2005 | Correction of DSL shaping parameters in Table 1. Change to PPPoA encapsulation with optional Radius Server authentication for DSL service. Clarification of advice for customer's DSL splitter/filter. |
| Issue 2.6 | 17 January 2007 | Amendments to GiGE interface – Autonegotiation needs to be set to 'ON'. BGP enhancements on DSL. Typos corrected and redundant information removed. |
| Issue 2.7 | 10 July 2009 | Addition of Ethernet in First Mile (EFM) Access Option utilising Local Loop Unbundling. Includes Section 3.2.2.2, 10Mbit/s EFM at Section 4.5.2 and additional power information at Section 5.2.3. |
| Issue 2.8 | July 2013 | Service Name Change from IP Clear to IP Connect UK.<br>Additional SIN references describing 21CN Ethernet Services.<br>The addition of Wholesale Broadband Connect access options: ADSL2+; Fibre to the Cabinet (FTTC); Fibre to the Premise (FTTP). |
| Issue 2.9 | September 2014 | Change SINet site references from http://www.sinet.bt.com to http://www.btplc.com/sinet/ |
| Issue 3.0 | October 2015 | Multiple changes |

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