SIN 498

Issue 7.3

January 2017

Suppliers' Information Note

For The BT Network

Generic Ethernet Access Fibre to the Cabinet (GEA-FTTC)

Service and Interface Description

For information on where to obtain SINs referenced in this document, please see the document sources list at http://www.btplc.com/sinet/Documentsource/index.htm

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1. Service Outline

1.1 General

Openreach will provide the Generic Ethernet Access Fibre to the Cabinet (GEA-FTTC) product variant, part of Openreach's Generic Ethernet Access (GEA) portfolio, over a combination of fibre and existing copper based infrastructure utilising VDSL2 technology.

This Suppliers' Information Note (SIN) provides details relevant to Communications Providers (CPs) regarding connectivity and interfaces.

Two product variants are detailed that differ in their interface presentation at the End User premises (User to Network Interface, or UNI). The first variant is an Openreach supplied and maintained VDSL2 modem. The second variant is a CP supplied and maintained VDSL2 modem.

This SIN also provides details of the tests required to demonstrate compliance of a CP provided modem to the various technical and operational requirements.

It should be noted that the information contained within this SIN is subject to change due to BT developments, changes in global VDSL2 industry standards or due to feedback from customers, including CPs. Please check with the http://www.btplc.com/sinet/SINs/index.htm site to ensure you have the latest version of this document.

In the event of a discrepancy between this document and referenced documents, this document takes precedence.

Further information regarding the product trial and pilot product launch can be obtained by contacting your Openreach Sales and Relationship Manager.

1.2 Service Availability

Openreach will provide GEA-FTTC as an 'always on' Virtual LAN (VLAN) between the Layer 2 Switch Optical Line Termination (L2S) equipment in the exchange and the End User premises.

The GEA-FTTC service is an overlay service, it will only be provided if a copper bearer with an active WLR3 or MPF service is available at the customer premises. GEA-FTTC can be delivered simultaneously with a WLR3 or MPF service and further details can be found in the GEA-FTTC Product Description on the Openreach Portal (see http://www.openreach.co.uk).

End Users can only receive a single GEA-FTTC service over an active WLR3 or MPF line.

If the underlying WLR3 or MPF service is ceased then the GEA-FTTC service is also ceased.

At the Point of Handover, the GEA-FTTC service will be delivered to the CP via a GEA Cablelink product. The GEA Cablelink will transport multiple GEA-FTTC services from the same L2S to a location within the same Point of Handover specified by the CP.

The VLAN will be able to carry data communication signals after the CP has registered for service activation for their End User.

GEA-FTTC will consist of physical network connectivity between:

- The end user premises, and
- A CP specified location within the Openreach Point of Handover.

The GEA-FTTC product will offer the following VDSL2 line rate:

- A peak downstream (from CP to EU) rate of up to 80 Mbit/s,
- A downstream prioritisation rate of 15 Mbit/s or 30 Mbit/s (depening on the product variant purchased) or line rate, whichever is the lower,
- A peak upstream (from EU to CP) rate of either up to 2 Mbit/s, up to 10 Mbit/s or up to 20 Mbit/s as selected by the CP.

These rates use 80,000,000 bit/s as 80 Mbit/s, and are the VDSL2 line rates. The VDSL2 rate reported needs to be interpreted by the CP in order to allow payload traffic to be transmitted optimally.

1.2.1 VDSL2 rates

The upstream and downstream VDSL2 data rate is reported to the CP BRAS/Radius upon PPP discovery (a similar mechanism exists for DHCP – see Section 2.1.7). The VDSL2 rate states the upper rate at which Ethernet traffic can be transmitted on the link. This traffic comprises of:

- A 4 byte per frame overhead added by Openreach for internal routing,
- A degree of overhead introduced by DSL (Packet Transfer Mode layer),
- The EU traffic sent from the CP, or from the EU.

As a result of these overheads, the actual achievable throughput in bits per second is dependent on the reported VDSL2 rate and frame size of the data being transmitted. Openreach advise CPs to consider carefully how they interpret the reported VDSL2 rate in relation to the services they sell, the specifics on an individual EU's use of the service, and any impacts of their own network.

For example, if the reported downstream VDSL2 data rate is 40,000 kbit/s and the IP packet size is 1500 bytes (i.e. Ethernet frame size at End User LAN is 1514 bytes) the maximum throughput achievable is actually 39,178 kbit/s (when measured at the EU LAN i.e. no VLAN header, but including Ethernet header). Alternatively, if the IP packet size is 64 bytes the maximum throughput achievable is further reduced to 35,721 kbit/s. This overhead is particularly important to consider in respect to the downstream shaper setting on the CP’s BRAS. CPs are advised to understand and account for the method that their BRAS uses to implement traffic shaping.

CPs should also be aware of the following:

- Where Openreach has provided and is managing the modem, daily status reports will be generated and transmitted consisting of no more than 8k bytes (64k bits) of data upstream at full line rate. These flows will take priority over EU data. The impact clearly depends on the VDSL2 traffic rate at the time.

- There will be occasional firmware upgrades which will involve reasonable volumes of traffic (M bytes). Openreach will report to CPs when these are scheduled across the GEA network.

If GEA Multicast is used (which does not transit the BRAS), the CP will need to take account of this traffic on the EU's line.

1.2.2 VDSL2 noise margins

Currently the default target downstream noise margin is set to 6dB. From March 2017 the target downstream noise margin shall be set to either 3, 4, 5 or 6dB – the actual value shall be determined by the Dynamic Line Management (DLM) algorithm based on line stability.

1.3 GEA Cablelink

The GEA Cablelink product will be offered for the CP to order connectivity to the L2S in the same Point of Handover building.

This will comprise:

- A 1 Gbit/s Ethernet port into the L2S. The Gigabit Ethernet interface will be set to auto-negotiate, 1000Base-LX (SingleMode only), or
- A 10 Gbit/s Ethernet port into the L2S. The 10 Gigabit Ethernet interface will be set to 10000Base-LR (SingleMode only); and
- Fibre connection from the port on the L2S to the location within the same Point of Handover specified by the CP.

CPs will need to specify the location of their equipment/presence to which the connection should be made as part of the order journey for each GEA-FTTC service ordered.

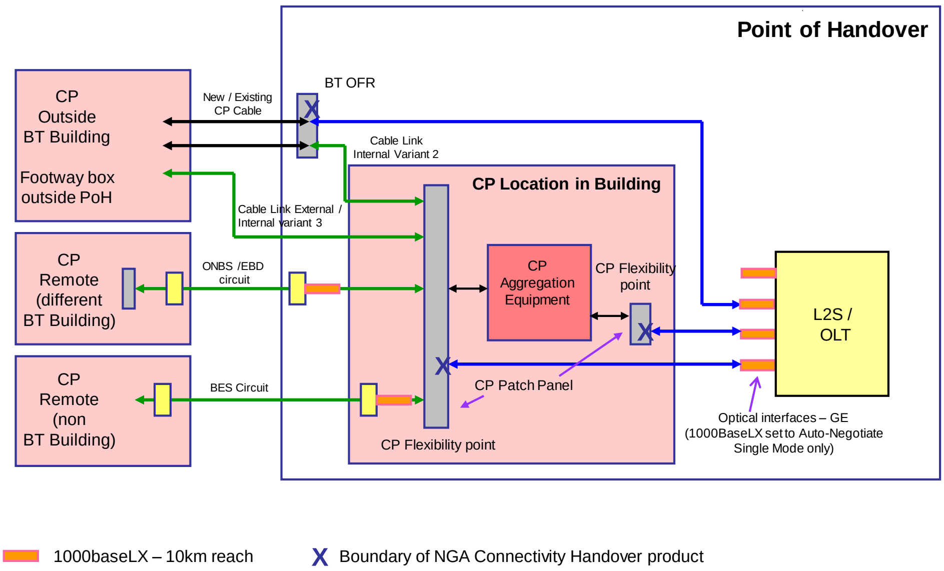

Figure 1 : GEA Head End Handover Connectivity

2. Interface Descriptions

2.1 GEA Cablelink

2.1.1 Physical connection

The identified interface option and location for the GEA Cablelink will need to be specified by the CP, either:

- CP owned and provided Interface Panel, or
- CP owned and provided equipment interface (Ethernet port).

The interface is the connector on the end of the Openreach fibre tail.

The following physical optical interface connector types only are supported for connection to the CP provided identified interface:

- FC/PC
- LC
- SC

Note - Angled connectors are NOT supported.

The physical interface must be specified on the order request. Any conversion of interfaces is the CP's responsibility, i.e. the CP must provide interface converters on its card or at the interface panel, if necessary. Openreach engineers must be provided with access to the identified interface point (whether that is an interface panel or the CP's actual interface card itself) for both fulfilment and assurance purposes.

GE and 10GE Single-Mode interfaces are described in SIN 360 [1].

More information about the GEA Cablelink product can be found in the GEA Cablelink Product Description on the Openreach Portal
(see http://www.openreach.co.uk).

2.1.2 Ethernet Frame Size

The maximum supported Ethernet frame size is 1530 bytes (excluding IFG and pre-amble and single/double tag – see 2.1.3).

2.1.3 VLAN Tagging Options at the GEA Cablelink for GEA-FTTC

2.1.3.1 Openreach added tags

On the GEA Cablelink, all traffic will be presented using single tagging or double tagging on a per VLAN basis. Both options can be used on the same GEA Cablelink on a per GEA order basis. The tagging option to use for a specific GEA order is explicitly selected by the CP when ordering.

The VLAN used for End User traffic is referred to as a Customer VLAN or "C-VLAN".

A CP may optionally choose to use an additional level of VLAN tagging so that C-VLANs can be grouped within another VLAN, referred to as a Service VLAN or "S-VLAN".

- Single Tagged Handover
    - The Outer VLAN is the C-VLAN.
    - The Outer VLAN will carry the EU traffic and will have a tag in the range 2 to 3000 or 3071 to 4094*. Openreach will allocate the lowest available unused tag.
- Double Tagged Handover
    - The Outer VLAN is the S-VLAN, and the Inner VLAN is the C-VLAN.
    - Outer VLAN tag(s) must be requested via a Modify order against a GEA Cablelink (GEA Cablelink provision must be complete) before they can be used in a GEA order.
        - The Outer VLAN will have a tag in the range 2 to 3000 or 3071 to 4094.
            - The CP can specify the tag to be added; or
            - Openreach will allocate the lowest available unused tag if the CP does not specify the tag.
    - Where double tagging is required the CP must include the Outer VLAN tag value in the GEA order.
    - The Inner VLAN will carry the EU traffic and will have a tag in the range 2 to 4094. Openreach will allocate the lowest available unused tag.

2.1.3.2 <u>CP added tags</u>

The following is true for Openreach provided Modems; Modems provided by CPs could differ depending on the CP's required implementation.

- CPs can optionally add tags in the downstream direction (commonly referred to as X-tags) and these will be transported transparently through to the UNI of the Openreach modem.
- EU CPE such as set top boxes (STB) and PCs may add X-tags in the upstream direction and these will be transported transparently through to the CP. An exception to this is tag 0 which will be removed by Openreach (see section 2.2.3 - Upstream priority marking - for more detail).

2.1.4 Ethertype

The Outermost VLAN Ethertype is configurable to 0x81-00 (default) or 0x88-A8 (as per IEEE802.1ad[17]. This applies to the GEA Cablelink as a whole and irrespective of single or double tagging of the GEA services carried.

* *Please note - values between 3001 and 3070 are reserved for GEA Multicast.*

2.1.5 Downstream Priority Marking

CPs can use the C-VLAN Priority Code Point (PCP) field[18] on downstream GEA-FTTC traffic. PCP values 0, 1, 2, 3, and 4 are supported. PCP values 5, 6 and 7 are not supported and will be re-marked to 4.

GEA-FTTC will make use of these markings in two ways:

- Scheduling traffic from the DSLAM to the VDSL2 modem; and
- In the event of congestion within the Openreach network, the markings will be used to identify which frames can be dropped first for a particular End User.

PCP traffic marking is optional.

Frames with higher markings are delivered first using strict priority. Note that downstream GEA Multicast, which has a PCP value of 3, converges with GEA Data at the DSLAM VDSL2 port. It is therefore possible to prioritise selected GEA Data traffic above Multicast (but only at the DSLAM port) by sending GEA Data with a PCP value of 4. CPs should be aware this could impact the Multicast service for the end user receiving high rates of priority 4 GEA data traffic.

2.1.5.1 Per EU / Intra EU frame drop prioritisation

The C-VLAN PCP markings are used to identify the order in which traffic can be dropped.

- PCP = ‘4,3,2,1’ = “Should Not Drop”
  (no drop priority differentiation between these 4 markings until the egress DSLAM VDSL port)
- PCP = ‘0’ = “Can Drop”

Where Double Tagging is used, the markings must be applied to the Inner C-VLAN.

The PCP field allows the CP to influence which frames are dropped first under congestion, thus allowing loss sensitive applications to have greater protection and at the same time allow best-efforts applications to benefit from full network capacity when it is available, but at the risk of frame loss. Openreach will remark the PCP field to ensure each EU has fair access to the available network capacity as follows:

- When an end-user’s “Should not drop” marked traffic is supplied below the prioritised rate, then some of that end-users “Can drop” frames will be arbitrarily promoted to “Should not drop” so that, if possible, the “Should not drop” traffic rate equals the prioritised rate.
- Where an end-user’s traffic is marked “Should not drop” and exceeds the prioritised rate, then some of that end-users frames will be arbitrarily demoted to “Can drop” so that the rate of “Should not drop” traffic equals the prioritised rate.

Therefore for optimal performance the CP should ensure loss-sensitive traffic is marked “Should not drop” and kept within the prioritised rate of the end-user’s service. Where the VDSL2 line rate is below the service prioritised rate the CP should also note the following on downstream shaping.

2.1.6 Downstream shaping

The CP is expected to shape the downstream traffic to match the actual VDSL2 line rate in order to avoid excessive traffic loss.

CPs should be aware that the mechanism for reporting the downstream and upstream line rates relies on a line re-train causing the CP, or the CPE, to initiate a new PPP session or a new DHCP request. The success of this method of line rate reporting is down to the CP's choice of timers used around PPP/DHCP handling.

If the PPP/DHCP survives a re-train, then the CP will be unaware of any change in the line rate and will not be able to shape appropriately.

The line re-train time for VDSL2 can be anywhere between 10 and 90 seconds, with typical values in the 20-30 second range.

As DHCP typically uses lease timeouts in the order of days rather than seconds, CPs intending to use DHCP are advised to consider the impact of downstream line rate changes on their service and any strategies they could adopt if they wish to shape downstream traffic in close relationship to the active line rate.

2.1.7 Intermediate Agent / DHCP Relay Agent

Where PPPoE is detected, additional tags will be inserted into the upstream flow (PADI) by the Intermediate Agent (IA) in the DSLAM. Any existing tags of the same type from the CPE will be overwritten. The IA tags will be removed by the DSLAM in the downstream direction (i.e. from the PADO, PADS messages).

Where DHCP is detected, the DSLAM will insert Option 82 Agent information field into the upstream flow (DHCP Discover). The Option 82 field will be removed by the DSLAM in the downstream response (DHCP Offer).

In order to ensure line rate information reported is accurate, PADI DHCP Discover packets will be dropped for an extended period following VDSL2 line re-train. This blocking period may last up to 25 seconds. This mechanism avoids blank line rate information being reported by the IA.

The following information will be supplied.

Note - any information in these fields from the end user will be over-written.

- ***Agent Remote ID*** – 63 character field – value is either
  - Value supplied by CP during provide / modify
    - From character set – a~z A~Z 0~9 @ . _ - ( ) / + : (Note space character is NOT supported)
    - Invalid characters in the order will cause order rejection

  or

  - DeviceName/S-VLAN ID/Frame No_Slot No_Port No/uservlan/C-VLAN ID if the CP does not set a value to be used
    - Changes if the port is changed for any reason – cannot be guaranteed to be constant
    - Any value supplied directly from any modem will be over-written
- ***Agent Circuit ID***
  - access-Node-Identifier eth frame/slot/port:c-vlan-id
    - The “frame/slot/port” value will change if the port used is changed after a port or card failure
- ***Access Loop characteristics***
  - 0x81 – Upstream line rate
  - 0x82 – Downstream line rate
- ***Access Loop Encapsulation***
  - 0x90 – gives data link type, tagging, protocol info as per R-132 in TR-101 = “eth” for GEA over VDSL2, “atm” for GEA over ADSL2plus

All of the above are formatted in accordance with Broadband Forum TR-101[13]

2.1.7.1 Inverted DHCP/PPPoE

The scenarios shown in the diagram below, where a DHCP Server or BRAS is located at an End Users premises served by FTTC or FTTP are not currently supported by the GEA Data service. This may result in dropped session initiation frames and will result in the scenarios below not being able to successfully operate.

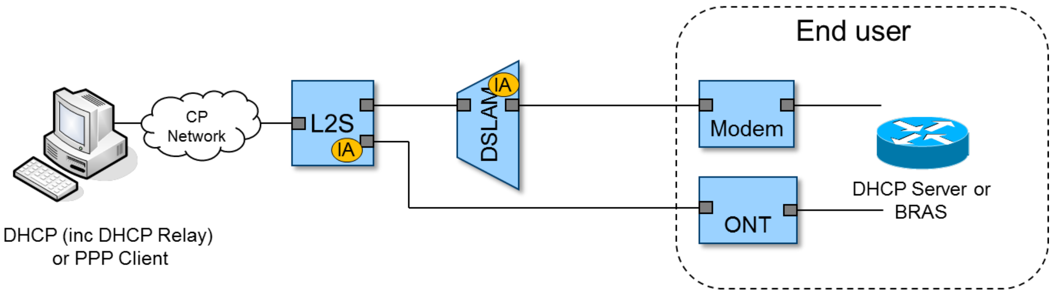

Figure 2 : Inverted DHCP/PPPoE

2.1.8 Ethernet OAM

Openreach provides CPs with the ability to test their GEA-FTTC circuits end-to-end between the CP's equipment and the Openreach provided VDSL2 modem. To do this CPs need to use Multicast Loopback Messages (MC LBMs) as described in Y.1731[14] at Maintenance Domain (MD) Level 2 with a destination MAC address of 01-80-C2-00-00-32. For compatibility reasons, CPs providing their own modem CPE are also required to implement this functionality in their modem devices.

In addition, CPs can send Ethernet OAM information end-to-end across their GEA-FTTC connection at MD Levels 3 and above.

An interworking overview of OAM is shown in Figure 3 and Figure 4 below.

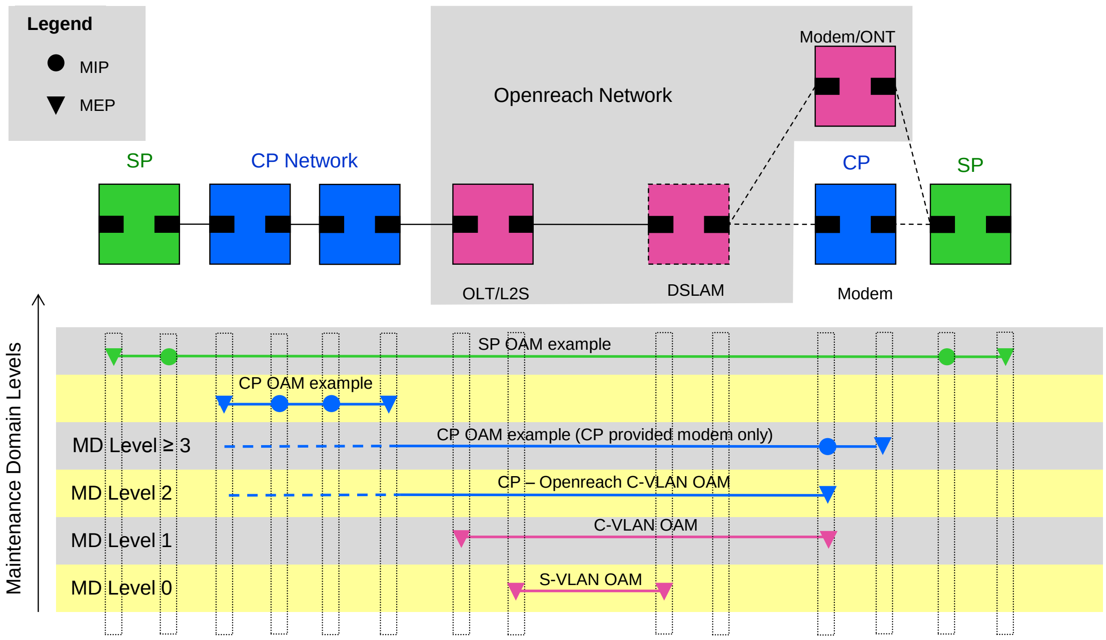

Figure 3 : OAM Interworking – Maintenance Domain Levels

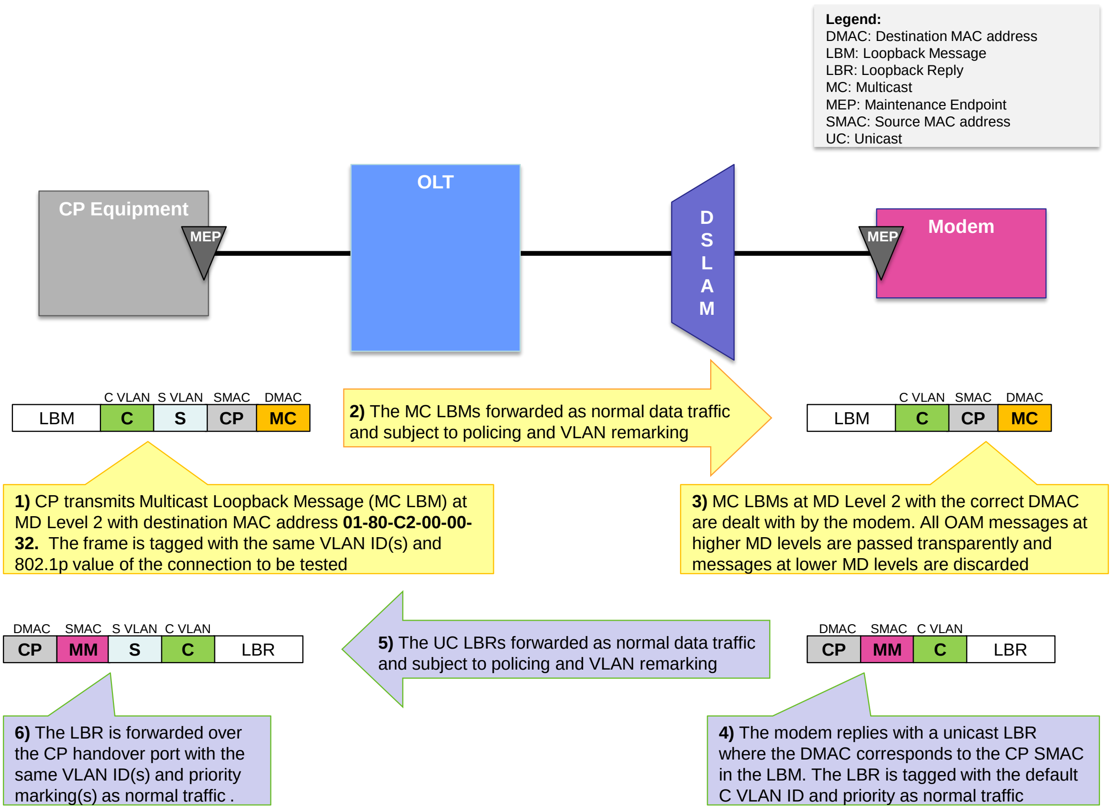

Figure 4 : OAM Interworking - Operation

2.1.9 Transparency

GEA-FTTC will not be transparent to:

- 802.3x PAUSE - Local link flow control protocol
- Slow Protocols - Set of protocols that includes LACP and 802.3ah OAM
- 802.1X Authentication - Authentication protocol
- Physical layer signalling such as auto-negotiation

2.1.10 Frame Duplication

CP equipment must observe Ethernet bridging rules. In particular frames sent from Openreach to the CP must not be reflected back to the Openreach network with source MAC unaltered. This applies both downstream at the Cablelink port and upstream at the modem or DSL port.

2.1.11 Multicast IP Group Addresses

Since the multicast MAC address is derived from the IP group address, CPs shall ensure that IP group addresses are unique in the lower 23 bits.

2.2 User Network Interface - General

2.2.1 Dynamic Line Management

Dynamic Line Management (DLM) is employed in GEA-FTTC. DLM constantly manages lines to maintain a target link quality (speed and stability). It does this for as long as the product exists.

At provision, the line is put on “wide open” VDSL2 line profiles allowing the upstream and downstream line speeds to run at the upper limit of the product option selected.

On the first day of operation, DLM will intervene if severe instability is detected. Otherwise, DLM will wait until the day after provision before deciding if it must intervene, provided that the line has been trained up for at least 15 minutes during the preceding day.

If DLM intervenes it will set a profile with a maximum rate and a minimum rate, where the minimum rate is set at approximately half of the maximum rate. The purpose of the minimum rate is to ensure that the line does not train at a rate which is significantly below the level the line should be able to achieve. If this happened, then the line is likely to remain at a very low rate until a re-train is forced by the user by powering off the modem.

Note : It is the DLM system that sets the line profile, and this should not be interfered with by CPs/users setting rates, SNR margins etc. at the modem.

Note : The upstream throughput is also constrained on the DSLAM to the upstream rate requested in the order, i.e. 2 Mbit/s, 10 Mbit/s or 20 Mbit/s, so even if the VDSL2 upstream line speed is higher, the upstream throughput is constrained to the level ordered for the product.

2.2.2 Upstream shaping

To avoid excessive traffic loss the CP is expected to shape the upstream traffic to match at least the lower of:

- Actual VDSL2 line rate ; or
- The upstream rate (2 Mbit/s, 10 Mbit/s or 20 Mbit/s) that has been purchased.

See also Section 2.1.6 Downstream Shaping.

In addition, CPs should consider the impact of upstream capacity on their GEA Cablelink.

- Openreach will shape traffic into the GEA Cablelink. This shaping will treat all GEA-FTTC Data traffic equally. Specifically, it will not make use of any markings applied by the CPE.
- Openreach will explicitly not manage traffic at an individual inner tag or outer tag level.

2.2.3 Upstream priority marking

CPs can (optionally) select the priority for each Ethernet frame via a VLAN PCP field sent into the Openreach modem from CPE.

- PCP = 2 or 3 (4-7 will be treated as 3) → High priority
- PCP = 0 or 1 or unmarked (no VLAN) → Low priority

High priority frames will be sent by the Openreach modem toward the CP ahead of the low priority frames. This prioritisation will be weighted i.e. the low priority traffic will not be completely suppressed even if high priority traffic exceeds the line rate.

Handling of the VLAN tag varies:

- Tag = 0 → VLAN tag is stripped out by the Openreach modem (PCP field is still used for prioritisation)
- Tag ≠ 0 → VLAN tag will be forwarded to the CP
  (where this tag is forwarded, the CP must be able to handle this additional tag)

Whether or not upstream QoS markings are used, the maximum upstream throughput may vary when compared with VDSL2 line rate. The actual variation in comparison with the VDSL2 line rate is up to 90% and 98% of line rate for 64 byte and 1500 byte packets respectively, and may be greater, depending on application.

2.2.4 Modem UNI Port Loopback Testing

Test and diagnostic action may require an Ethernet port loopback to be applied to the modem VDSL2 port in order to loop downstream traffic back upstream to the Openreach test head or CP test head. These tests will interrupt upstream traffic from the EU and should therefore only be enabled with the EU’s consent. The EU must also agree to stop any downstream Multicast Service traffic and power off their Set Top Box if they have one, as any GEA Multicast VLAN traffic may interfere with testing on the GEA Data VLAN.

In addition, once the port loopback has been enabled, unicast test traffic initiated by the user can be used to test connectivity and maximum upstream throughput.

2.3 Openreach Provided Modem Product Variant

2.3.1 Use of NTEs

Openreach engineers will install a ‘Service Specific Front Plate’ (SSFP) to the Openreach line box (i.e. NTE5) and Openreach VDSL2 modem in the premises as shown in Figure 5.

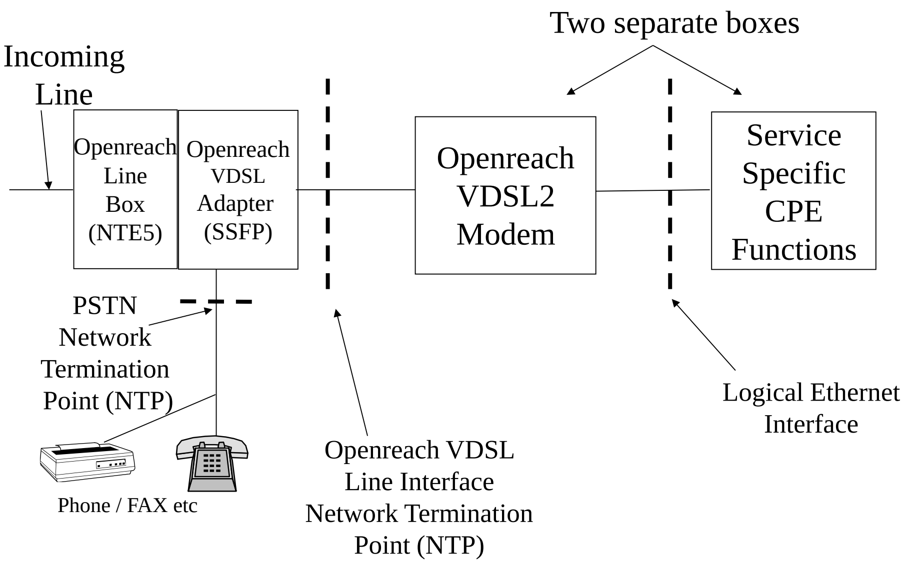

Figure 5 : Openreach Installed Centralised Filter Topology

The purpose of the SSFP is to isolate the high frequency VDSL2 signals from existing legacy products/wiring within the home to prevent service degradation on those products.

The SSFP will fit to an NTE5 only. If any other type of NTE is present at the end user premises, the Openreach engineer will change this as part of the service provision visit.

The requirements for this SSFP are defined in Section 3.2.6.1.

2.3.2 Openreach VDSL2 Modem

Figure 6 : VDSL2 modem Type 1

Figure 7 : VDSL2 modem Type 2

The current Openreach VDSL2 modem offers two UNIs in the form of Ethernet ports; Port LAN1 is used for fast data presentation (supporting CP provided broadband) and Port LAN2 is spare in anticipation of future product developments.

The active Ethernet EU port (i.e. Port LAN1) on the VDSL2 modem will be set to:

- 10/100Base-Tx Auto-negotiation (with RJ-45 connectivity),
- MDI/MDIX auto-sensing,
- Data transfer at wire-speed for all packet sizes,
- Built-in layer-2 switch.

The technical specification of the interface connections provided by the NTE device is described in SIN 360[1].

2.3.2.1 Size & Weight

VDSL Modem Type 1 (Figure 6)

162mm x 120mm x 29mm (Length x Width x Height)

Weight approx. 300g

VDSL Modem Type 2 (Figure 7)

177mm x 134mm x 35.6mm (Length x Width x Height)

Weight approx. 400g

2.3.2.2 Power Supply

The power supply unit (PSU) to the Openreach VDSL2 modem is a single, low voltage power interface. The PSU is suitable for use with the standard domestic UK supplied 240V 50Hz (AC) and conforms to the relevant standards. The power consumption is:

- VDSL modem Type 1 <6.5W
- VDSL modem Type 2 <8.6W

2.3.2.3 Electrical Safety

The Openreach VDSL2 modem is compliant with the following:

- BS EN 60950-1[10]

2.3.2.4 Location of VDSL2 Modem

The VDSL2 modem will be normally be wall mounted within the End User's premise, although it is safe to operate freestanding in either the horizontal or vertical plane. The modem should not be stacked under/over other items that would impede air flow or prevent the unit dissipating heat.

2.4 CP Provided Modem Product Variant

Openreach intend to introduce a GEA-FTTC product variant that allows the CP to provide and be responsible for the user's VDSL2 modem. Typically, this modem will be integrated with IP gateway functionality within a single device and connected to a single mains power source. CPs or their EUs will be responsible for maintaining the firmware of their modems and monitoring their connectivity and performance, typically via a TR-069[19] interface using CPE WAN Management Protocol (CWMP).

The CP provided modem and filtering devices must meet the requirements of this specification in order to provide reliable operation and to avoid harm to other VDSL2 lines sharing the same cable binder. Openreach reserves the right to withhold or limit service where potential violation of the Access Network Frequency Plan (ANFP)[9] or impact to another customers' service is detected.

The detailed technical requirements for CP provided modems are defined in Section 3 of this document and the related test descriptions required to demonstrate compliance to these requirements are defined in Annex A.

The terms and conditions associated with the communication and deployment of those network changes can be found within the GEA Contracts which are available from http://www.openreach.co.uk/orpg/home/products/super-fastfibreaccess/contracts/sffacontracts.do

CPE connected to BT's network will be expected to be upgraded to remain compliant with the evolving BT network, as reflected in changes to this SIN.

2.4.1 Physical Network Termination

Openreach provide a metallic line with a Line-box, also known as a Network Terminating Equipment, (NTE). The physical interface is the standard telephone socket on the line box as described in SIN 351[2].

The CP must provide a VDSL2 filter that plugs into the Metallic Line NTE and a modem device which plugs into the filter. This filter is required to separate PSTN and VDSL2 signals carried on the same line. Two possible connection topologies exist for these filters:

- Using a CP supplied, single, self-installed CPE VDSL2 centralised filter deployed between the line box and all PSTN CPE (centralised filter topology – see Figure 9). The requirements for this centralised filter are defined in Section 3.2.6.1
- Using multiple CP supplied self-installed CPE VDSL2 in-line micro filters, one for each device plugged into the wired extensions off the line box (distributed filter topology – see Figure 8). The requirements for this distributed filter are defined in Section 3.2.6.2.

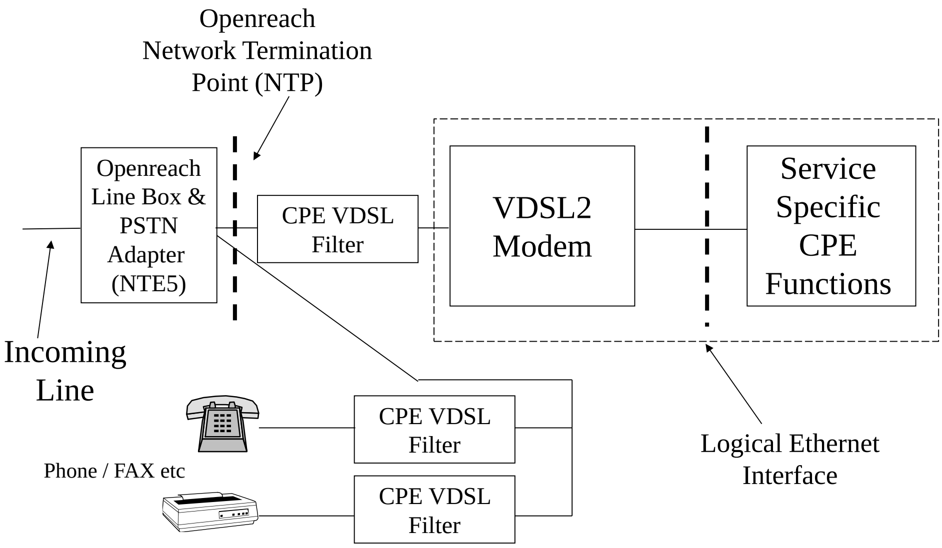

Figure 8: Distributed Filter Topology

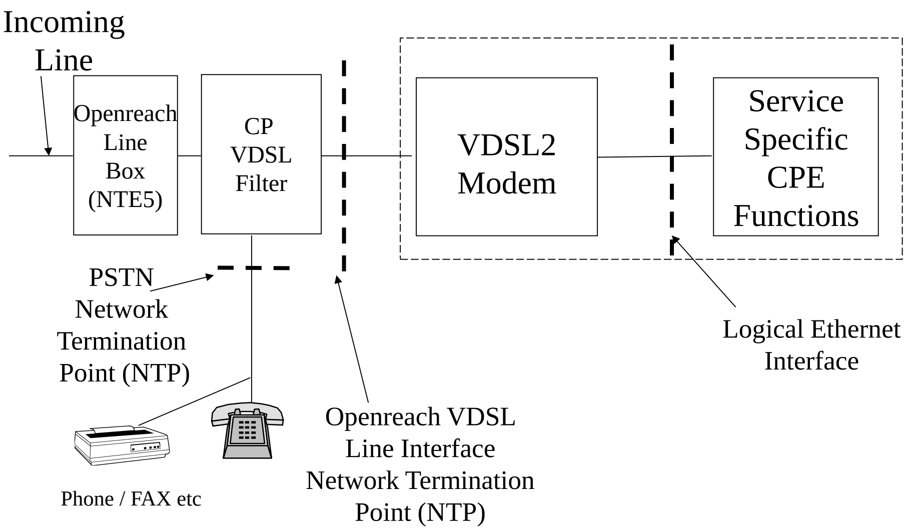

Figure 9 : Centralised Filter Topology

2.4.2 Filter Installation topology

In the cases outlined in Figure 8 and Figure 9, the filters are classed as Customer Premises Equipment (CPE) and could be deployed in two distinct topologies. Either multiple jack-connected CPE filters can be used as in the arrangement shown in Figure 8, or a single centralised in-line filter can be provided as in the arrangement shown in Figure 9. In all cases, there must be a filter function between the line-box and any item of PSTN CPE, including modems, fax machines, set-top boxes etc.

When CPE VDSL2 filters are used, the network termination point (NTP) for VDSL2 services to which this SIN relates, is located at the Line-box. However the physical VDSL2 modem may be connected into one of the VDSL2 CPE filters as shown in Figure 8, or into a centralised filter as shown in Figure 9.

Note that when a centralised CPE VDSL2 filter is in use as shown in Figure 9, the VDSL2 modem can ONLY be connected at the line-box, as the filter prevents the VDSL2 signal reaching the extension sockets.

2.4.3 Street Access Physical Realisation

Street Access is an Openreach product, offered on EOI basis, which delivers an Ethernet service from a BT local exchange to ruggedized terminating units housed in remote street furniture (lamp posts or street cabinets). It provides city-wide coverage that offers network infrastructure services for a variety of clientele and applications such as public safety services, public access WLAN hotspot providers (e.g. BT Openzone) and Managed Radio Communications Services (MRCS).

The Street Access product shall be provided to a suitable external enclosure (street cabinet, pillar, lamppost, wall box).

The enclosure shall be assumed to be a partially controlled electrical environment providing safe separation of power and the Openreach termination point (Openreach shall assume all operatives working in the enclosure will require appropriate power training & accreditation).

The Communications Provider shall mark the Openreach termination point on a fire retardant wooden backboard with a footprint of 90mm x 115mm with allowance of at least 45 mm for cable entry into the bottom edge of the termination. The termination box is 75mm deep with a hinged lid (from top edge) requiring 160mm clearance forward of the backboard.

Termination in the enclosure will be via a BT NTE1A as shown in Figure 10. The NTE1A is a passive waterproof box that comes provided with a standard BT voice module (IP56 rated box presenting a standard BT POTS socket BT601 within).

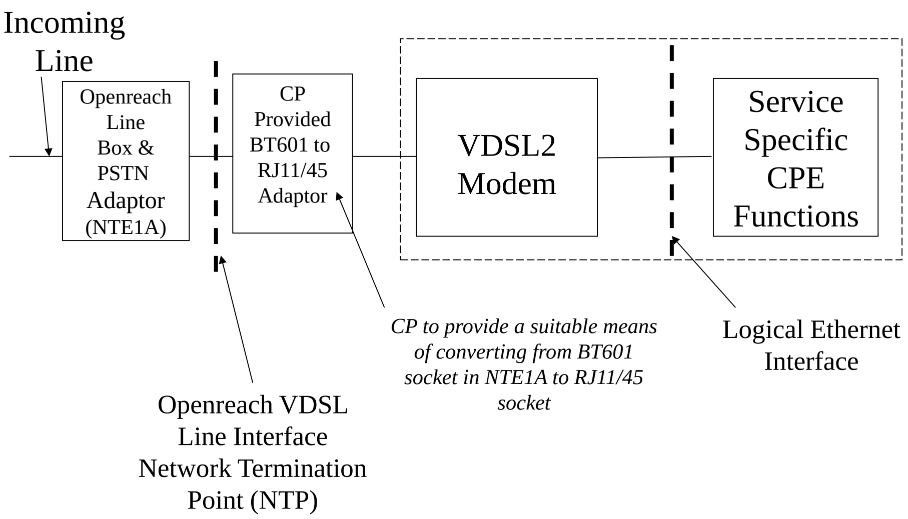

Figure 10 : Street Access Topology

A suitable conversion from the BT601 socket on the NTE1A to an RJ11 socket will need to be provided by the CP. No telephony apparatus (telephone, telemetry) shall be connected to the Street Access product and as such a low-pass filter shall not be connected to the NTE1A (i.e. use of micro-filter or service conditioning faceplate will not be allowable with the NTE1A).

Access to the enclosure via a hosted appointment for the underlying copper line installation shall be provided to Openreach to allow installation of the NTE1A. Security of the enclosure shall be assumed to be sufficient to prevent unauthorised access to the NTE1A.

3. CPE Requirements For GEA over VDSL2

This section defines the requirements of CP provided modems that must be met for connection to Openreach User Network Interface (UNI). These requirements include logical functions within the CPE necessary to support and maintain Openreach services delivered over GEA-FTTC.

The nomenclature used for each requirement is R.X.Y where:

R stands for Requirement,

X is the category (PHY, VDSL2, ETH, WAN, OAM) and

Y is the requirement number

In this section the term 'modem' refers to the CP provided modem and 'WAN interface' refers to the interface on the modem connecting to the Openreach FTTC network.

3.1 Scope

The protocol layers within this scope are depicted in Figure 11.

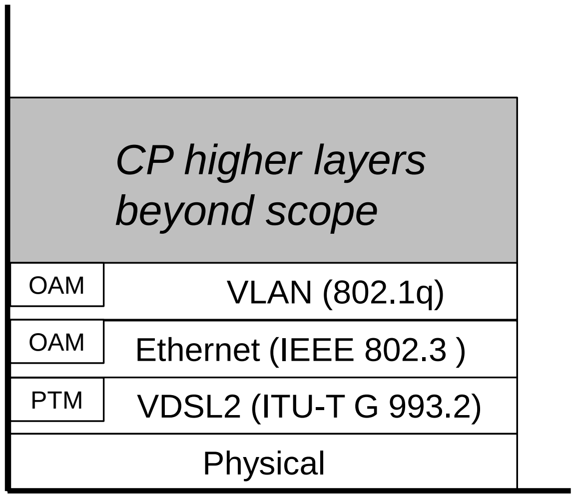

Figure 11 : Protocol Layers in Scope for GEA

3.2 Requirements

The CP provided modem shall support all the requirements as described in the following subsections. Additional guidance is also provided as a "Note" where relevant.

A full description of the tests required to demonstrate compliance with these requirements are detailed in Annex A of this document.

3.2.1 Physical Connection

R.PHY.1 The socket on the modem connecting to the Openreach UNI (i.e. WAN port) shall be either a RJ11 or RJ45 type to enable it to be connected to the VDSL2 filter using standard leads. The VDSL2 connection is presented on the middle two pins - i.e. pins 3&4 (RJ11) or pins 4&5 (RJ45). The other pins are not connected. Pin numbering is from the left, looking into the socket with the contacts uppermost. Polarity is unimportant.

Note: Openreach do not currently offer a bonded VDSL2 product (where two or more VDSL2 lines are connected to one modem device to increase bandwidth). This SIN will be updated if and when Openreach offer this feature.

3.2.2 VDSL2 Layer

R.VDSL2.1 The modem used shall fully comply with the VDSL2 mandatory requirements of G.993.2[3].

R.VDSL2.2 The modem shall support VDSL2 Profile 17a as defined in G.993.2[3].

R.VDSL2.3 Withdrawn.

R.VDSL2.4 The modem shall comply with the requirements of Part C of the BT Access Network Frequency Plan[9].

R.VDSL2.5 The modem shall support 17MHz operation using band plan B8-11 (i.e. plan 998ADE17) as defined in Annex B of G.993.2[3].

R.VDSL2.6 The modem shall support operating with cabinet based VDSL2. This involves supporting tone-sets A43 and A43C (as defined in G.994.1 Amendment 1[4]), plus downstream PSD shaping and upstream power back-off as defined in G.997.1[5] and G.993.2[3]. The use of additional tone-sets (B43, B43c, V43) is not permitted as these may cause adverse interference to other DSL systems operating in the same cable binder.

R.VDSL2.7 The modem shall support Upstream Power Back Off (UPBO) as defined in G.993.2[3].

R.VDSL2.8 The modem shall support the use of the upstream band (U0) between 25kHz and 138kHz.

R.VDSL2.9 The modem shall support seamless rate adaptation (SRA) as defined in Section 13.1 of G.993.2[3].

R.VDSL2.10 The modem shall support downstream PHY layer retransmission as defined in G.998.4[6]. When downstream retransmission is implemented, the “Retransmission used Downstream (RTX_USED_ds)” parameter shall be reported via the DSLAM in accordance with Clause 7.5.1.38 of G.997.1.

R.VDSL2.11 The modem should support upstream PHY layer retransmission as defined in G.998.4[6]. When upstream retransmission is implemented, the "Retransmission Used Upstream (RTX_USED_us)" parameter shall be reported via the DSLAM in accordance with Clause 7.5.1.38 of G.997.1[5].

R.VDSL2.12 The modem shall support 17MHz Vectoring as defined in G.993.5[7]. This requires the modem to be "vector ready".

R.VDSL2.13 The modem shall support the alternate electrical length estimation methodology (AELEM) for estimating the electrical length of the connection between the modem and the DSLAM (mode ELE-M1) as defined in G.993.2[3]. This is required to provide accurate estimation of the electrical length of the channel over which the modem is operating (i.e. the insertion loss of the cable measured at 1MHz) to help ensure accurate UPBO setting and compliance with Part C of the BT Access Network Frequency Plan[9].

R.VDSL2.14 Withdrawn.

R.VDSL2.15 The modem shall support bit swap as defined in G.993.2[3].

R.VDSL2.16 The modem shall support the correct reporting of Vendor ID, Version Number and Serial Number as described in section 11.2.3.6 of G.993.2 [3].

R.VDSL2.17 The modem shall support the correct reporting of key VDSL2 test and diagnostic parameters according to G.997.1[5]. These parameters are shown in Table 1.

Equipment Metric Name <Name> (<Section>/G.997.1)
xTU-R Vendor ID xTU-R G.994.1 Vendor ID 7.4.2/G.997.1
xTU-R system vendor ID 7.4.4/G.997.1
xTU-R version number 7.4.6/G.997.1
xTU-R serial number 7.4.8/G.997.1
FEC seconds-line far end† (downstream) FECS-LFE (7.2.1.2.1/G.997.1)
Errored second-line far end (downstream)

† *In this case, "far end" refers to the remote end of the transmission system with respect to the DSLAM i.e. the far-end is the customer premises modem end.*

ES-LFE (7.2.1.2.2/G.997.1)
Severely errored second-line far end (downstream) SES-LFE (7.2.1.2.3/G.997.1)
Upstream line attenuation LATNus 7.5.1.10/G.997.1
Downstream line attenuation LATNds 7.5.1.9/G.997.1
Upstream signal-to-noise (SNR) ratio margin SNRMus 7.5.1.16/G.997.1
Downstream signal-to-noise ratio margin SNRMds 7.5.1.13/G.997.1
Upstream data rate
Downstream data rate
Upstream maximum attainable data rate ATTNDRus 7.5.1.20/G.997.1
Downstream maximum attainable data rate ATTNDRds 7.5.1.19/G.997.1
Upstream traffic count
Downstream traffic count
Upstream Actual Aggregate Transmit Power ACTATPus 7.5.1.25/G.997.1
INMINPEQ downstream 7.2.1.5.1/G.997.1-200711-Amd2
INMIIAT Downstream 7.2.1.5.3/G.997.1-200711-Amd2
INMME downstream 7.2.1.5.3/G.997.1-200711-Amd2
Actual INP Upstream ACTINP 7.5.2.4/G.997.1
Actual INP Downstream ACTINP 7.5.2.4/G.997.1
Downstream H(f) logarithmic subcarrier group size HLOGGds 7.5.1.26.5/G.997.1
Downstream H(f) logarithmic representation HLOGpsds 7.5.1.26.6/G.997.1
Downstream QLN(f) subcarrier group size QLNGds 7.5.1.27.2/G.997.1
Downstream QLN(f)

QLNpsds 7.5.1.27.3/G.997.1
Downstream SNR(f) subcarrier group size SNRGds 7.5.1.28.2/G.997.1
Downstream SNR(f) SNRpsds 7.5.1.28.3/G.997.1
Downstream bits allocation BITSpsds 7.5.1.29.1/G.997.1
Forward error correction – Channel far-end FEC-CFE 7.2.2.2.2/G.997.1

Table 1 : Key Test and Diagnostic Parameters (taken from G.997.1[5])

R.VDSL2.18 The CPE modem shall fully support concurrent operation of vectoring and downstream retransmissionas as described in G.993.5 [7] and G.998.4 [6].

R.VDSL2.19 The CPE modem shall support target downstream noise margin settings of 3, 4, 5 or 6dB.

Note: Openreach currently enables downstream PHY Layer retransmission as defined in ITU-T recommendation G.998.4[6]. Openreach does not currently enable upstream PHY Layer retransmission as defined in G.998.4 but expects to do so in due course. It is therefore strongly recommended that the CPE modem should support both downstream and upstream PHY layer retransmission to minimise errors and retrains.

Note: Openreach do not currently support Virtual Noise (VN) requirements as defined in G.993.2[3]. This SIN will be updated if at a later date Openreach decide to offer this feature.

Note: Openreach does not currently offer a timing reference source solution over VDSL2. CPs seeking to implement a timing reference source for future functionality should consider NTR as per G 993.2[3].

Note: Where the modem is an integrated device with PPP and/or DHCP functionality, it is recommended that change in state of the VDSL2 physical layer also triggers change of state of PPP/DHCP state. For example, on transition to “showtime” this should re-initialise the PPP session and/or force DHCP to renew. This will ensure the BRAS is informed of the new VDSL2 net data rate via the Intermediate Agent (see BBF TR-101[14]).

Note: CPs should undertake to remotely manage the upgrade and roll-back of their modem firmware to enable mitigation of future network changes on their live modem population. This SIN will be updated if at a later date Openreach decide to make this a mandatory requirement.

3.2.3 Ethernet Layer

R.ETH.1 The modem shall support an Ethernet frame size of between 68 and 1534 bytes. For clarity, this figure includes 4 bytes for the C-VLAN, and excludes bits allocated to pre-amble, Inter-Frame Gap, and Frame

Check Sequence at the user network interface (UNI). Support for frame sizes above 1534 bytes (inclusive of C-VLAN) is not guaranteed.

3.2.4 WAN VLAN Layer

R.WAN.1 The modem shall support IEEE 802.1q VLAN encapsulation.

R.WAN.2 All ingress frames to the Openreach UNI shall be encapsulated within an IEEE 802.1q VLAN (C-VLAN) which will be used for routing within Openreach.

R.WAN.3 Where the CP intends to use Multicast for GEA, the modem shall be capable of simultaneously supporting Multicast and Unicast over the same single-tagged VLAN.

R.WAN.4 The Ethertype (Tag Protocol Identifier) field of the Ethernet frame shall be set to 0x8100 on ingress to Openreach UNI. On egress, Openreach will also set this field to 0x8100.

R.WAN.5 The CVLAN Canonical Format Indicator shall be zero on ingress to Openreach UNI. Openreach will set this to 0 towards the modem.

R.WAN.6 Where the CP intends to use GEA data and Multicast for GEA services the VLAN ID shall be set to 101 (ingress and egress). Traffic without a correct VLAN ID will be dropped.

R.WAN.7 Where the CP intends to use Multicast, IGMP reports destined for Openreach Multicast for GEA shall be encoded as IGMPv3 or IGMPv2 over C-VLAN ID 101. Source Specific Multicast option within IGMPv3 must not be used.

R.WAN.8 Withdrawn.

R.WAN.9 Where the CP is using PPP and intends to use Multicast for GEA, the modem shall be able to detect and process multicast frames differently to unicast. Multicast for GEA frames sent into Openreach (IGMP reports) shall not be encapsulated with PPP otherwise they will passed transparently as normal GEA traffic.

Note: In addition to the Openreach requirements set herein, the modem should also support NICC Ethernet ALA Service Definition[12].

Note: Scheduling priority to the upstream VDSL2 line speed is a function within the modem. If different traffic QoS levels are to be supported, careful consideration should be given to the potential for starvation of low priority queues within the modem and the impact this might have on the user experience and fault rates.

Note: It is recommended that IGMP membership reports are given a high queue scheduling priority.

Note: Where the modem is configured with an IGMP proxy function, it may be useful to know that the Openreach Multicast for GEA will accept IGMP packets with a source address of 0.0.0.0.

Note: Modem providers are urged to pay close attention to the challenges of IPv6 support. Openreach currently provide DHCP Option 82 insertion support for IPv4. To ensure the equivalent is supported in future IPv6 networks, namely Lightweight DHCPv6 Relay Agent, modem vendors should implement DHCPv6 in accordance to BBF TR-177[22] and referenced IETF standards within that document. Close attention to on-going developments of these documents is also recommended.

Note: Openreach expect CPs to only configure their devices for and send traffic for GEA Data on VLAN101. No other VLANs should be used and if they are then this may impact service. In addition Openreach may use other VLAN tags on the DSLAM access port for internal use, traffic from any other VLANs apart from VLAN101 should be ignored/dropped

3.2.5 Ethernet OAM

R.OAM.1 Withdrawn.

R.OAM.2 (a) The modem WAN interface shall support Loopback Messages (LBM) as described in ITU-T Y.1731[14].
(b) The modem shall respond to LBM over VLAN ID 101 with a Loopback Reply Message (LBR), at MD Level 1 and should respond with a LBR at MD Level 2. The LBM destination MAC address could be either multicast or unicast, both shall be supported. Multicast destination addresses for the LBMs are as follows:

1. MD Level 1: 01-80-C2-00-00-31
2. MD Level 2: 01-80-C2-00-00-32

(c) An inner customer X-tag, if present in the LBM (in addition to the Openreach tag), should be returned in the LBR message.

Note: Loopback messages at MD Level 2 and above are allocated for CP use. The requirement R.OAM.2 for MD Level 2 LB is to maintain functional compatibility with Openreach provided Modems and existing CP and Openreach diagnostic support systems. See Section 2.1.8 for further information on OAM implementation.

Default settings are as follows:

- MD level: Level 1 for Openreach and Level 2 for CP, other layers transparent
- VID of MA: VLAN ID = 101 (Modem however needs to take in to account any X-tag the CP may send in addition to this)
- MEP ID list of MA: MEP ID is not required for OAM loopback
- Direction of MEP on the WAN port should be down: The MEP should respond to LoopBack messages from the DSLAM direction, and responses should be sent back towards the DSLAM

- MEP ID of MEP on the WAN port: MEP ID is not required for OAM LoopBack
- MD Name format: MD Name & format is not required for OAM LoopBack
- MD Name: MD Name is not required for OAM LoopBack
- MA Name format: MA Name & format is not required for OAM LoopBack
- MA Name: MA Name is not required for OAM LoopBack
- CC interval: Only supporting OAM LoopBack at present, therefore CC interval not required

R.OAM.3 The modem WAN interface shall support 802.3ah (802.3[11] clause 57 OAM) and shall support the feature “OAM remote loopback” configured to passive mode. The modem shall participate in the discovery process initiated by the Openreach DSLAM, responding to OAMPDUs from the Openreach DSLAM (which will be in Active mode). This also includes reporting successful or failed setting or removal of loopback and reporting loopback state to the DSLAM upon request. The modem shall not be able to request the DSLAM to apply loopback as it is in passive mode.

The 802.3ah OAM Loop Back is intended to provide a physical loop back at the modem for all frames arriving from the Openreach DSLAM so that if required (during T2R) Openreach can, using an Openreach Test Head, prove the location of throughput and performance faults on or off the Openreach network

CPs shall have a roadmap for R.OAM.3 that has been agreed with Openreach product line

R.OAM.4 The modem should support “dying gasp” as defined in Section 11.3.3.2 of G.993.2[3] and Section 7.1.1.2.3 of G.997.1[5].

Note: “Dying gasp” is not a mandatory requirement but CP’s are encouraged to implement this in their modems as it will enable the Openreach Test & Diagnostic systems to differentiate between a modem being turned off by the end user (loss of power) or a loss of signal (loss of connectivity) caused by a potential network or home wiring issue. This will support CPs in their diagnostic approach to ensure that their End Users have checked the relevant setup prior to submitting a fault to Openreach, thus avoiding a potentially chargeable engineering visit.

3.2.6 CPE VDSL2 Filter Requirements

In order to ensure correct operation with the BT VDSL2 and PSTN networks, CPE VDSL2 filter devices intended for connection to BT GEA-FTTC lines shall meet one of two alternative sets of recommendations:

R.FILTER.1 Centralised splitters shall comply with the requirements of ETSI Specification TS 101 952-1[15] as set out in Section 3.2.6.1.

R.FILTER.2 Distributed splitters shall comply with the requirements of ETSI Specification TS 101 952-3[16] as set out in Section 3.2.6.2

3.2.6.1 Centralised CPE VDSL2 filter device requirements

In this case the filter shall be compliant with TS 101 952-1[15] with the following options selected:

i) Option B category of Section 6 of TS 101 952-1.

ii) The option to support metering pulses as described in section 6.7 of TS 101 952-1 does ***not*** need to be implemented.

iii) The option to provide common mode rejection as described in section 6.14 of TS 101 952-1 does not need to be implemented, although it is known that this option can help to improve DSL service reliability.

iv) The applicable tables in Normative Annex A of TS 101 952-1 for VDSL2 filters are

- Table A.2 (Dedicated requirements for splitters for xDSL system variants),
- Table A.3 (Differentiation of IL in the xDSL band between LE and TE side),
- Table A.6 (Dedicated frequency ranges for splitters for VDSL2 system variants) and
- Table A.9 (Dedicated requirements for passive splitters for VDSL2 over POTS variants at the TE side).

3.2.6.2 Distributed CPE VDSL2 filter device requirements

In this case the filter shall be compliant with TS 101 952-3[16] with the following options selected:

i) Option B category of section 6 of TS 101 952-3.

ii) The option to support metering pulses as described in section 6.7 of TS 101 952-3 does not need to be implemented.

iii) The applicable tables in Normative Annex A of TS 101 952-3 for VDSL2 filters are

- Table A.2 (Dedicated requirements for distributed filters for xDSL system variants),
- Table A.3 (Overview of all POTS band requirements for all types of filters and N values),
- Table A.4 (Overview of Insertion Loss in the xDSL band for all types of filters
- Table A.7 (Dedicated frequency ranges for distributed filters for VDSL2 system variants).

Where appropriate, the requirements for either the “Standard” filter class (see Section 6.1.1 of TS 101 952-3) with N=3 or the “Enhanced” filter class with N=4 shall be selected from the appropriate column in the tables (N is the minimal number of parallel filters in the test setup - see Section 6.4.1 of TS 101 952-3).

iv) If the CPE VDSL2 filter is to be used in a multiple filter topology then the filter shall pass the recommendations of TS 101 952-3 with up to two other CPE VDSL2 filters (Standard) or three CPE VDSL2 filters (Enhanced) connected in parallel with the CPE VDSL2 filter under test. Each filter shall have their Telephony Port open circuit.

3.2.6.3 Additional notes about CPE filters

The standard BT PSTN CPE interface is a 3 wire circuit (A-line, B-line and bell wire) whereby the bell wire is AC-coupled from the B-line. This bell wire must either be filtered by the filter or left open circuit at the Line Port and recreated at the Telephony Port of the filter. This may be achieved using a 1.8 μF capacitor between the B line (pin 5) and the bell wire (pin 4) at the Telephony Port.

It should be noted that during normal operation of BT PSTN services switching may occur between line states such as line feed, reversed line feed, ringing and dialling (loop disconnect or tone). These changes of state may be associated with large transient voltage excursions. The performance of data circuits operating from the VDSL2 Port under these conditions is a function of the data modem internal performance. This and other factors may be a cause for specifications outside the scope of this document.

The A-line and B-line may be disconnected, shorted together, taken to earth or connected to standard network conditions (Voltages up to -95 V, PSTN conditions, ringing etc) at any point in the system. No maintenance intervention should be required after such an event to restore normal modem operation.

3.2.7 Supplementary Information

CPs considering the requirements of their network connectivity devices for the medium to long term future, may wish to consider the applicable General Conditions of Entitlement (see Note 1) for PATS and other services, in addition to other guidance documents such as Ofcom’s “Guidelines on the use of battery back-up to protect lifeline services delivered using fibre optic technology” (see Note 2) when specifying their wider modem/router requirements. Should applicable regulation or guidance change, a revised version of this SIN may result.

Note 1: http://stakeholders.ofcom.org.uk/telecoms/ga-scheme/general-conditions/

Note 2: http://stakeholders.ofcom.org.uk/consultations/superfast-broadband/summary

4. CPE Requirements For FTTC GEA over ADSL2plus (OPTIONAL)

This section defines the requirements of CP provided modems that must be met for connection to Openreach User Network Interface (UNI) for FTTC GEA over ADSL2plus. These requirements include logical functions within the CPE necessary to support and maintain Openreach services delivered using FTTC GEA over ADSL2plus.

The nomenclature used for each requirement is R.X.Y where:

R stands for Requirement,

X is the category (PHY, ADSL2+, ATM, ETH, WAN, OAM) and

Y is the requirement number

In this section the term 'modem' refers to the CP provided modem and 'WAN interface' refers to the interface on the modem connecting to the Openreach FTTC network.

4.1 Scope

The protocol layers within this scope are depicted in Figure 12.

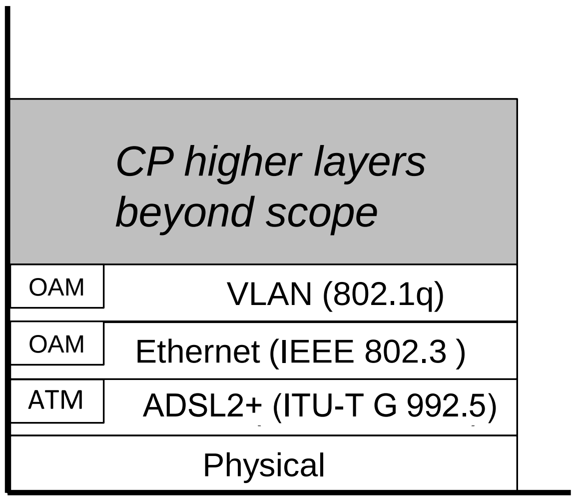

Figure 12 : Protocol Layers in Scope for GEA over ADSL2plus

GEA over ADSL2plus employs Ethernet over ATM mode (XoEoA, where 'X' is PPP or IP) over cabinet based ADSL2plus. Cabinet based ADSL2plus is used to provide extended reach beyond what is possible with VDSL2. The Ethernet layer functionality and requirements do not differ from what is offered and supported on standard GEA-FTTC.

It should be noted that XoA is *not* supported by GEA over ADSL2plus.

4.2 Requirements

The CP provided modem shall support all the requirements as described in the following subsections. Additional guidance is also provided as a "Note" where relevant.

A full description of the tests required to demonstrate compliance with these requirements are detailed in Annex B.

4.2.1 Physical Connection

The CP GEA over ADSL2plus modem shall meet the requirements defined in Section 3.2.1.

Note: Openreach do not currently offer a bonded ADSL2plus product (where two or more ADSL2plus lines are connected to one modem device to increase bandwidth). This SIN will be updated if and when Openreach offer this feature.

4.2.2 ADSL2plus Layer

R.ADSL2+.1 The chipset shall use silicon that fully complies with the requirements of G.992.3[8] and G.992.5[23] (including all published amendments to date).

R.ADSL2+.2 The modem shall support ADSL2plus non-overlapped spectrum operation as defined in Annex A of G.992.5[23] (ie ADSL2plus over POTS).

R.ADSL2+.3 The modem shall comply with the requirements of Part C of the UK Access Network Frequency Plan[9].

R.ADSL2+.4 The modem shall use the upstream band between 25kHz and 138kHz.

R.ADSL2+.5 The modem shall be capable of operating with cabinet based ADSL2plus. This involves supporting tone-sets A43 and A43C (as defined in G.994.1 Amendment 1), plus downstream PSD shaping as defined in G.997.1 and G.992.5. The use of additional tone-sets (B43, B43c, V43) is not permitted as these may cause adverse interference to other DSL systems operating in the same cable.

R.ADSL2+.6 The modem shall be capable of supporting the complete range of optional extended framing parameters defined in G.992.5[23]. These are also defined in ETSI 105-388[24].

R.ADSL2+.7 The modem shall support bit swap as defined in G.992.3[8].

R.ADSL2+.8 The modem shall be capable of supporting seamless rate adaptation as defined in Section 7.11 of G.992.3[8] and Section 7.11 of G.992.5[23].

R.ADSL2+.9 The modem shall support the correct reporting of Vendor ID, version Number and Serial Number as described in G.992.3[8].

R.ADSL2+.10 The modem shall support the correct reporting of key ADSL2plus test and diagnostic parameters according to G.997.1[5].

R.ADSL2+.11 The modem shall accurately report Hlog and QLN information.

R.ADSL2+.12 The modem shall support downstream PHY layer retransmission as defined in G.998.4[6]. When downstream retransmission is implemented, the “Retransmission used Downstream (RTX_USED_ds)” parameter shall be reported via the DSLAM in accordance with Clause 7.5.1.38 of G.997.1[5].

R.ADSL2+.13 The modem should support upstream PHY layer retransmission as defined in G.998.4[6]. When upstream retransmission is implemented, the “Retransmission Used Upstream (RTX_USED_us)” parameter shall be reported via the DSLAM in accordance with Clause 7.5.1.38 of G.997.1[5].

4.2.3 ATM Layer

R.ATM.1 All Ethernet traffic on the Openreach UNI (ingress and egress) shall be encapsulated within ATM cells using ATM Adaptation Layer 5 (AAL5).

R.ATM.2 Where the CP intends to use Multicast for GEA over ADSL2+, the modem shall be capable of simultaneously supporting Multicast and Unicast over the same VPI/VCI.

R.ATM.3 The modem shall use VPI/VCI 0/38 for GEA Data and Multicast traffic (ingress and egress). Traffic without a correct VPI/VCI will be dropped.

4.2.4 Ethernet Layer

The GEA over ADSL2+ modem shall meet the requirements defined in Section 3.2.3.

4.2.5 WAN VLAN Layer

The GEA over ADSL2+modem shall meet the requirements defined in Section 3.2.4.

4.2.6 Ethernet OAM

The GEA over ADSL2+modem shall meet the requirements defined in Section 3.2.5.

4.2.7 CPE Filter Requirements

The filter devices provided for GEA over ADSL2+ shall meet the requirements defined in Section 3.2.6

5. References

[1]	SIN 360	Ethernet Customer Interfaces, Interface Characteristics.	
[2]	SIN 351	BT Public Switched Telephone Network (PSTN): Technical Characteristics Of The Single Analogue Line Interface	
[3]	ITU-T G.993.2	Very high speed Digital Subscriber Line 2	
[4]	ITU-T G.994.1	Handshake Procedures for Digital Subscriber Line (DSL) Transceivers	
[5]	ITU-T G.997.1	Physical Layer Management for Digital Subscriber Line (DSL) Transceivers	
[6]	ITU-T G.998.4	Improved Impulse Noise Protection for DSL Transceivers	
[7]	ITU-T G.993.5	Self-FEXT Cancellation (Vectoring) for Use With VDSL2 Transceivers	
[8]	ITU-T G.992.3	Asymmetric Digital Subscriber Line Transceivers 2 (ADSL2)	
[9]	NICC ND:1602	Specification of the Access Network Frequency Plan (ANFP) Applicable to Transmission Systems Used on the BT Access Network Specification of the Access Network Frequency Plan (ANFP) applicable to transmission systems used on the BT Access Network	March 2016
[10]	BS EN 60950-1	Information technology equipment. Safety. General requirements.	
[11]	IEEE 802.3	Standards for Local Area Networks: CSMA/CD Access Method	
[12]	NICC ND:1030	Ethernet ALA Service Definition	
[13]	BBF TR-101	Broadband Forum – Migration to Ethernet-Based DSL Aggregation	April 2006
[14]	ITU-T Y.1731	OAM functions and mechanisms for Ethernet based networks	July 2011

[15]	ETSI TS 101-952-1 (v1.1.1)	Access network xDSL splitters for European Deployment; Part 1: Generic specification of xDSL over POTS splitters	
[16]	ETSI TS 101-952-3 (v1.1.1)	Access network xDSL splitters for European Deployment; Part 3 Generic specification of static distributed filters for xDSL over POTS	
[17]	IEEE802.1ad	Virtual Bridged Local Area Networks, Amendment 4: Provider Bridges	2005
[18]	802.1D-2004	IEEE Standard for Local and metropolitan area networks – Media Access Control (MAC) Bridges	2004
[19]	BBF TR-069	Broadband Forum – CPE WAN Management Protocol	
[20]	BBF TR-114	Broadband Forum – VDSL2 Performance Test Plan	
[21]	ETS 101 270	ETSI Transmission and Multiplexing (TM); Access transmission systems on metallic access cables; Very high speed Digital Subscriber Line (VDSL); Part 1: Functional requirements, Version V 1.3.1	
[22]	BBF TR-177	Broadband Forum - IPv6 in the context of TR-101	
[23]	ITU-T G.992.5	Asymmetric digital subscriber line transceivers 2 (ADSL2) – Extended bandwidth (ADSL2plus)	
[24]	ETSI TS 105 388	Access transmission systems on metallic access cables; Asymmetric Digital Subscriber Line (ADSL2plus) - European specific requirements	

Note: For dated references, only the edition cited applies. For non-specific references, the latest edition of the referenced document (including any amendments) applies.

<Q – is there any danger in removing the dates from these references highlighted ?>

6. Abbreviations

Abbreviation	Description
AAL5	ATM Adaptation Layer 5
ADSL	Asymmetric Digital Subscriber Line
ADSL2plus or ADSL2+	Second generation ADSL with extended bandwidth
AELEM	Alternate Electrical Length Estimation Methodology
ALA	Active Line Access
AM	Amplitude Modulation

ANFP	Access Network Frequency Plan
ATM	Asynchronous Transfer Mode
AWG	Arbitrary Waveform Generator
AWGN	Additive White Gaussian Noise
BRAS	Broadband Remote Access Server
BS EN	British Standard European Normative
CAL	Cabinet Assigned Loss (equivalent to ESEL).
CP	Communications Provider
CPE	Customer Premises Equipment
C-VLAN	Customer VLAN
CWMP	CPE WAN Management Protocol
DHCP	Dynamic Host Configuration Protocol
DLM	Dynamic Line Management
DPBO	Downstream Power Back Off
DSL	Digital Subscriber Line
DSLAM	Digital Subscriber Line Access Multiplexer
EMS	Element Manager System
EOI	Equivalence Of Input
ES	Errored Second
ESEL	E-side Electrical Length. Electrical length of cable between exchange and cabinet, measured at 300kHz. Equivalent to CAL.
EU	End User
FC/PC	Fixed Connection – fibre optic connector
FEC	Forward Error Correction
FEXT	Far End Crosstalk
FTTC	Fibre To The Cabinet
GE	Gigabit Ethernet
GEA	Generic Ethernet Access
GEA-FTTC	Generic Ethernet Access Fibre to the Cabinet
HDSL	High speed Digital Subscriber Line
Hlog	Channel response (Insertion loss vs. frequency)
HoP	Handover Port
IA	Intermediate Agent
ID	Identifier
IEEE	Institute of Electrical and Electronic Engineers
IFG	Inter-Frame Gap
IGMP	Internet Gateway Managed Protocol

INP	Impulsive Noise Protection
IP	Internet Protocol
iSSFP	Interstitial Service Specific Face Plate
KL0 or kl0	Estimated loop length between CPE and DSLAM, measured at 1MHz
L2S	Layer 2 Switch (with integrated OLT)
LACP	Link Aggregation Control Protocol
LAN	Local Area Network
LB	Loopback
LBM	Loopback Message
LBR	Loopback Reply
LC	Lucent Connector/Local Connector – fibre optic connector
LNEL	Local Network Evaluation Laboratory
MA	Maintenance Association
MAC	Media Access Control
MCT	Modem Conformance Test
MD	Maintenance Domain
MDI/MDIX connection	Medium Independent interface (cross-over) – Ethernet port
MDIO	Management Data Input Output
MEP	Maintenance End Point
MPF	Metallic Path Facility
MTU	Maximum Transmission Unit
NIT	Network Integration Testing
NTE5	Network Terminating Equipment #5. The point in the customer's premises where the Openreach network terminates.
OAM	Operations, Administration, Maintenance
OFR	Optical Fibre Rack
OLT	Optical Line Termination
PADI	PPPoE Active Discovery Initiation
PADO	PPPoE Active Discovery Offer
PADS	PPPoE Active Discovery Session- confirmation
PATS	Publicly Available Telephone Service
PCP	Priority Code Point aka 802.1p priority. See [19]
PHY Layer	Physical Layer
POTS	Plain Old Telephony Service
PPP	Point to Point Protocol
PPPoE	Point to Point Protocol over Ethernet

PSD	Power Spectral Density
PSTN	Public Switched Telephone Network
PSU	Power Supply Unit
PTM	Packet Transfer Mode
PTM-TC	Packet Transfer Mode – Transmission Convergence
QLN	Quiet Line Noise
QoS	Quality of Service
REIN	Repetitive Electrical Impulse Noise
RFI	Radio Frequency Interference
RJxx	Registered Jack – a standardised physical network connector
RTX	Retransmission
SC	Standard Connector
SES	Severely Errored Second
SIN	Suppliers' Information Note (BT publication)
SNR	Signal to Noise Ratio
SRA	Seamless Rate Adaptation
SSFP	Service Specific Front Plate
STB	Set-Top Box
S-VLAN	Service VLAN
TP-100	Twisted Pair cable with 100 Ohm impedance
UNI	User Network Interface
VDSL	Very high-speed Digital Subscriber Line
VDSL2	Second generation VDSL
VLAN	Virtual Local Area Network
WAN	Wide Area Network
WBC	Wholesale Broadband Connect (see http://www.openreach.co.uk)
WLR3	Wholesale Line Rental
xDSL	Generic term for the family of DSL transmission systems
XoA	X over ATM (where 'X' is IP or PPP)
XoEoA	X over Ethernet over ATM (where 'X' is IP or PPP)

7. History

Issue	Date	Changes
1.0	June 2009	First Issue. Initially to be held in parallel with STIN 494, which relates to the FTTC GEA trial.

2.0	Aug 2009	Replaces STIN 494, as the FTTC GEA trial has moved into the pilot phase. Additions to Sections 1.2 (Service Availability) and 2.1.5 (Downstream Shaping), plus minor editorials.
3.0	Nov 2009	Dynamic Line Management details added to section 1.2
3.1	Dec 2009	VLAN, DLM and Shaping additional information
3.2	March 2010	Update to section 2.2.7, additional OAM details in section 2.1.7, additional text for clarification input in Section 2.1.4, and update to the Contents
3.3	Feb 2012	Updates to upstream speeds, and C VLAN ranges.
4.0	July 2012	Incorporated CP provided modem product option.
4.1	October 2012	Minor editorial amendments and further technical clarifications made
4.2	November 2012	Editorial clarifications made in respect of Version 4.1, and correction made to Clause 2.1.51
4.3	January 2013	Section 2.1.2 – Maximum Ethernet frame size changed from 1532 to 1530 bytes. Requirement R.VDSL2.10 for downstream PHY Layer retransmission reinstated. Requirement R.VDSL2.11 for upstream PHY Layer retransmission reinstated. Requirement R.ETH.1 changed to reduce MTU size from 1536 to 1534 bytes. Section 3.2.2 – Additional explanatory notes added.
5	June 2013	Requirement R.PHY.1 – Text changed to permit use of either RJ11 or RJ45 connector. Requirement R.VDSL2.10 – Downstream retransmission made mandatory Requirement R.ETH.1 – Text reworded to clarify that multiple MTU sizes can be supported, one of which must be 1534 bytes Requirement R.WAN.3 – The following text added to start of text "Where the CP intends to use Multicast for GEA…" Additional clarification text added to R.OAM.3. Additional section on Street Access added to Section 2.4. Requirements R.WAN.6 and R.WAN.7 clarified. Requirement R.OAM.2 expanded to include addresses Requirement for optional support of "Dying gasp" added to OAM section. Annex A : Test Requirements section added.
5.1	September 2013	Several minor typos corrected Section 2.3.2 – Text clarified Requirement R.OAM.2 – Text clarified Requirement R.OAM.3 – Text clarified A4.2.2.8 – Interleaved profiles ammended. A.4.2.2.12-Bit swap test description clarified to ensure that bit swap activity around the RF tone is specifically checked A.4.2.5.1 – Test for Loopback Messages clarified and an error in Step 4 corrected. Second note added regarding VLAN101

		A.4.2.5.2 – Informative note moved to A.4.2.5.1
6.0	August 2014	Major update to define requirements and associated test procedures for GEA over ADSL2+ (see Section 4 and Annex B) Several minor typos and formatting corrected ADSL2plus references added Abbreviations updated 2.1.7 – Access Loop Encapsulation updated to include ATM requirement for GEA over ADSL2+ A.1.4 – Table defining insertion loss at 300kHz and 1MHz added A.4.1.2 – Requirement for warm and cold start added A.4.2.2.2 – Crosstalk included in test description A.4.2.2.3 – Crosstalk included in test description A.4.2.2.4 – Requirement for warm and cold start added A.4.2.2.6 – Crosstalk included in test description A.4.2.2.8 – Multiple profiles replaced by a single open profile A.4.2.2.9 – Multiple profiles replaced by a single open profile A.4.2.2.11 – AELEM test description updated A.4.2.2.14 – Open A.4.2.2.15 – Hlog/QLN reporting moved into main test requirements section from A.4.3.1.3 A.4.3.1.1 – Multiple profiles replaced by a single open profile A.4.3.1.3 – Moved into Section A.4.2.2.15
7.0	January 2016	Section 1.1 Link to Openreach SIN website updated. Section 2.1.6 Train-up time increased to 90s. Section 2.1.11 New section added to clarify multicast IP group addresses. Section 3.2.2 New requirement (R.VDSL2.18) added to verify concurrent support of vectoring and downstream retransmission. Section 3.2.2 Note updated to reflect the fact that downstream retransmission in enabled on the Openreach GEA platform. Section 3.2.4 Note added confirming VLAN101 mapping requirements. Section A.3 Table 4 updated to reflect upgraded Spirent noise generator/injectors used by BT. Section A.4.1.1 Train-up duration increased to 90s . A.4.2.2.8 Clarification added that this test will only be performed if upstream retransmission is NOT supported by the CPE under test. A.4.2.2.8 Test procedure updated to include verification of sync rates for different levels of retransmission. A.4.2.2.8 Profile names and details updated to reflect those used in Openreach network. A.4.2.2.9 Clarification added that this test will only be performed if BOTH downstream and upstream retransmission are supported by the CPE under test. A.4.2.2.9 Test procedure updated to include verification of sync rates for different levels of retransmission. A.4.2.2.9 Profile names updated to reflect those used in Openreach network. A.4.2.2.10 Test updated to check that CPE synchronises at 1800m and 2400m when vectoring is implemented. A.4.2.2.16 New test added to verify concurrent support of vectoring and downstream retransmission. A.4.3.1.1 Test updated to use retransmission profile rather than interleaved profile.

		A.4.3.1.2 Test updated to use retransmission profile rather than interleaved profile.
7.1	February 2016	A.4.2.2.10 Requirement to vector at 1800m and 2400m removed from this version of the SIN
7.2	November 2016	Section 1.2.2 New section added to include new downstream target noise margin settings Section 1.3 Updated to include 10Gbps Cable Links. Section 2.1.10 Updated to clarify Ethernet bridging rules Section 3.2.2 New requirement (R.VDSL2.19) added to verify support of different target noise margins. A.4.2.2.17 New test to verify support for different target noise margins. A.4.2.3 Clarification on Ethernet framesize added. Test procedure updated. A.4.2.4 Text clarification. Note added relating to testing of R.WAN.4, R.WAN.5 and R.WAN.6. A4.2.5 Text clarification. Test procedure updated.
7.3	January 2017	Profile names updated to reflect live network profiles. (Note that the parameters in the profiles remain unchanged) References updated to reflect latest publication dates

Annex A Test Requirements for GEA over VDSL2

This Annex provides a detailed breakdown of the modem conformance test (MCT) requirements to enable a piece of vendor CPE to be validated against the CPE Requirements defined in Section 3 of this document. This is based on the requirements of TR-114[20] except that it refers to BT specific noise models, service profiles, cable lengths and gauges and also the use of band plan 998ADE17 (including the Upstream 0 (US0) band).

Details of how to engage with BT on Modem Conformance Testing may be obtained by contacting our Service Establishment team at: customer.establishment@openreach.co.uk.

A.1 Test Configuration

A.1.1 Band Profiles

The following default band profile shall be used for all tests unless otherwise specified:

O2_0_6_36_1_6_18_1This default band differs from the band profile defined in TR-114[20] in that it permits the use of a 17MHz band plan that supports use of the upstream 0 (US0) band between 25kHz and 138kHz. The band plans defined in TR-114 currently do not support the use of US0.

This profile defines the following parameters:

O2_0_6_36_1_6_18_1		
Parameter	**Downstream Setting**	**Upstream Setting**
Maximum Data Rate	80Mbit/s	20Mbit/s
Minimum Data Rate	128kbit/s	128kbit/s
Minimum Noise Margin	0dB	0dB
Target Noise Margin	6dB	6dB
Maximum Noise Margin	31dB	31dB
Dmax	0	0
INP min	0	0
Adaption Mode	Adapt at start up	Adapt at start up
Operating Mode	G.993.2	
Band Plan	998ADE17 (Plan B8-11)	

Table 2 : GEA Profile Definition

A.1.2 Loops

European VDSL test loop #1 (0.5mm Cu)[21] shall be used for all tests. This will be simulated using a wireline simulator.

Note that the Broadband Forum (BBF) TR-114[20] currently defines European loops for evaluating 17MHz operation using 0.4mm gauge (i.e. 26AWG) cable while BT specifies the use of 0.5mm gauge cable (aka TP-100).

A.1.3 Plain Old Telephony Service (POTS)

It should be noted that POTS shall be connected onto the line via the splitter in the DSLAM on all test lines.

A.1.4 Crosstalk

The VDSL2 "Stockholm Lite" noise model shall be used as it includes the US0 band whereas the noise models defined in TR-114 do not currently include this frequency band (25 to 138kHz). This is representative of the noise ensemble that can be expected in a typical GEA cable binder.

A separate pair of noise files (upstream and downstream) is generated for each distance. In addition, a set of noise files is required for each of the 27 CAL (Cabinet Assigned Loss) values defined in the ANFP[9] as the DPBO shaping impacts the transmit PSD of the VDSL2 signal launched at the cabinet. The noise files for a 500m length of 0.5mm copper cable (equivalent to an electrical loss of 9dB measured at 1MHz) are shown below for CAL values of 10, 30 and 50dB.

The ITU-T G.993.2 Recommendation[3] uses the term E-side Electrical Length (ESEL) to refer to the loss of the cable connecting the exchange to the cabinet. The BT ANFP uses the term Cabinet Assigned Loss (or CAL) to describe the same parameter. In both cases, the insertion loss is measured at a frequency of 300kHz. For the purposes of this document, the two terms are interchangeable.

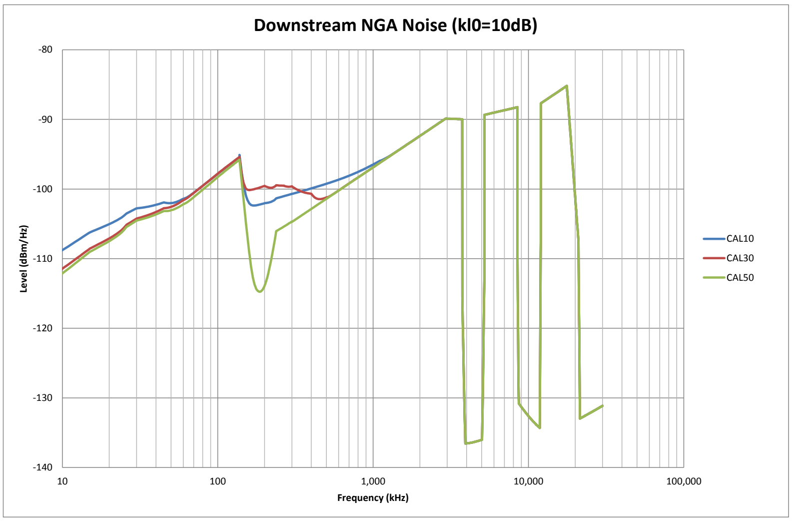

Figure 13 : Downstream GEA Noise Spectrum

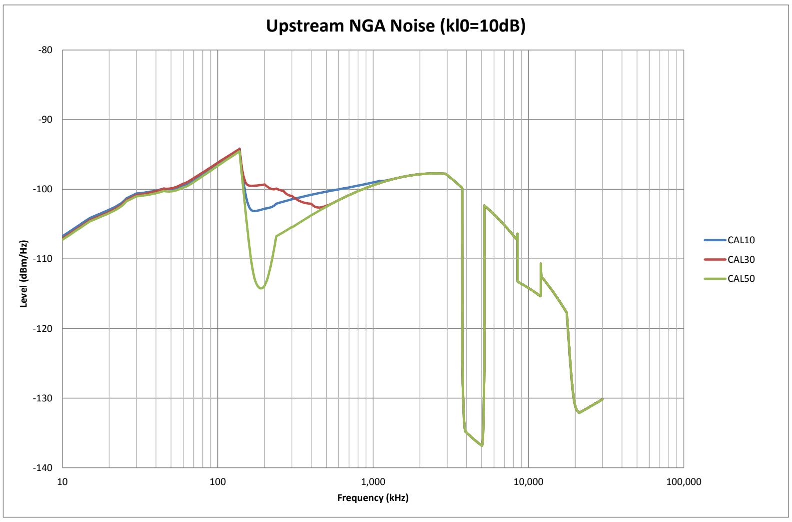

Figure 14 : Upstream GEA Noise Spectrum

These noise files can be generated and injected using a noise generator/injector unit. The PSD data required to generate and calibrate the noise files for CAL values of 10, 30 and 50dB over a range of lengths of 0.5mm gauge cable is contained in the companion spreadsheet entitled "Selected Cabinet Stockholm Lite Noise Files".

The following table shows the insertion loss of the various cable lengths used in the various tests at both 300kHz and 1MHz.

Length (0.5mm gauge)	IL @ 300kHz (dB)	IL @ 1MHz (dB)
100m	1	1.8
200m	2	3.6
500m	5.1	9
1000m	10.1	18
1300m	13.1	23.4
1500m	15.2	27
2000m	20.2	36
2200m	22.2	39.6

Table 3 : Insertion Loss Values for Various Lengths of 0.5mm Gauge cable

If line simulators are used in evaluating system performance it is recommended that the loop length is adjusted to give the closest match to the loss at 1MHz as specified in Table 3. This will ensure that the greatest repeatability is achieved during testing.

A.2 Network Equipment

Currently Openreach uses network equipment from two strategic vendors (namely ECI and Huawei) in its GEA FTTC network. This means that any CP provided modem must be able to operate across a variety of DSLAM chassis types and line cards.

The test procedures described in this document shall be performed using the current firmware versions of network equipment deployed in the Openreach FTTC GEA network unless otherwise stated.

A.3 Test Equipment

The test equipment used by BT to perform these tests is shown in Table 4. Other equivalent equipment may be substituted.

Test Equipment	Example
Baluns (x2)	North Hills 0320BF
TP100 Line Simulator	Spirent DLS8235
Noise Generator/Injector	Spirent DLS5800/ DLS5410DC
Function Generator	Agilent 33250B
Arbitrary Waveform Generator	Sony Tektronix AWG2021
RMS/Peak Voltmeter	Rhode and Schwartz URE3
Spectrum Analyser	HP3585A
Impedance Matching network	Custom Built (see Figure 15)

Table 4 : BT's GEA Test Equipment

A.3.1 Details of Impedance Matching Network

In order to measure the transmit power spectral density (PSD) of the VDSL2 system under test an impedance matching network (aka Loss Pad) is needed to correct the impedance of the simulated loop to as close as possible to the 100 Ohm reference impedance. Such a matching network is shown in Figure 15.

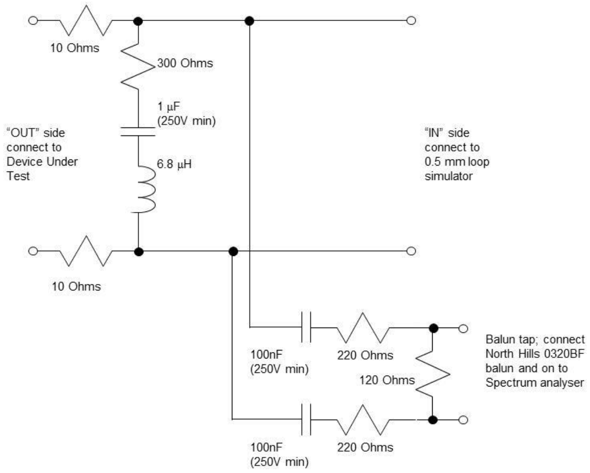

Figure 15 : VDSL2 PSD matching pad and balun tap

The output of the balun tap for this matching network has a loss from the device under test of 20.7 dB, and in addition a further 0.4 dB loss must be allowed for the balun. The loss of this path must be taken into account when calculating the PSD.

A.4 Modem Conformance Test (MCT) Requirements for GEA

The MCT requirements for GEA are split into the following three sections:

- Initial Gating
- Compliance with Section 3 of SIN 498
- GEA Testing

The details of the various tests are defined in the following paragraphs.

A.4.1 Initial Gating Tests

The purpose of these tests is to check that the CPE modem can synchronise with a GEA field configuration and will not cause network harm. It is necessary for a CPE to "Pass" both of these tests before full SIN 498 conformance testing can commence. If either of these tests results in a "Fail", the CPE vendor will be informed by Openreach and asked to resolve the issue.

A.4.1.1 Synchronisation

Description – The modem shall achieve synchronisation to a reference GEA DSLAM and can achieve end-to-end-connectivity with an external server.

Test Procedure – Connect modem to a port on the DSLAM via a 100m length of simulated 0.5mm gauge cable and ensure that it trains up and reaches synchronisation. Following this, attempt to set up an end-to-end connection between a PC connected to the CPE and an external server.

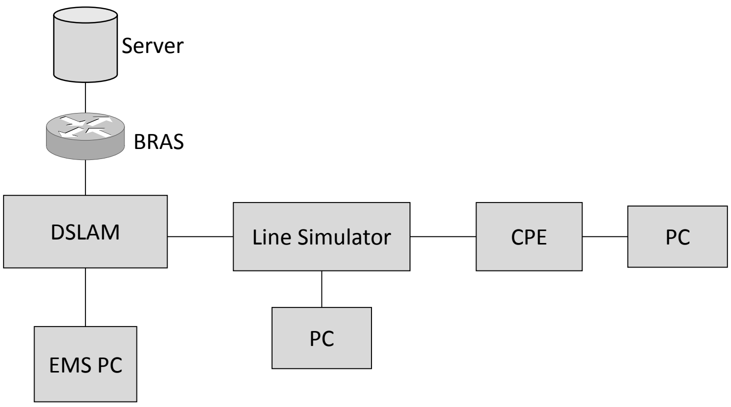

Figure 16 : Test Configuration for Checking Basic Synchronisation

1. Configure DSLAM to implement an ESEL value of 30dB and ensure that the default band profile is loaded onto a port.
2. Set line simulator to a loop length of 100m with noise injection disabled (i.e. noise free).
3. Connect the CPE modem to that port and check that it reaches synchronisation within 90 seconds.

4. If synchronisation is attained, check that the modem stays in synchronisation for a minimum of 120 seconds.
5. Check that end-to-end connectivity has been achieved by launching an Internet session using the PC connected to the CPE. This will confirm whether the modem has established a DHCP or PPP session with the server.

Expected Outcome – This test will be deemed a "Pass" if the modem attains synchronisation within 90 seconds, stays trained up for a minimum of 120 seconds and can achieve an end to end connection with the external server, else the test will be deemed a "Fail". This test also verifies that the physical layer interface on the CPE modem is wired correctly (Requirement R.PHY.1).

A.4.1.2 Network Interference

Description – The modem shall not cause adverse interference to other systems operating in the same cable binder. In order to validate this, the modem shall only implement the A43 or A43c tone sets defined in G.994.1[4], demonstrate that it does not cause adverse interference to other lines operating in a vectored group and comply with the requirements of Part C of the BT Access Network Frequency Plan[9].

Test Procedure – Measure upstream PSD on three different line lengths (100m, 500m and 1300m) to check that system complies with Part C of the BT ANFP and that upstream transmit power does not exceed that defined for Profile 17a (G.993.2[3]).

1. Configure DSLAM to implement an ESEL value of 30dB and configure a port with the default band profile.
2. Connect the DSLAM and the CPE using the Test Configuration shown in Figure 18.
3. Set line simulator to simulate a loop length of 100m with noise injection disabled (i.e. noise free)
4. During train-up, capture the handshake tones generated by each end of the transmission system.
5. Compare tones against those defined for A43 and A43c to check that tones other than A43/A43c are NOT being used.
6. Once the CPE has attained synchronisation, capture upstream PSD and wideband power and compare against Part C of the BT ANFP.
7. Repeat for both a warm-start and a cold-start‡.
8. Repeat for 500m and 1300m loop lengths.

Note that this test also covers requirements R.VDSL2.4 (Compliance with Part C of the BT ANFP), R.VDSL2.7 (Support of UPBO) and the upstream part of R.VDSL2.6 (Support of Cabinet Based Operation).

‡ *A warm-start is when the modem is disconnected from the line but remains powered up. Resynchronisation occurs when the modem is reconnected to the line. A cold-start is when the modem is powered off and then powered back on again (i.e. a full restart).*

In addition, it is also necessary to verify that the CPE modem does not cause adverse interference to an GEA system implementing vectoring. The details for this test are defined in Section A.4.2.2.10 (Support of vectoring - R.VDSL2.12).

Expected Outcome - If the upstream transmit spectrum complies with the spectrum limits defined in Part C of the BT ANFP over the various loop lengths tested, the upstream transmit power does not exceed 14.5dBm, only tone-sets A43 and A43C are used, and the CPE is shown not to have an adverse impact on the performance of a vectored group then this will be deemed a "Pass", else the result will be a "Fail".

A.4.2 SIN 498 Modem Conformance Tests

See Section 3 for details of the specific requirements to which these conformance tests refer.

A.4.2.1 Physical Layer Tests

Each of the following sections defines the test required to demonstrate compliance to a particular requirement of SIN 498. The requirement number is shown in brackets after the title of the test.

A.4.2.1.1 <u>Physical Connection (R.PHY.1)</u>

Description - The socket on the CPE modem connecting to the Openreach UNI (i.e. WAN port) shall be either a RJ11 or RJ45 type to enable it to be connected to the VDSL2 filter using standard leads. The VDSL2 connection is presented on the middle two pins - i.e. pins 3&4 (RJ11) or pins 4&5 (RJ45). The other pins are not connected. Pin numbering is from the left, looking into the socket with the contacts uppermost. Polarity is unimportant.

Test Procedure – Visual inspection.

Expected Outcome – The basic synchronisation and network interference tests will confirm whether the DSL socket on the CPE modem has been wired correctly (see A.4.1).

A.4.2.2 VDSL2 Layer

A.4.2.2.1 <u>Support of Mandatory Requirements of G.993.2 (R.VDSL2.1)</u>

Description – The CPE modem used shall fully comply with the VDSL2 mandatory requirements of G.993.2[3].

Test Procedure – Vendor derived, in line with G.993.2. Copy to be provided to BT on request.

Expected Outcome – Vendor to confirm (in writing) via the Modem Conformance Test Request form, that their modem complies with the mandatory requirements of G.993.2.

A.4.2.2.2 <u>Support of Profile 17a and 998ADE17 Band Plan (R.VDSL2.2 and R.VDSL2.5)</u>

Description – The Modem shall support 17MHz operation using band plan B8-11 (i.e. plan 998ADE17) as defined in Annex B of G.993.2[3].

Test Procedure – For each value of ESEL to be evaluated, measure downstream PSD on short line (100m) to check that full 17MHz bandwidth is being utilised and that downstream transmit power does not exceed that defined for Profile 17a.

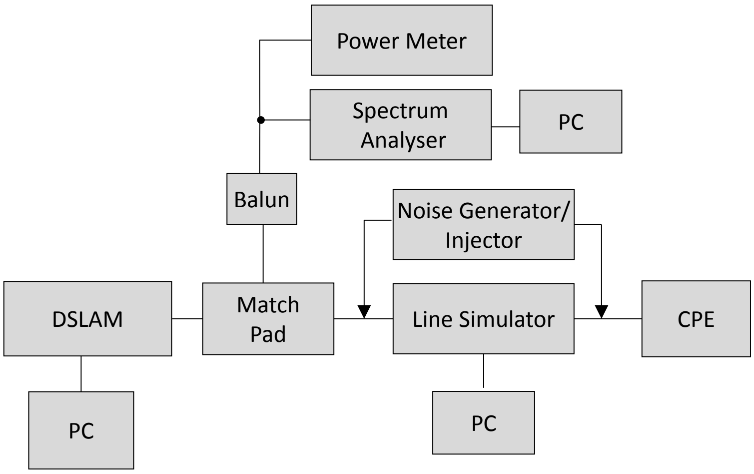

Figure 17 : Test Configuration for Measuring Downstream PSD

Details of the impedance matching pad used are shown in Figure 15.

1. Configure DSLAM to implement an E-side electrical length (ESEL) value of 30dB and configure a port with the default band profile.
2. Set line simulator to a loop length of 100m with crosstalk injected at each end of the system.
3. Connect CPE to DSLAM using the Test Configuration shown in Figure 17.
4. Ensure that CPE has attained synchronisation.
5. Capture downstream PSD and wideband power and compare against Part B of the BT ANFP.
6. Check that the full 17MHz spectrum is used.
7. Repeat for a minimum of two other ESEL values (nominally 10dB and 50dB).

Expected Outcome – This test will be deemed a “Pass” if the full 17MHz band plan 998ADE17 spectrum is observed (i.e. use of downstream band between 12 and 17.664MHz) and that the downstream transmit power does not exceed 14.5dBm. If these criteria are not met, then the result is a “Fail”.

A.4.2.2.3 Compliance with BT ANFP Part C (R.VDSL2.4)

Description – The Modem shall comply with the requirements of Part C of the BT Access Network Frequency Plan[9].

Test Procedure – Measure upstream PSD on three different line lengths (100m, 500m and 1300m) to check that system complies with Part C of the BT ANFP and that upstream transmit power does not exceed that defined for Profile 17a.

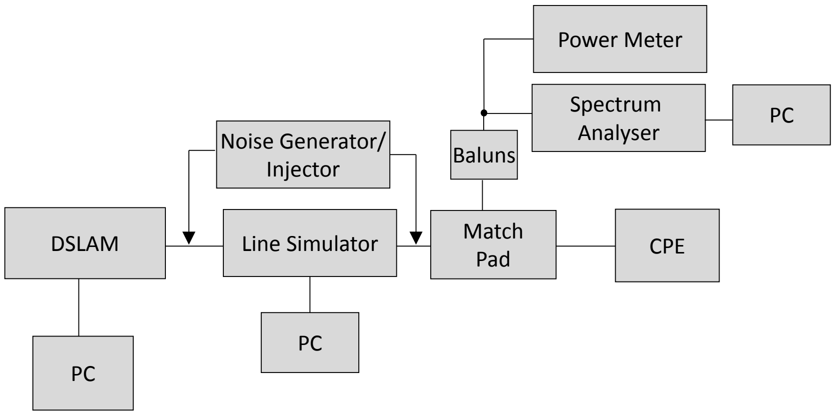

Figure 18 : Test Configuration for Measuring Upstream PSD

Details of the impedance matching pad used are shown in Figure 15.

1. Configure DSLAM to implement an ESEL value of 30dB and the default band profile.
2. Connect CPE to DSLAM using the Test Configuration shown in Figure 18.
3. Set line simulator to a loop length of 100m with crosstalk injected at each end of the system.
4. Ensure that CPE has attained synchronisation.
5. Capture upstream PSD and wideband power and compare against Part C of the BT ANFP.
6. Repeat for 500m and 1300m loop lengths.

Expected Outcome - If the upstream transmit spectrum complies with the spectrum limits defined in Part C of the BT ANFP over the various loop lengths tested and the total upstream transmit power measured does not exceed 14.5dBm then this will be deemed a “Pass”, else the result will be a “Fail”.

A.4.2.2.4 Support of Cabinet based VDSL2 Operation (R.VDSL2.6)

Description – The Modem shall support operating with cabinet based VDSL2. This requires the support of tone-sets (or carrier sets) A43 and A43C (as defined in G.994.1 Amendment 1[4] and shown in Table 5), plus downstream PSD shaping and upstream power back-off as defined in G.997.1[5] and G.993.2[3]. In order to achieve synchronisation, the modem must also support these tone-sets.

Carrier Set Designation	Upstream Carrier Sets		Downstream Carrier Sets	
	Tone Numbers	Maximum power level/carrier (dBm)	Tone Numbers	Maximum power level/carrier (dBm)
A43	9 17 25	-1.65	40 56 64	-3.65
A43c	9 17 25	-1.65	257 293 337	-3.65

Table 5 : Carrier Sets A43 and A43c

Note that use of additional tone-sets (B43, B43c, V43 etc.) is not permitted as these may cause the spectral limits defined in Parts B and C of the BT ANFP to be breached, resulting in adverse interference to other DSL systems operating in the same cable binder.

Test Procedure – The Test Configuration shown in Figure 17 shall be used for this test.

1. Set spectrum analyser for a start frequency of 10kHz and a stop frequency of 5MHz.
2. Configure DSLAM to implement an E-side electrical length (ESEL) value of 30dB and the default band profile.
3. Connect CPE to DSLAM using the Test Configuration shown in Figure 17.
4. Set line simulator to a loop length of 100m with noise injection disabled (i.e. noise free).
5. During train-up, capture the handshake tones generated by each end of the transmission system.
6. Compare tones against those defined for A43 and A43c.
7. Plot captured downstream tones against ANFP Part B spectral limit to check that PSD shaping has been applied to the tones and that tones other than A43/A43c are NOT being used.
8. Repeat for both a warm-start and a cold-start.
9. Repeat for a minimum of two other ESEL values (nominally 10dB and 50dB).

Expected Outcome - This test will be deemed a “Pass” only if A43/A43c tone sets are being used and that the correct amount of downstream PSD shaping is being applied to the tone to ensure compliance with the appropriate limit masks defined in Part B of the BT ANFP for each value of ESEL evaluated and for both a warm-start and a cold-start. If these criteria are not met, then the result is a “Fail”.

A.4.2.2.5 Support of UPBO (R.VDSL2.7)

Description – The Modem shall support Upstream Power Back Off (UPBO) as defined in G.993.2 .

Test Procedure – See Section A.4.2.2.3 “Compliance with BT ANFP Part C (R.VDSL2.4)”.

Expected Outcome - If the upstream transmit spectrum complies with Part C of the BT ANFP over the various loop lengths tested then this will be deemed a “Pass” as this requires UPBO to be implemented correctly, else the result will be a “Fail”.

A.4.2.2.6 Support of U0 Band (R.VDSL2.8)

Description – The Modem shall support the use of the upstream band (U0) between 25kHz and 138kHz.

Test Procedure –

1. Configure DSLAM to implement an ESEL value of 30dB and the default band profile.

2. Connect CPE to DSLAM using the Test Configuration shown in Figure 18.
3. Set line simulator to a loop length of 2000m with crosstalk injected at each end of the system.
4. Ensure that CPE has attained synchronisation.
5. Capture upstream PSD and wideband power and compare against Part C of the BT ANFP.
6. Check that the U0 band is used.

Expected Outcome – This test will be deemed a "Pass" if the U0 band is observed (i.e. use of upstream band between 25 and 138kHz). If this band is not seen then the result is a "Fail".

A.4.2.2.7 Support of Seamless Rate Adaptation (R.VDSL2.9)

Description – The Modem shall support seamless rate adaptation (SRA) as defined in Section 13.1 of G.993.2[3].

Test Procedure – Configure system to operate in the presence of crosstalk, reduce level of crosstalk at each end and then check whether SRA is implemented. Note that this will require a dedicated profile (SRAD800_001_00_00U200_001_00_00) which is basically the same as the default profile but with SRA enabled and some additional parameters defined as shown in Table 6.

Parameter	**Downstream**	**Upstream**
Minimum upshift time (s)	10	0
Minimum downshift time (s)	10	0
Upper threshold margin (dB)	9	9
Lower threshold margin (dB)	3	3

Table 6 : Settings for Seamless Rate Adaptation Profile

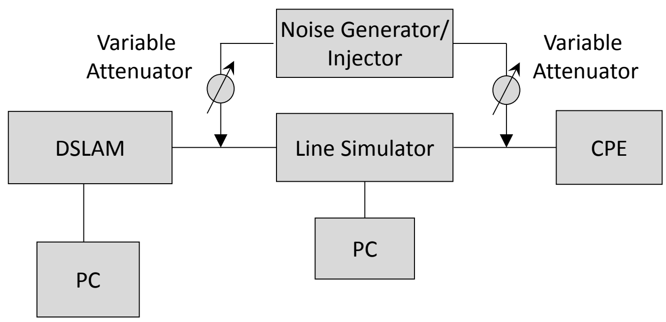

Figure 19 : Test Configuration for Checking Seamless Rate Adaptation§

1. Configure DSLAM to implement an ESEL value of 30dB and the dedicated SRA profile.

§ *Note that the variable attenuators can be stand alone or part of the noise generator*

2. Connect CPE to DSLAM using the Test Configuration shown in Figure 19.
3. Set line simulator to a loop length of 500m with crosstalk injected at each end of the system.
4. Ensure that CPE has attained synchronisation.
5. Record upstream and downstream margin and data rates as reported by the DSLAM.
6. Reduce crosstalk injected at CPE end of link (i.e. downstream) by 1dB and record downstream rate and noise margin.
7. Reduce downstream crosstalk in 1dB steps, recording the downstream margin and data rates for each step. After a 5dB reduction in crosstalk (i.e. a 5dB improvement in margin), the upper margin threshold value will be exceeded and the data rate should change.
8. Repeat for the upstream direction.
9. The CPE should not lose synchronisation during this test.

Expected Outcome – This test will be a "Pass" if the system is found to change data rate in each direction when the noise margin improves by 5dB without losing synchronisation. If the rate does not change or if the system retrains, then the result will be a "Fail".

A.4.2.2.8   Support of Downstream Retransmission (R.VDSL2.10)

Description – The modem shall support downstream PHY layer retransmission as defined in G.998.4[6]. This test shall only be performed if the CPE modem does NOT support upstream retransmission.

Test Procedure -

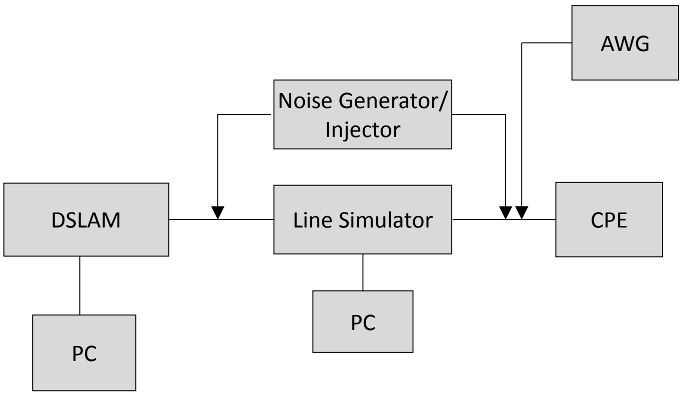

Figure 20 : Test Configuration for Verifying Downstream Retransmission

Part A

1. Configure DSLAM to implement an ESEL value of 30dB and the HIGH downstream retransmission profile (with fast upstream) O2_3_6_36_3_6_18_1.
2. Connect CPE to DSLAM using the Test Configuration shown in Figure 21.
3. Set line simulator to a loop length of 100m with no crosstalk injected at either end of the system.

4. Ensure that CPE has attained synchronisation, check whether downstream and upstream retransmission are implemented and then record the downstream and upstream data rates from the element management system.
5. Repeat the above process for the default (i.e. fast) profile.
6. Repeat the above process for the LOW downstream retransmission profile (with fast upstream) O2_3_6_36_2_6_18_1.

Expected Outcome

The upstream and downstream data rates recorded with retransmission enabled should not be significantly different from those recorded for the fast profile. If there is a significant difference (e.g. 52Mbit/s downstream and 1Mbit/s upstream) between the rates the the test will be deemed a “Fail”.

Part B

1. Configure DSLAM to implement an ESEL value of 30dB and retransmission profile O2_3_6_36_3_6_18_1. The retransmission parameters used in this profile are defined in Table 7.
2. Connect CPE to DSLAM using the Test Configuration shown in Figure 20.
3. Set line simulator to a loop length of 2000m with no crosstalk injected at either end of the system.
4. Ensure that CPE has attained synchronisation, check whether downstream retransmission is implemented and then leave the system running for 20 minutes.
5. Capture 15 minute performance data from element manager and check that key parameters are reported
6. Now turn crosstalk noise on at each end of system and repeat test. Note that level of crosstalk noise should be attenuated by 6dB in both upstream and downstream for this test.
7. Capture 15 minute performance data and compare with that recorded previously.
8. Check that reported data rate, maximum attainable line rate and noise margin have changed in each direction.
9. Now configure the arbitrary waveform generator (AWG) to generate VDSL2 shaped REIN comprising 100 μs bursts every 10 ms at an amplitude of -110dBm/Hz (measured at 1MHz) on both channels and repeat steps 7 and 8.
10. The 15 minute data should now show a number of parameters including uptime, number of retrains, errored seconds , severely errored seconds and/or FEC seconds. The error counts should NOT exceed 900 for any given 15 minute period.
11. Now configure the arbitrary waveform generator (AWG) to generate VDSL2 shaped REIN comprising 9 ms bursts every second at an amplitude of -110dBm/Hz (measured at 1MHz) and repeat steps 7 and 8.
12. Once again the 15 minute data should show a number of parameters including Actual INP, RTX_USED_ds, uptime, number of retrains, errored seconds ,

severely errored seconds and/or FEC seconds. The error counts should NOT exceed 900 for any given 15 minute period.

13. Now reconfigure the DSLAM to use the equivalent open interleaved profile (O2_1_6_36_3_6_18_1) and repeat steps 4 to 12. Note that the system may retrain during this test when operating in interleaved mode – this behaviour is expected.
14. This test can be repeated for 200m, 500m, 1000m and 1500m if required using the aforementioned open profiles. However, in order to reduce test time, only the 2km test is mandatory.

Parameter	O2_3_6_36_2_6_18_2		O2_3_6_36_2_6_18_1		O2_3_6_36_3_6_18_3		O2_3_6_36_3_6_18_1	
	D/S	**U/S**	**D/S**	**U/S**	**D/S**	**U/S**	**D/S**	**U/S**
RTX_MODE	1	1	1	1	1	1	1	**U/S**
MAXNDR_RTX	80000	20000	80000	20000	80000	20000	80000	1
MAXETR_RTX	80000	20000	80000	20000	80000	20000	80000	20000
MINETR_RTX	100	100	100	100	100	100	100	20000
DELAYMIN_RTX	0	0	0	N/A	0	0	0	100
INPMIN_REIN_RTX	1	1	1	N/A	1	1	1	N/A
INPMIN8_REIN_RTX	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
DELAYMAX_RTX	13	13	13	N/A	18	18	18	N/A
INPMIN_SHINE_RTX	8	8	8	N/A	32	32	32	N/A

INPMIN8_SHINE_RTX	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
SHINERATIO_RTX	1	1	1	N/A	5	5	5	N/A
IAT_REIN_RTX	0	0	0	N/A	0	0	0	N/A
LEFTR_THRESH	0	0	0	N/A	0	0	0	N/A

Table 7 : Parameters Used For Retransmission Profiles

Note: If the modem performance exceeds the upper or lower rates in the interleaved banded profiles (i.e. excessive margin or failure to reach synchronisation) then an alternative profile should be selected with different rates.

Expected Outcome – The CPE shall implement downstream retransmission. In addition, with downstream retransmission enabled, during any 15 minute period the system should report <10 errored seconds and no retrains in the downstream direction. If both the feature enablement and the feature behaviour are met as defined, then this will be deemed a "Pass", else the modem will be deemed to have failed the test. In general, the error performance of the modem with retransmission enabled should be better (i.e. fewer errors and retrains) than that achieved using the interleaved profile.

A.4.2.2.9 Support of Upstream Retransmission (R.VDSL2.11) - Optional

Typically a system would not just implement upstream retransmission so this test is designed to verify the operation of downstream and upstream retransmission running concurrently. This test will only be performed if the modem supports both upstream and downstream retransmission.

Description – The modem shall support downstream and upstream PHY layer retransmission as defined in G.998.4[6].

Test Procedure -

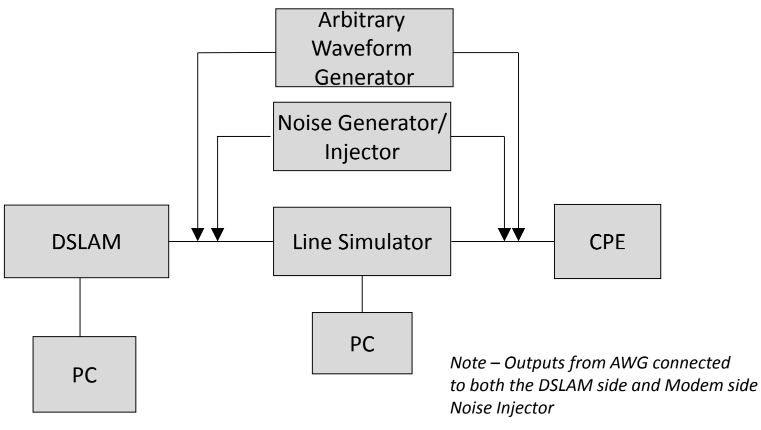

Figure 21 : Test Configuration for Verifying Downstream and Upstream Retransmission

Part A

1. Configure DSLAM to implement an ESEL value of 30dB and the open retransmission profile O2_3_6_36_3_6_18_3.
2. Connect CPE to DSLAM using the Test Configuration shown in Figure 21.
3. Set line simulator to a loop length of 100m with no crosstalk injected at either end of the system.
4. Ensure that CPE has attained synchronisation, check whether downstream and upstream retransmission are implemented and then record the downstream and upstream data rates from the element management system.
5. Repeat the above process for the default (i.e. fast) profile.
6. Repeat the above process for the retransmission profile O2_1_6_36_3_6_18_2.

Expected Outcome

The upstream and downstream data rates recorded with retransmission enabled should not be significantly different from those recorded for the fast profile. If there is a significant difference (e.g. >5Mbit/s downstream and 1Mbit/s upstream) between the rates the the test will be deemed a "Fail".

Part B

1. Configure DSLAM to implement an ESEL value of 30dB and the open retransmission profile O2_3_6_36_3_6_18_3.
2. Connect CPE to DSLAM using the Test Configuration shown in Figure 21.
3. Set line simulator to a loop length of 2000m with no crosstalk injected at either end of the system.
4. Ensure that CPE has attained synchronisation, check whether downstream and upstream retransmission are implemented and then leave the system running for 20 minutes.
5. Capture 15 minute performance data from element manager and check that key parameters are reported
6. Now turn crosstalk noise on at each end of system and repeat test. Note that level of crosstalk noise should be attenuated by 6dB in both upstream and downstream for this test.
7. Capture 15 minute performance data and compare with that recorded previously.
8. Check that reported data rate, maximum attainable line rate and noise margin have changed in each direction.
9. Now configure the arbitrary waveform generator (AWG) to generate VDSL2 shaped REIN comprising 100 μs bursts every 10 ms at an amplitude of -110dBm/Hz (measured at 1MHz) on both channels and repeat steps 7 and 8.
10. The 15 minute data should now show a number of parameters including uptime, number of retrains, errored seconds , severely errored seconds and/or FEC seconds. The error counts should NOT exceed 900 for any given 15 minute period.

11. Now configure the arbitrary waveform generator (AWG) to generate VDSL2 shaped REIN comprising 9 ms bursts every second at an amplitude of -110dBm/Hz (measured at 1MHz) and repeat steps 7 and 8.
12. Once again the 15 minute data should show a number of parameters including Actual INP, RTX_USED_ds, RTX_USED_us, uptime, number of retrains, errored seconds , severely errored seconds and/or FEC seconds. The error counts should NOT exceed 900 for any given 15 minute period.
13. Now reconfigure the DSLAM to use the equivalent open interleaved profile (O2_1_6_36_3_6_18_2) and repeat steps 4 to 12. Note that the system may retrain during this test when operating in interleaved mode – this behaviour is expected.
14. This test can be repeated for 200m, 500m, 1000m and 1500m if required using the aforementioned open profile. However, in order to reduce test time, only the 2km test is mandatory.

The retransmission parameters used in this profile are defined in Table 7.

Note: If the modem performance exceeds the upper or lower rates in the interleaved banded profiles (i.e. excessive margin or failure to reach synchronisation) then an alternative interleaved profile should be selected.

Expected Outcome – The CPE shall implement downstream and upstream retransmission. In addition, with downstream and upstream retransmission enabled, during any 15 minute period the system should report <10 errored seconds and no retrains in both the downstream and upstream direction. If these criteria are met, then this will be deemed a “Pass”, else the modem will be deemed to have failed the test. In general, the error performance of the modem with retransmission enabled should be better (fewer errors and retrains) than that using an interleaved profile.

A.4.2.2.10 Support of Vectoring (R.VDSL2.12)

Description – The Modem shall support 17MHz Vectoring as defined in G.993.5[7]. This requires the Modem to be "vector ready".

Test Procedure - Vectoring is not currently enabled on the BT GEA platform therefore testing is currently conducted solely on a test platform. The test configuration used is shown in Figure 22.

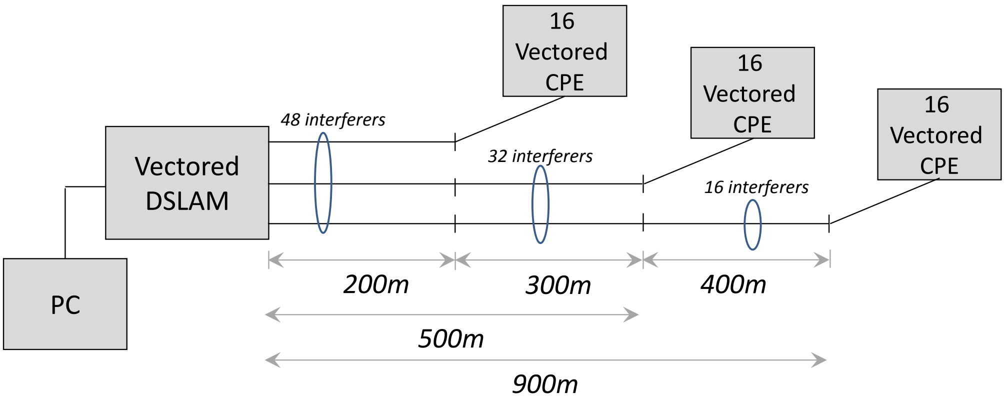

Figure 22 : Test Configuration for Checking Vectoring

From this it can be seen that the vectoring test configuration comprises three lengths of 100-pair cable (200m, 300m and 400m) which are connected in series to form a 500m length (i.e. 200m + 300m) and a 900m length (i.e. 200m + 300m + 400m) of cable, In this set-up there are 16 vectored CPE located 200m from the DSLAM, another 16 vectored CPE located 500m from the DSLAM and a final 16 vectored CPE located 900m from the DSLAM. The same cable segments are used to construct the 200m, 500m and 900m lengths. This means that there are 48 (i.e. 3 x 16) interferers present in the 200m length, 32 (2 x 16) interferers in the 300m length and 16 interferers in the 400m length.

Note that these lengths are intended to be representative rather than prescriptive – other lengths can be used.

1. Capture the performance data of the 48 modems both with vectoring disabled and with vectoring enabled. This enables the performance to be benchmarked.
2. Replace one of the modems located 200m from the DSLAM with the CPE under test.
3. Measure the non-vectored performance and then the vectored performance (assuming that the CPE supports vectoring).
4. Repeat for 500m and 900m cable lengths.
5. Compare the results obtained using the CPE at each cable length against those obtained using the 48 BT provided CPE. Note whether the CPE under test supports vectoring and whether there is any significant drop in performance either to the modem or the rest of the vector group when vectoring is enabled.

Expected Outcome – “Pass” if modem is capable of supporting vectoring and does not adversely affect the performance of the vector group, “Fail” if not.

A.4.2.2.11 Support of AELEM (R.VDSL2.13)

Description – The Modem shall support the alternate electrical length estimation methodology (AELEM) for estimating the electrical length of the connection between the Modem and the DSLAM (mode ELE-M1) as defined in G.993.2[3].

Note: AELE-Mode=2 is to be used, but AELE-Mode = 3 is under consideration and may be used in the future (as defined in G.993.2 section 7.2.1.3.2.1: Electrical Length Estimation Method).

Test Procedure – The AELEM test gives an indication of how well a CPE estimates loop length in the presence of bridged taps. A microfilter with home wiring based deployment is required as shown in Figure 23, using the following test procedure.

1. Connect CPE to DSLAM using the test setup shown in Figure 23.
2. Configure DSLAM to implement an ESEL value of 30dB and apply an AELEM enabled DSL profile to the line.
3. Set line simulator to a loop length of 500m (this equates to a kl0 value of 9dB measured at 1MHz) with the appropriate crosstalk injected at each end of the system.
4. Ensure that CPE has attained synchronisation.
5. Wait 2 minutes for system to stabilise.
6. Capture the upstream transmit PSD spectrum (see Section A.4.2.2.3 for details).
7. Compare against the ANFP Part C PSD mask using the companion spreadsheet entitled "AELEM PSD spreadsheet for 500m".
8. Record the kl0 per band (i.e. US1 and US2 band) and compare it to the estimated kl0 per band in Table 8.
9. Repeat steps 1-8 for a 100m loop (this equates to a kl0 value of 1.8dB measured at 1MHz) using the companion spreadsheet entitled "AELEM PSD spreadsheet for 100m"

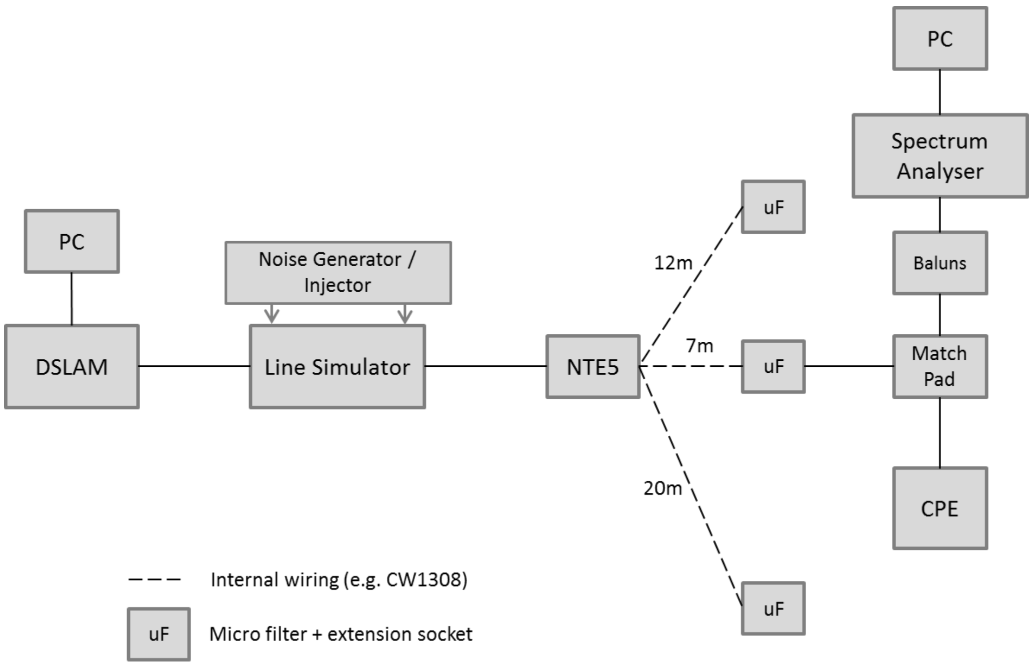

Figure 23 : Test Configuration for Checking Support of AELEM

Frequency Band	Estimated kl0 for 100m (dB @ per band)	Estimated kl0 for 500m (dB per band)
US1 (3.75 to 5.2MHz)	7.0	14.7
US2 (8.5 to 12MHz)	3.7	11.6

Table 8 : Estimated kl0 Values for Band Plan 998ADE17

Expected Outcome - If AELEM is implemented correctly, then the ANFP Part C mask should not be violated using the appropriate companion AELEM spreadsheet and the DSLAM reported kl0 values for each band should not exceed +/- 1dB of the limits defined in Table 8.

A.4.2.2.12 Support of Bit Swap (R.VDSL2.15)

Description – The Modem shall support bit swap as defined in G.993.2[3].

Test Procedure –

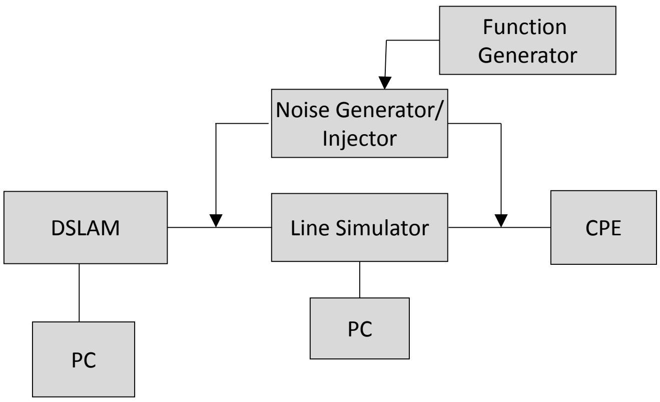

Figure 24 : Test Configuration for Checking Bit Swap

1. Configure DSLAM to implement an ESEL value of 30dB and the default band profile.
2. Connect CPE to DSLAM using the Test Configuration shown in Figure 24.
3. Set line simulator to a loop length of 500m with crosstalk injected at each end of the system.
4. Ensure that CPE has attained synchronisation.
5. Capture bit allocation table (both upstream and downstream) from element manager.
6. Inject a narrow band RFI source at the CPE end of the link using the function generator – this simulates a broadcast AM transmission. Set frequency to 3MHz and set power at -50dBm and increase over 1 minute to -20dBm in 2dB steps.
7. Recapture downstream bit allocation table from element manager.
8. The downstream bit allocation table should reveal a reduction in the bit allocation data at 3MHz (ie tone #696).
9. Inject a narrow band RFI source at the DSLAM end of the link using the function generator – this simulates a broadcast AM transmission. Set

frequency to 10MHz and set power at -50dBm and increase over 1 minute to -10dBm in 2dB steps.
10. Recapture upstream bit allocation table from element manager.
11. The upstream bit allocation table should reveal a reduction in the bit allocation data at 10MHz (ie tone #2319).
12. The system should not retrain during this test.

Expected Outcome – "Pass" if bit swap is observed in the upstream and downstream bit allocation tables around the frequency of the interfering tone and modem does not lose synchronisation, else "Fail".

A.4.2.2.13 Correct Reporting of Vendor Information (R.VDSL2.16)

Description – The Modem shall support the correct reporting of Vendor ID, Version Number and Serial Number as described in section 11.2.3.6 of G.993.2 [3].

Test Procedure – The CP shall provide the information shown in Table 9 and Table 10 to Openreach prior to the start of any testing. This will be as part of the Openreach Customer Establishment Process – details can be found at: http://www.openreach.co.uk.

CPE Manufacturer
CPE Product Name/Model
CPE Software Release Number
CPE Serial Number
System Vendor ID
Chipset Manufacturer
Chipset Hardware Version
Chipset Firmware Version

Table 9 : CPE Information

Splitter Manufacturer
Product Name/Model
CPE Software Release Number
Version Number
Serial Number
Type (Centralised/Distributed)

Table 10 : CPE Splitter Information

The element manager on the DSLAM will be used to validate the CPE Information. This should reflect the information provided in Table 9. CPE splitter information will be verified visually if possible against the information provided in Table 10.

Expected Outcome – If the reported data matches the information provided in Table 9 then this will be deemed a "Pass", else the CPE will be deemed to have failed the test.

A.4.2.2.14 Correct Reporting of Key Test and Diagnostic Parameters

Description – The Modem shall support the correct reporting of key VDSL2 test and diagnostic parameters according to G.997.1[5]. These parameters are listed in Table 1 (see Section 3.2.2).

Test Procedure -

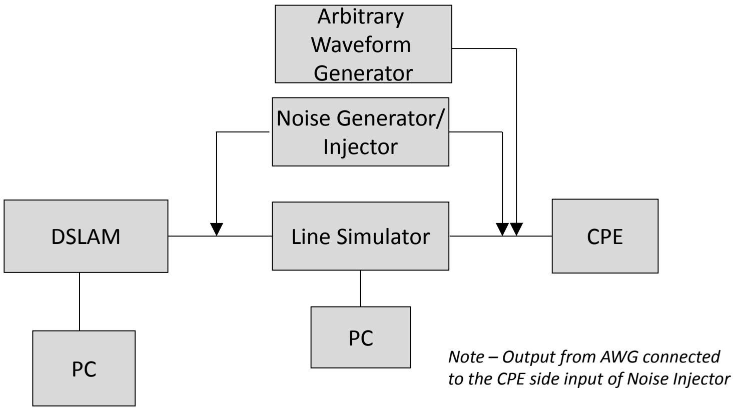

Figure 25 : Test Configuration for Checking Test and Diagnostic Parameters

1. Configure DSLAM to implement an ESEL value of 30dB and the default band profile.
2. Connect CPE to DSLAM using the Test Configuration shown in Figure 25.
3. Set line simulator to a loop length of 500m with no crosstalk injected at either end of the system.
4. Ensure that CPE has attained synchronisation and then leave the system running for 20 minutes.
5. Capture 15 minute performance data from element manager and check that key parameters are reported.
6. Now turn crosstalk noise on at each end of system and repeat test.
7. Capture 15 minute performance data and compare with that recorded previously.
8. Check that reported data rate, maximum attainable line rate and noise margin have changed in each direction.
9. Now configure noise generator to inject a 5ms micro-interrupt onto the CPE end of the link every 10 seconds and leave to run for 20 minutes.
10. The 15 minute data should now show a number of errored seconds (~90), severely errored seconds and/or FEC seconds.
11. Now turn micro interrupts off and configure the arbitrary waveform generator (AWG) to generate VDSL2 shaped REIN comprising 100µs bursts every

10ms at an amplitude of -110dBm/Hz (measured at 1MHz) and inject onto the line using the noise injector. Leave system to run for 20 minutes

12. The 15 minute data should now show a number of errored seconds (ES), severely errored seconds (SES) and/or forward error correction (FEC) seconds. The error counts should NOT exceed 900 for any given 15 minute period. If no SES are observed, the amplitude of the signal should be increased until SES are observed. Note that the system may retrain during this test – this behaviour is expected.
13. Now configure the DSLAM with an open interleaved profile O2_1_6_36_3_6_18_2 and repeat Steps 9 through 12.
14. The 15 minute data should now report interleaver settings (INPmin and Dmax) for each direction in addition to errored second (ES), severely errored seconds (SES) and/or FEC seconds.

Expected Outcome – If the reported data matches the information provided in Table 1 and error counts do not exceed 900 during any 15 minute period then this will be deemed a "Pass", else the CPE will be deemed to have failed the test.

A.4.2.2.15 Verification of Hlog and QLN (T2R Capability)

Description – This test is defined to test whether a CPE interworks with the GEA DSLAMs sufficiently well to report Hlog and QLN back to the DSLAM in a deployment scenario using micro-filters and home wiring. This data is used for test and diagnostic purposes to reduce time to repair. The presence of the extension wiring in this case should cause deep nulls to appear in the Hlog data.

It is recommended that this test is performed as part of the AELEM test (see Section A.4.2.2.11) as both use the same test set-up. However, it can be also be performed in isolation if required.

Test Procedure –

1. Set the line simulator to 500m length (This equates to a kl0 value of 9dB measured at 1MHz) with the appropriate crosstalk injected at each end of the system.
2. Connect the spectrum analyser as shown in Figure 26 and capture the reference Hlog spectrum on the line. This will form the Hlog template required for this test.

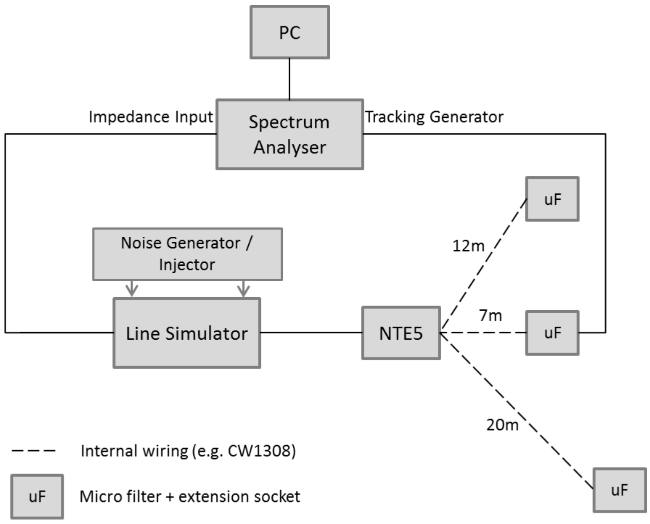

Figure 26 : Test Configuration for Hlog reference

3. Connect the test setup as shown in Figure 27A and B and capture the reference QLN on the line for both upstream and downstream directions. This will form the QLN templates required for this test.

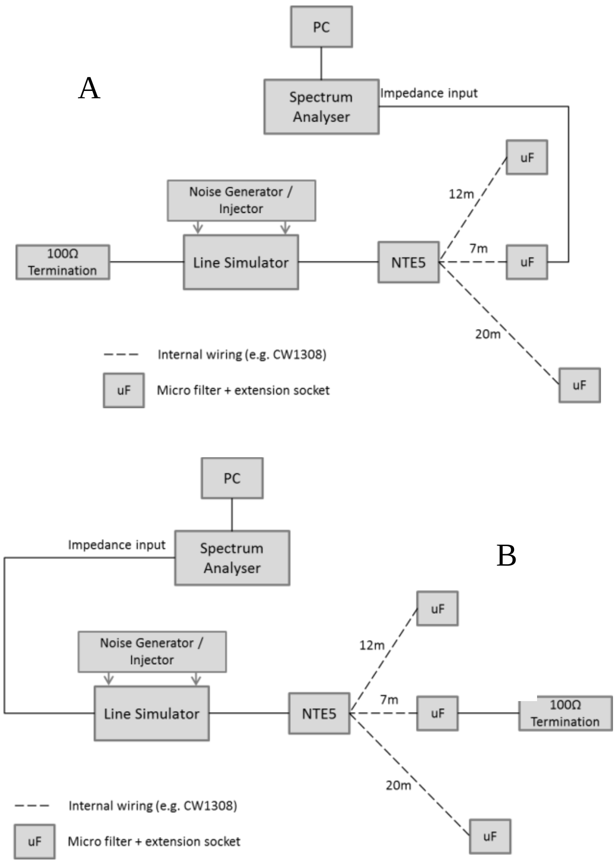

Figure 27 : Test Configuration for QLN capture

4. Connect CPE to DSLAM using the test setup shown in Figure 28.

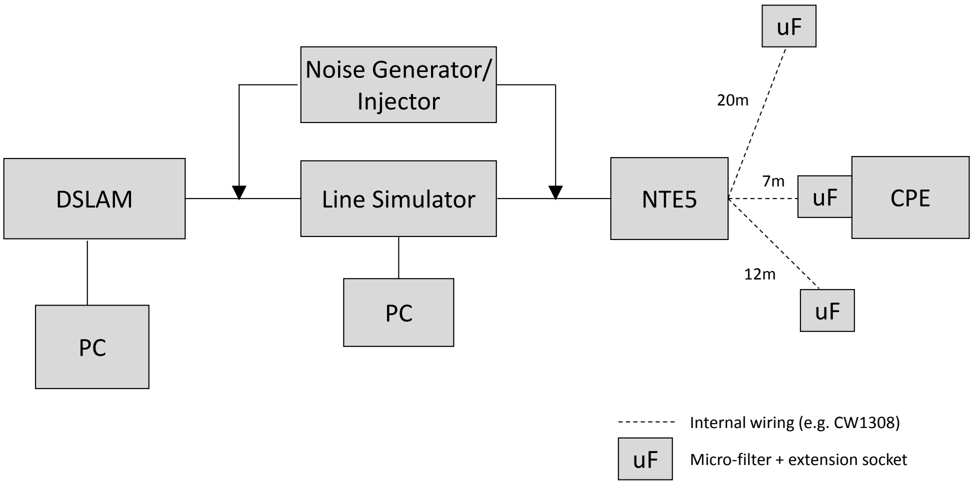

Figure 28 : Test Configuration for Hlog/QLN test

5. Configure DSLAM to implement an ESEL value of 30dB and apply an AELEM enabled DSL profile to the line.
6. Inject the appropriate crosstalk at each end of the system.
7. Record Hlog/QLN data from the DSLAM element manager.
8. Compare the Hlog and QLN data to the reference templates captured previously in Steps 2 and 3 above.
    a. Note: for the QLN reference plot:
        i. Upstream bands use trace from Figure 27A
        ii. Downstream bands use trace from Figure 27B
        iii. Convert the power (in dBm) reference QLN measured by the spectrum analyser to dBm/Hz using the correct bandwidth correction factor/dB.

Expected Outcome - The Hlog test will be deemed a “Pass” if the Hlog falls within a mask of +/- 3.5dB of the reference PSD captured in step 3. The QLN test will be deemed a “Pass” if the upstream and downstream QLN data falls within a range of +/- 3.5dB of the reference value captured in step 4.

A.4.2.2.16 <u>Concurrent Vectoring and Downstream Retransmission (R.VDSL2.18)</u>

The CPE modem shall fully support concurrent operation of vectoring and downstream retransmission as described in G.993.5 [7] and G.998.4 [6].

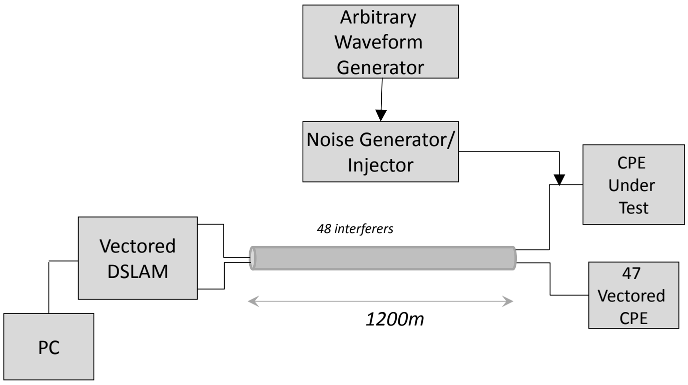

Figure 29 : Test Configuration for Verifying Concurrent Downstream Retransmission and Vectoring

Test Procedure –

1. Configure DSLAM to implement an ESEL value of 30dB and the O2_1_6_36_3_6_18_2open interleaved profile on all 48-ports.
2. Connect 47 reference CPE (ie known to support vectoring and downstream retransmission) and the CPE under test to 48-pairs of a 1200m length of 50-pair cable and ensure that all CPE reach synchronisation with vectoring disabled.
3. Capture 15 minute performance data for all 48 modems.
4. Enable vectoring and recapture 15 minute performance data once all lines have successfully retrained.
5. Now configure the arbitrary waveform generator (AWG) to generate VDSL2 shaped REIN comprising 100µs bursts every 10ms at an amplitude of -110dBm/Hz (measured at 1MHz) and inject it onto the pair connected to the CPE under test.
6. The 15 minute data should now show a number of parameters including Actual INP, RTX_USED_ds, uptime, number of retrains, errored seconds, severely errored seconds and/or FEC seconds on the pair connected to the CPE under test and also on some (or all) of the other pairs of the cable. Note that the error count should NOT exceed 900 for any given 15 minute period.
7. Now configure the DSLAM to implement the O2_3_6_36_3_6_18_3retransmission profile on all 48-ports and repeat steps 3 to 6.
8.

Expected Outcome – The CPE shall implement downstream retransmission and vectoring concurrently. In addition, with retransmission enabled, during any 15 minute period the system should report <10 errored seconds and no retrains in the downstream direction across all ports. If these criteria are met then this will be deemed a “Pass”, else the modem will be deemed to have failed the test. In general, the error performance of the CPE under test with retransmission enabled should be better (ie fewer errors) than that using an interleaved profile.

A.4.2.2.17 Support of different target downstream noise margins (R.VDSL2.19)

Description – The modem shall support multiple target downstream noise margin settings

Test Procedure -

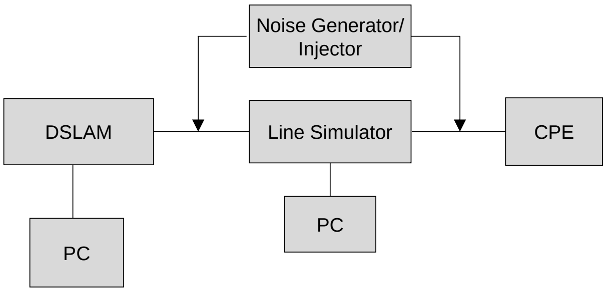

Figure 30 : Test Configuration for Verifying Different Target Noise Margins

Part A

1. Configure DSLAM to implement an ESEL value of 30dB and the default (ie 6dB target noise margin) downstream retransmission profile (with fast upstream) O2_3_6_36_3_6_18_1.
2. Connect CPE to DSLAM using the Test Configuration shown in Figure 30.
3. Set line simulator to a loop length of 200m with crosstalk injected at either end of the system.
4. Ensure that CPE has attained synchronisation, then record the downstream and upstream data rates from the element management system.
5. Repeat the above process but with the downstream target noise margin set to 3dB as in profile O2_3_3_36_3_6_18_1.
6. Repeat the above process for the LOW downstream retransmission profile (with fast upstream) O2_3_6_36_2_6_18_1.
7. Repeat the above process but with the downstream target noise margin set to 3dB as in profile O2_3_3_36_2_6_18_1

Expected Outcome

The downstream rates recorded with the 3dB target noise margins should be significantly higher than those recorded with the 6dB target margins. There should not be any significant difference in reported rates between the high and low retransmission profiles.

Note: It is assumed that if the modem supports a target noise margin of 3dB and 6dB then it shall also support target noise margins of 4 and 5dB

A.4.2.3 Ethernet Layer

A.4.2.3.1 Ethernet Frame Size (R.ETH.1)

Description – The modem shall support a minimum Ethernet frame size equal to or larger than 68 bytes, and a maximum frame size of equal to or less than 1534 bytes at the WAN interface. For clarity, this figure includes 4 bytes for the C-VLAN (101), and excludes bits allocated to pre-amble, Inter-Frame Gap, and Frame Check Sequence at the user network interface (UNI). Support for frame sizes less than 68 bytes and above 1534 bytes (inclusive of C-VLAN) is not guaranteed..

Test Procedure - Configure the system as shown in Figure 31 and Figure 32.

Note: This test procedure incorporates tests for:

- R.ETH.1
- R.WAN.1
- R.WAN.2

Note: The following requirements shall be verified via vendor self-certification:

- R.WAN.4
- R.WAN.5
- R.WAN.6

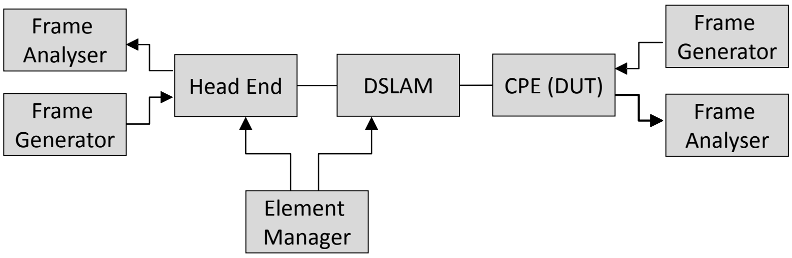

Figure 31: Ethernet Test Configuration (Logical)

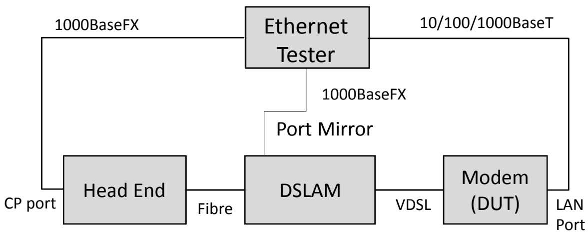

Figure 32: Ethernet Test Configuration (Physical)

1. Login to the Element Manager and verify that the service configuration is present.
2. Using Element Manager, configure default VDSL2 line profile (O2_0_6_36_1_6_18_1) and apply the profile on the Headend and DSLAM. The profile must be applied on the VDSL2 port connected between the DSLAM and the modem.
3. Configure the Ethernet tester port connected to the Head End and provision it to generate downstream traffic with the following attributes:
   (a) Port speed set to 1 Gbps

(b) Source address set to "Valid Source MAC-address' and Set Destination address to "Valid Destination MAC-address”.
(c) Enable VLAN by configuring outer and inner VLAN tag as appropriate.
(d) Set Rate Control to less than the traffic profile applied to the VDSL2 line connected between DSLAM and Modem.
(e) Set Frame Size as 1518 and increment up to a maximum of 1534 bytes. Note that GEA Data service supports an Ethernet frame size of between 68 and 1534 bytes.
(f) Set the Tag Protocol Identifier as 0X8100 .

4. Configure the Ethernet tester port connected to modem with the following attributes:
   (a) Set port speed 100 Mbps.
   (b) Source address set to " valid Source MAC-address” and Destination address set to " valid Destination MAC-address”.
   (c) Set Rate Control according to the traffic profile applied to the VDSL2 line connected between DSLAM and Modem .
   (d) Set Frame Size as 1518 and increment up to a maximum of 1534 bytes.
5. Start Transmitting end-to-end L2 bi-directional test traffic from simultaneously from the tester ports configured in earlier steps and Stop Transmitting after the specified duration (for example 60 seconds)
6. For the port connected to the Headend ,Set Rate Control to be more than the traffic profile applied to the VDSL2 line connected between DSLAM and Modem.
7. Start transmitting from the ports again.
8. Stop the traffic after a specified duration e.g. 2minutes. Record the tester results/statistics at the receiving port of the tester.
9. Capture the packets at the ingress of DSLAM by applying port mirroring and verify VLAN ID as 101. The modem shall support IEEE 802.1q VLAN encapsulation and all ingress frames shall be encapsulated within 802.1q VLAN. Traffic without a correct VLAN ID will be dropped.
10. Verify Tag Protocol Identifier (Ethertype) and CFI in the Packet. Apply packet capture at CP HoP side also and verify the packet captures.
11. Logout from Element Manager.

Expected Outcome –

(step 1) The login should be successful and Headend, DSLAM and modem configured correctly.
(step 2) Default VDSL2 line profile is configured and applied successfully.
(step 3) Provisioning should be completed successfully for the Headend connected port on the Ethernet tester
(step 4) Provisioning should be completed successfully for the modem connected port on the Ethernet tester. The maximum Ethernet frame size supported should be between 68 and 1534 bytes.
(step 5) No packet loss should be observed.
(step 6) Rate control on the Headend must be successfully updated.
(step 7) Packet loss should be observed.

(step 8) Only 80Mbps traffic i.e. equivalent to PIR rate should get received on the receiving port of the tester as traffic should get policed at the ingress port of the Headend as per the policy applied.
(step 9) VLAN ID 101 should be present in captured packets with 802.1q tag. Incorrect VLAN ID traffic should be discarded.
(step 10) Ethertype must be set to 0x8100 and CFI value as 0 on 802.1q tag. Openreach will set CFI to 0 towards the modem.
(step 11) Logout from Element Manager should be successful.

Note1 : If there is a serious configuration error or if IEEE 802.1q VLAN encapsulation (R.WAN1 and R.WAN2) is not supported, the test configuration should be verified by repeating the test using a known “good” modem. If the test is passed successfully, then the problem must be with the CP modem under test; either it is not correctly setup or IEEE 802.1q VLAN encapsulation is not supported. Note that it is the CP’s responsibility to provide the CPE pre-configured for use with GEA.

Note 2: This test is intended to show that only VLAN 101 is used. Any other VLANs used will be identified to feedback incorrect usage to CP.

A.4.2.4 WAN/VLAN Layer

A.4.2.4.1 Support of IEEE 802.1q VLAN Encapsulation (R.WAN.1)

Description – The Modem shall support IEEE 802.1q VLAN encapsulation.

See A.4.2.3.1.

A.4.2.4.2 Ingress frames encapsulated within IEEE 802.1q VLAN (R.WAN.2)

Description –All ingress frames to the Openreach UNI shall be encapsulated within an IEEE 802.1q VLAN (C-VLAN) with a value of 101 which will be used for switching within Openreach..

See A.4.2.3.1.

A.4.2.4.3 Simultaneous Support of Multicast and Unicast over the same VLAN (R.WAN.3)

Description – Where the CP intends to use Multicast for GEA, the modem shall be capable of simultaneously supporting Multicast and Unicast over the same single-tagged VLAN (101).

See A.4.2.3.1.

A.4.2.4.4 Ethertype field of Ethernet frame set to 0x8100 on ingress to Openreach UNI (R.WAN.4)

Withdrawn – replaced by vendor self-certification

A.4.2.4.5 CVLAN Canonical Format Indicator set to 0 on ingress to Openreach UNI (R.WAN.5)

Withdrawn – replaced by vendor self-certification

A.4.2.4.6 VLAN ID set to 101 (R.WAN.6)

Withdrawn – replaced by vendor self-certification

A.4.2.4.7 IGMP Reports Encoded Correctly (R.WAN.7)

Description –Where the CP intends to use Multicast, IGMP reports destined for Openreach Multicast for GEA shall be encoded as IGMPv3 or IGMPv2 over C-VLAN ID 101. Source Specific Multicast option within IGMPv3 must not be used. This test is not performed by BT as it requires connectivity to a multi-cast head-end.

Note that this test is only required if the CP intends to use multicast for GEA.

Test Procedure – Vendor derived. Copy to be provided to BT on request.

Expected Outcome – Vendor to confirm (in writing) via the Modem Conformance Test Request form, that if multicast is to be used, IGMP reports destined for Openreach Multicast for GEA are encoded as IGMPv3 or IGMPv2 over C-VLAN ID 101 and that the Source Specific Multicast option within IGMPv3 is not used.

A.4.2.4.8 Multicast Frames detected and processed correctly (R.WAN.9)

Description –Where the CP is using PPP and intends to use Multicast for GEA, the modem shall be able to detect and process multicast frames differently to unicast. Multicast for GEA frames sent into Openreach (IGMP reports) shall not be encapsulated with PPP otherwise they will passed transparently as normal GEA traffic. This test is limited to verifying that IGMPs are forwarded over the Multicast VLAN when performed by BT as full multicast testing requires connectivity to a multi-cast head-end.

Note that this test is only required if the CP intends to use multicast for GEA.

Test Procedure – Vendor derived. Copy to be provided to BT on request.

Expected Outcome – Vendor to confirm (in writing) via the Modem Conformance Test Request form, that if multicast is to be used, their modem shall be able to detect and process multicast frames differently to unicast.

A.4.2.5 OAM Layer

A.4.2.5.1 Support of Loop Back Messages (R.OAM.2)

Description –

(a) The modem WAN interface shall support Loopback Messages (LBM) as described in ITU-T Y.1731[14].
(b) The modem shall respond to LBM over VLAN ID 101 with a Loopback Reply Message (LBR), at MD Level 1. The LBM destination MAC address could be either multicast or unicast, both are to be supported. Multicast destination addresses for the LBMs are as follows:

1. MD Level 1: 01-80-C2-00-00-31

(c) An inner customer X-tag, if present in the LBM (in addition to the Openreach tag), should be returned in the LBR message.

Note: Loopback messages at Maintenance Domain (MD) Level 2 and above are allocated for CP use. Any use of MD levels 2 and above is optional and entirely within the CP's domain, and will therefore not be tested. See Section 2.1.8 for further information on OAM implementation.

Test Procedure –

1. Login to the Element Manager.
2. Navigate to Device Management and click on the Headend
3. Select ETHERNET OAM from the Services options
4. Navigate to the Maintenance Domain screen
   a) Add a new maintenance domain with the name FTTx_MD_Openreach_1
   b) Select the MD level as 1
5. Navigate to the Maintenance Association screen
   a) Add a new association with the name FTTx_MD_Openreach_1
   b) Select the continuity check (CC) interval one minute
6. Add a new Maintenance End Point (MEP) with the parameters:
   a) MEP ID local MEP ID 1
   b) Interface Info
   c) Interface direction up
   d) VLAN tag =VLAN id configured
   e) Continuity Check Messages (CCM)[**] and Link Trace Message (LTM) priority 5
7. Select the MEP created in step 6 select 'Loop Back'.
   Input the number of loopback messages
   Start the loopback test
8. Logout from Element Manager.

Expected Outcome –

(step 1) Login should be successful.
(step 2) New screen should open for the Headend device.
(step 3) A new MD should be created successfully.
(step 4) A new MA should be created successfully.
(step 5) A new MEP should be created successfully
(step 6) Loopback test results should show the number of frames sent being equal to the number of frames received.
(step 7) Logout from EMS should be successful.

[**] *CCM are the messages between 2 MEP's and any 3 consecutive failures will raise a Loss of Connectivity (LOC) alarm*

A.4.2.5.2 Support of 802.3ah Loopback (R.OAM.3)

Description - The modem WAN interface shall support 802.3ah (802.3[11] clause 57 OAM) and shall support the feature “OAM remote loopback” configured to passive mode. The modem shall participate in the discovery process initiated by the Openreach DSLAM, responding to OAMPDUs from the Openreach DSLAM (which will be in Active mode). This also includes reporting successful or failed setting or removal of loopback and reporting loopback state to the DSLAM upon request. The modem shall not be able to request the DSLAM to apply loopback as it is in passive mode.

Test Procedure –

1. Run the end-to-end data traffic via the tester.
2. Enable EFMOAM loopback at DSL port on EMS with "Forward" mode and a specific timer value
3. Dowstream data traffic should be returned upstream to the tester
4. Upstream traffic should be discarded

Expected Outcome – Upstream and downstream traffic should resume after the loopback has been disabled

A.4.2.5.3 Support of “Dying Gasp” (R.OAM.4)

Description – The Modem should support “dying gasp” as defined in Section 11.3.3.2 of G.993.2 and Section 7.1.1.2.3 of G.997.1[5].

Test procedure –

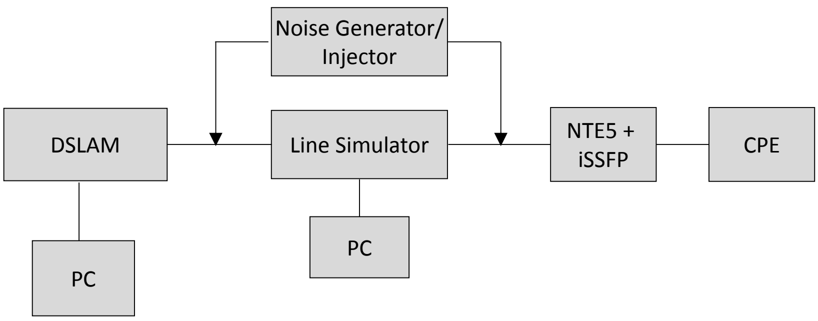

Figure 33 : Test Configuration for verifying “Dying Gasp”

1. Configure DSLAM to implement an ESEL value of 30dB and configure a port with the default band profile.
2. Connect the DSLAM and the CPE using the Test Configuration shown in Figure 33.
3. Set line simulator to simulate a loop length of 300m with noise injection disabled (i.e. noise free).

4. Once the CPE has attained synchronisation, verify that no additional alarms have been raised on the EMS.
5. Disconnect the plug from the power socket on the CPE. The modem should now power off.
6. Check and record the EMS alarm messages.
7. Replace power plug in socket and allow modem to resynchronise.
8. Repeat steps 5 and 6 but this time switch off the power at the mains socket (or disconnect PSU from socket).
9. Check and record the EMS alarm messages.
10. Repeat steps 3 to 9 for a loop length of 1000m.

Expected Outcome – If “dying gasp” is supported, the alarm message will report “Loss of Power”. If “dying gasp” is not supported, the EMS alarm will report “Loss of Frame or Loss of Sync”.

A.4.2.5.4 Correct Reporting of Key Test and Diagnostic Parameters (R.VDSL2.17)

Although this test is described in the VDSL test requirments section, it is also necessary to verify that the key test and diagnostic parameters are correctly reported in the bulk files that are generated by the DSLAM.

Description – The Modem shall support the correct reporting of key VDSL2 test and diagnostic parameters according to G.997.1. These parameters are shown in Table 1 (see Section 3.2.2).

Test Procedure –

1. Login to NGA vendor FTP server using the correct credentials:-
2. Navigate to the required folder for the bulk data files
3. Verify the following on the system file uploaded:
   a) Network Device ID = "NE Name on the EMS"
   b) Device Sub-Element ID = "Shelf/Slot/Port"
   c) Sub Element Type = "PTP/Sys"
   d) Time Stamp
   e) PMP_TRANS_OCTET = transmitted frames
   f) PMP_RECV_OCTET = Received Frames
   g) PMP_UP_DISC_FRAMES = 0
   h) PMP_DW_DISC_FRAMES = 0
   i) PMP_CPU_UTIL
   j) PMP_MEM_UTIL
   k) PMP_TEMP_VAL
   l) PMP_VOLTAGE_VAL
4. Verify the following on the DSL file uploaded with the values displayed on the Element Manager:
   a) xTu-R Version
   b) Network Device ID

c) Device Sub-Element ID
d) Sub Element Type
e) Time Stamp
f) PMP_DSL_OPR_MODE = 5
g) PMP_ATUR_VDR_ID = Vendor ID
h) PMP_DSL_PRF_NAME = "Profile Name"
i) FEC seconds-line far end(downstream)
j) Errored second-line far end (downstream)
k) Severely errored second-line far end (downstream)
l) PMP_FAIL_FULL_INIT = No of failure
m) PMP_LINE_ATTN_US
n) PMP_LINE_ATTN_DS
o) PMP_SNR_US
p) PMP_SNR_DS
q) PMP_LINE_RATE_US
r) PMP_LINE_RATE_DS
s) PMP_MAX_ATBL_DR_US
t) PMP_MAX_ATBL_DR_DS
u) PMP_UP_TIME = Up time in Mins
v) PMP_TRFC_US
w) PMP_TRFC_DS
x) PMP_PWR_STT
y) PMP_AATP_US
z) PMP_AATP_DS
aa) PMP_R_US
bb) PMP_R_DS
cc) PMP_S_US
dd) PMP_S_DS
ee) PMP_D_US
ff) PMP_D_DS
gg) PMP_N_US
hh) PMP_N_DS
ii) RTX_USED_DS
jj) RTX_USED_US

Expected Outcome –

(step 1) Login should be successful. User should be able to navigate to NBI interface on the server.
(step 2) Bulk file needs to be available in the appropriate folder on the Element Manager. There shouldn't be any discrepancy on the pathname.
(step 3) All key VDSL2 test and diagnostic parameters should be correctly reported. Values should match those in the Element Manager.
(step 4) Values should be the same as per the DSL line parameters under the performance tab on the Element Manager.

A.4.2.6 CPE Filters

R.FILTER.1 Centralised Splitters

Description - Centralised splitters shall comply with the requirements of ETSI Specification TS 101 952-1[15] with the following options selected:

i) Option B category of Section 6 of TS 101 952-1.

ii) The option to support metering pulses as described in section 6.7 of TS 101 952-1 does not need to be implemented.

iii) The option to provide common mode rejection as described in section 6.14 of TS 101 952-1 does not need to be implemented, although it is known that this option can help to improve DSL service reliability.

iv) The applicable tables in Normative Annex A of TS 101 952-1 for VDSL2 filters are:

- Table A.2 (Dedicated requirements for splitters for xDSL system variants),
- Table A.3 (Differentiation of IL in the xDSL band between LE and TE side),
- Table A.6 (Dedicated frequency ranges for splitters for VDSL2 system variants) and
- Table A.9 (Dedicated requirements for Passive splitters for VDSL2 over POTS variants at the TE side).

Test Description – As defined in TS 101 952-1.

Expected Outcome – Vendor to provide written confirmation, via the Modem Conformance Test Request form, that their centralised splitter filter complies with the above requirements.

R.FILTER.2 Distributed Splitters (i.e. Micro filters)

Description - Distributed splitters shall comply with the requirements of ETSI Specification TS 101 952-3 [16] with the following options selected:

i) Option B category of section 6 of TS 101 952-3.

ii) The option to support metering pulses as described in section 6.7 of TS 101 952-3 does not need to be implemented.

iii) The applicable tables in Normative Annex A of TS 101 952-3 for VDSL2 filters are:

- Table A.2 (Dedicated requirements for distributed filters for xDSL system variants),
- Table A.3 (Overview of all POTS band requirements for all types of filters and N values),
- Table A.4 (Overview of Insertion Loss in the xDSL band for all types of filters
- Table A.7 (Dedicated frequency ranges for distributed filters for VDSL2 system variants).

Where appropriate, the requirements for either the “Standard” filter class (see Section 6.1.1 of TS 101 952-3) with N=3 or the “Enhanced” filter class with N=4 shall be selected from the appropriate column in the tables (N is the minimal number of parallel filters in the Test Configuration - see Section 6.4.1 of TS 101 952-3).

iv) If the CPE VDSL2 filter is to be used in a multiple filter topology then the filter shall “Pass” the recommendations of TS 101 952-3 with up to two other CPE VDSL2 filters (Standard) or three CPE VDSL2 filters (Enhanced) connected in parallel with the CPE VDSL2 filter under test. Each filter shall have their Telephony Port open circuit.

Test Description – As defined in TS 101 952-3.

Expected Outcome – Vendor to provide written confirmation, via the Modem Conformance Test Request form, that their distributed splitter filters comply with the above requirements.

A.4.3 GEA testing

A.4.3.1 Transmission Performance Testing

In addition to the SIN 498 tests defined above, the transmission performance of the CPE will also be measured against the current Live GEA reference models. This will involve the modem performance being evaluated with the DSLAM configured to implement both fast and retransmission profiles.

A.4.3.1.1 Deployment Scenario 1 : SSFP With No Home Wiring

Description – This test gives an indication of how a CPE would perform if connected to the Openreach GEA network as part of a SSFP based deployment scenario (i.e no home wiring). It is also used to record a bench-mark of the CPE modem's performance against the current (i.e. LIVE) network firmware which can then be used to check whether the transmission performance of the CPE modem is adversely affected by future network upgrades. Testing should be performed using both FAST and RETRANSSMISSION operation.

Test Description (FAST) –

1. Configure DSLAM to implement an ESEL value of 30dB and the default band profile.
2. Connect CPE to DSLAM using the test setup shown in Figure 34.
3. Set line simulator to a loop length of 200m with the appropriate crosstalk injected at each end of the system.
4. Record time taken for the CPE to attained synchronisation. This shall be <90s on all loops regardless of line length.
5. Wait 2 minutes for system to stabilise then record key transmission performance parameters (data rate, margin etc.) from EMS.
6. Repeat steps 3 to 5 for 500m, 1000m, 1500m, 2000m and 2200m cable lengths.
7. Repeat for ESEL values of 10 and 50dB.
8. Repeat for all current combinations of Openreach DSLAMs and line cards.

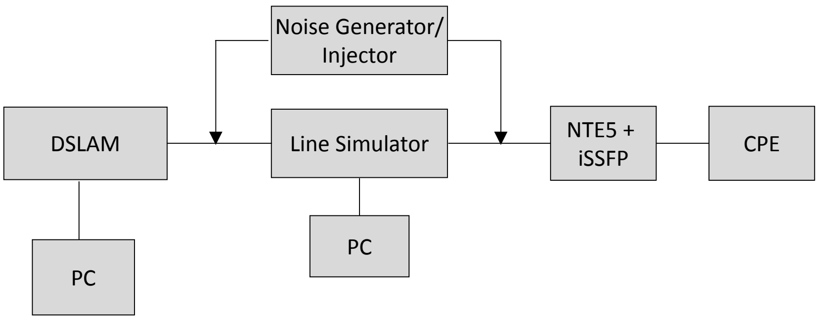

Figure 34 : Test Configuration for Measuring Transmission Performance (SSFP with no home wiring)

Test Description (RETRANSMISSION) –

As for FAST operation but using the appropriate retransmisionprofile (O2_3_6_36_3_6_18_3) for each loop length and ESEL.

ESEL values	Lengths
10 dB, 30 dB, 50 dB	200m, 500m, 1000m, 1500m, 2000m,

	2200m

Table 11 : ESEL Values and Loop Lengths for Interleaved Testing

Expected Outcome – This test will provide an indication on how the CPE performs when connected to the current Openreach GEA network for both fast and interleaved operation.

A.4.3.1.2 Deployment Scenario 2 : Microfilter With Home Wiring

Description – This test gives an indication of how a CPE would perform if connected to the Openreach GEA network as part of a deployment scenario using microfilters and home wiring). Comparing the results against those obtained from an SSFP based deployment scenario (i.e. no home wiring) will give an indication on how the CPE performance is affected by bridged taps caused by telephony extensions in the customer's premises. In this configuration, the three lengths of cable (7m, 12m and 20m) connected to the NTE5 (the demarcation point in the customer's premises where the Openreach network terminates) are representative of telephony wiring extensions and are specifically chosen to introduce notches in the VDSL downstream and upstream frequency bands. Testing should be performed using both FAST and RETRANSMISSION operation.

Test Description (FAST) –

1. Configure DSLAM to implement a ESEL value of 30dB and the default band profile.
2. Connect CPE to DSLAM using the test setup shown in Figure 35.
3. Set line simulator to a loop length of 200m with the appropriate crosstalk injected at each end of the system
4. Record time taken for the CPE to attained synchronisation. This shall be <90s on all loops regardless of line length.
5. Wait 2 minutes for system to stabilise then record key transmission performance parameters (data rate, margin etc.) from EMS.
6. Repeat steps 3 to 5 for 500m, 1000m, 1500m, 2000m and 2200m cable lengths.
7. Repeat for ESEL values of 10 and 50dB.
8. Repeat for all current combinations of Openreach DSLAM and line cards.
9. Compare results against those obtained for a SSFP based deployment scenario to determine impact of telephony extension wiring on CPE modem performance.

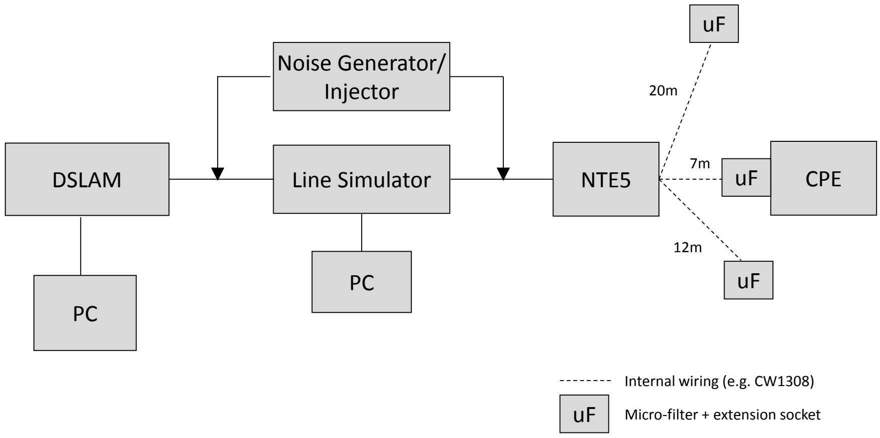

Figure 35 : Test Configuration for Measuring Transmission Performance (Microfilter with home wiring)

Test Description (RETRANSMISSION) –

As for FAST operation but using the retransmission profile O2_3_6_36_3_6_18_3

Expected Outcome – This test will provide an indication on how the CPE performs when connected to the current Openreach GEA network for both fast and interleaved operation.

A.4.3.2 Verification of "Router Only" Functionality

Description – This test is defined to test whether a CPE modem can achieve end-to-end-connectivity with an external server when connected directly to the Ethernet UNI on the Openreach modem i.e. when operating in "Router Only" mode.

Test Procedure – Connect Openreach modem to a port on the DSLAM via a 100m length of simulated 0.5mm gauge cable and ensure that it trains up and reaches synchronisation. Connect CPE modem to the Ethernet port on the Openreach modem and attempt to establish a connection with the remote server.

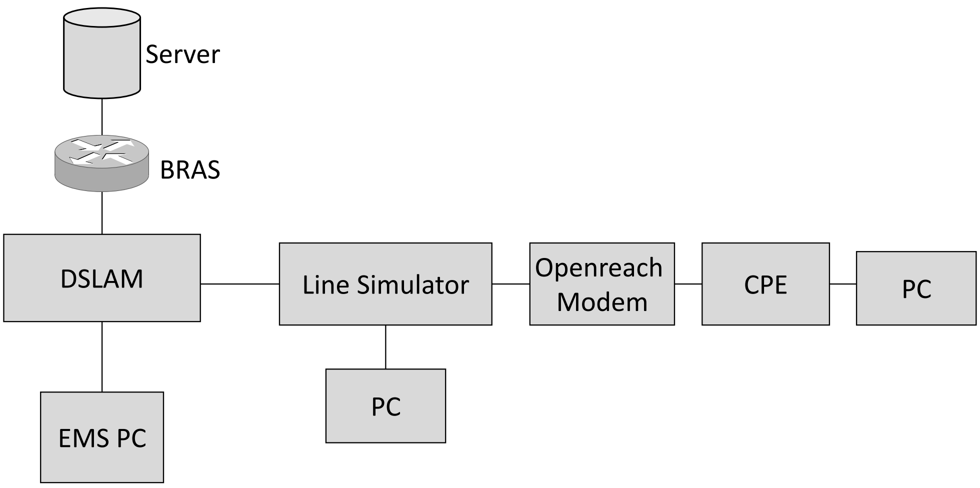

Figure 36 : Test Configuration for Checking "Router Only" Functionality

1. Configure DSLAM to implement an ESEL value of 30dB and ensure that the default band profile is loaded onto a port.
2. Set line simulator to a loop length of 100m with noise injection disabled (i.e. noise free)
3. Connect the Openreach modem to that port and check that it has attained synchronisation.
4. Connect the CPE modem to the Ethernet UNI on the Openreach modem. Following this, attempt to set up an end-to-end connection between a PC connected to the CPE and an external server.
5. Check that end-to-end connectivity has been achieved by launching an Internet session using the PC connected to the CPE. This will confirm whether the modem has established a DHCP or PPP session with the server.

Expected Outcome – This test will be deemed a “Pass” if the CPE modem can achieve an end to end connection with the external server through the Openreach modem, else the test will be deemed a “Fail”.

Annex B Test Requirements for GEA over ADSL2+

This Annex provides a detailed breakdown of the modem conformance test (MCT) requirements to enable a piece of vendor CPE to be validated against the CPE Requirements for GEA over ADSL2+ defined in Section 4 of this document. This is adapted from the requirements of TR-114[20] except that it refers to BT specific noise models, service profiles, cable lengths and gauges.

Details of how to engage with BT on Modem Conformance Testing may be obtained by contacting our Service Establishment team at: customer.establishment@openreach.co.uk.

B.1 Test Configuration

B.1.1 Band Profiles

The following default band profile shall be used for all GEA over ADSL2+ tests unless otherwise specified:

lraD120_001_00_00U014_001_00_00

This default band differs from the band profile defined in TR-114 [20] in that it defines the use of an ADSL2plus band plan that supports use of the upstream 0 (US0) band between 25kHz and 138kHz.

This profile defines the following parameters:

lraD120_001_00_00U014_001_00_00		
Parameter	**Downstream Setting**	**Upstream Setting**
Maximum Data Rate	12,288kbit/s	1408kbit/s
Minimum Data Rate	128kbit/s	128kbit/s
Minimum Noise Margin	0dB	0dB
Target Noise Margin	6dB	6dB
Maximum Noise Margin	31dB	31dB
Dmax	0	0
INP min	0	0
Adaption Mode	Adapt at start up	Adapt at start up
Operating Mode	G.992.5	
Band Plan	Non-overlapped ADSL2plus over POTS (G.992.5 Annex A)	

Table 12 : GEA over ADSL2+ Profile Definition

B.1.2 Loops

European VDSL test loop #1 (0.5mm Cu)[21] shall be used for all tests. This will be simulated using a wireline simulator.

Note that the Broadband Forum (BBF) TR-114[20] currently defines European loops for evaluating 17MHz operation using 0.4mm gauge (i.e. 26AWG) cable while BT specifies the use of 0.5mm gauge cable (aka TP-100).

B.1.3 Plain Old Telephony Service (POTS)

It should be noted that POTS shall be connected onto the line via the splitter in the DSLAM on all test lines.

B.1.4 Crosstalk

The VDSL2 "Stockholm Lite" noise model shall be used as it includes the US0 band whereas the noise models defined in TR-114 do not currently include this frequency band (25 to 138kHz). This is representative of the noise ensemble that can be expected in a typical GEA cable binder. As GEA over ADSL2+ will be deployed alongside standard GEA, the same noise models can be used for both technologies.

A separate pair of noise files (upstream and downstream) is generated for each distance. In addition, a set of noise files is required for each of the 27 CAL (Cabinet Assigned Loss) values defined in the ANFP[9] as the DPBO shaping impacts the transmit PSD of the ADSL2plus signal launched at the cabinet. The noise files for a 2500m length of 0.5mm copper cable (equivalent to an electrical loss of 45dB measured at 1MHz) are shown below for CAL values of 10, 30 and 50dB. These noise files are based on VDSL2 signals as this is typical of the crosstalk that will be encountered when GEA over ADSL2+ is deployed.

The ITU-T G.992.5 Recommendation[23] uses the term E-side Electrical Length (ESEL) to refer to the loss of the cable connecting the exchange to the cabinet. The BT ANFP uses the term Cabinet Assigned Loss (or CAL) to describe the same parameter. In both cases, the insertion loss is measured at a frequency of 300kHz. For the purposes of this document, the two terms are interchangeable.

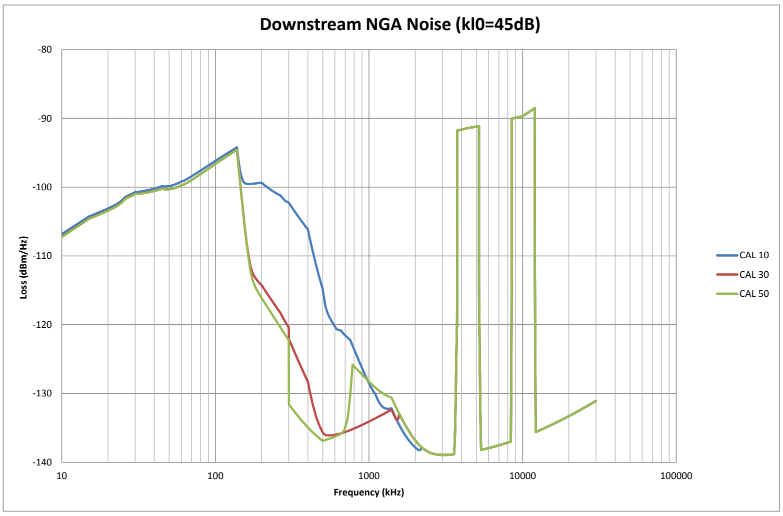

Figure 37 : Downstream GEA over ADSL2+ Noise Spectrum

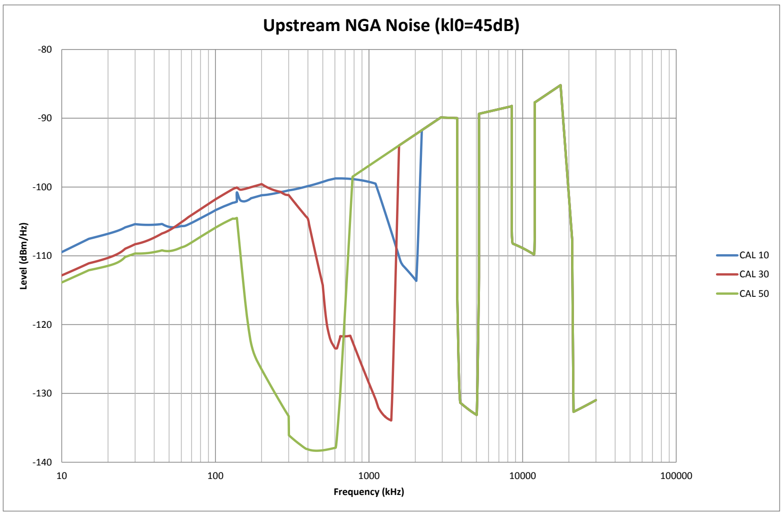

Figure 38 : Upstream GEA over ADSL2+ Noise Spectrum

These noise files can be generated and injected using a noise generator/injector unit. The PSD data required to generate and calibrate the noise files for CAL values of 10, 30 and 50dB over a range of lengths of 0.5mm gauge cable is contained in the companion spreadsheet entitled "Selected Cabinet Stockholm Lite Noise Files" (see Section A.1.4).

The following table shows the insertion loss of the various cable lengths used in the various tests at both 300kHz and 1MHz. It should be noted that GEA over ADSL2+ is only intended for use on long lines where it will give improved performance over convential GEA, hence the reduced number of loop lengths.

Length (0.5mm gauge)	IL @ 300kHz (dB)	IL @ 1MHz (dB)
2000m	20.2	36
2500m	25.3	45
3000m	30.4	54

Table 13 : Insertion Loss Values for Various Lengths of 0.5mm Gauge cable

If line simulators are used in evaluating system performance it is recommended that the loop length is adjusted to give the closest match to the loss at 1MHz as specified in the above Table. This will ensure that the greatest repeatability is achieved during testing.

B.2 Network Equipment

Currently Openreach uses network equipment from two strategic vendors (namely ECI and Huawei) in its GEA FTTC network. However, only equipment provided by Huawei is currently capable of supporting GEA over ADSL2+.

The test procedures described in this document shall be performed using the current firmware versions of Huawei network equipment deployed in the Openreach FTTC GEA network unless otherwise stated.

B.3 Test Equipment

The test equipment used by BT to perform these tests is shown in Table 14. Other equivalent equipment may be substituted.

Test Equipment	Example
Baluns (x2)	North Hills 0320BF
TP100 Line Simulator	Spirent DLS8235
Noise Generator/Injector	Spirent DLS5800/ DLS5410DC
Function Generator	Agilent 33250B
Arbitrary Waveform Generator	Sony Tektronix AWG2021
RMS/Peak Voltmeter	Rhode and Schwartz URE3
Spectrum Analyser	HP3585A
Impedance Matching network	Custom Built (see Figure 15)

Table 14 : BT's GEA Test Equipment

B.3.1 Details of Impedance Matching Network

In order to measure the transmit power spectral density (PSD) of the L system under test an impedance matching network (aka Loss Pad) is needed to correct the impedance of the simulated loop to as close as possible to the 100 Ohm reference impedance. Such a matching network is shown in Figure 15.

B.4 Modem Conformance Test (MCT) Requirements for GEA over ADSL2+

The MCT requirements for GEA over ADSL2+ are split into the following three sections:

- Initial Gating
- Compliance with Section 4 of SIN 498
- GEA over ADSL2+ Testing

The details of the various tests are defined in the following paragraphs.

B.4.1 Initial Gating Tests

The purpose of these tests is to check that the CPE modem can synchronise with a GEA over ADSL2+ field configuration and will not cause network harm. It is necessary for a CPE to "Pass" both of these tests before full SIN 498 conformance testing can commence. If either of these tests results in a "Fail", the CPE vendor will be informed by Openreach and asked to resolve the issue.

B.4.1.1 Synchronisation

Description – The modem shall achieve synchronisation to a reference GEA over ADSL2+ DSLAM and can achieve end-to-end-connectivity with an external server.

Test Procedure – Connect modem to a port on the DSLAM via a 2000m length of simulated 0.5mm gauge cable and ensure that it trains up and reaches synchronisation. Following this, attempt to set up an end-to-end connection between a PC connected to the CPE and an external server.

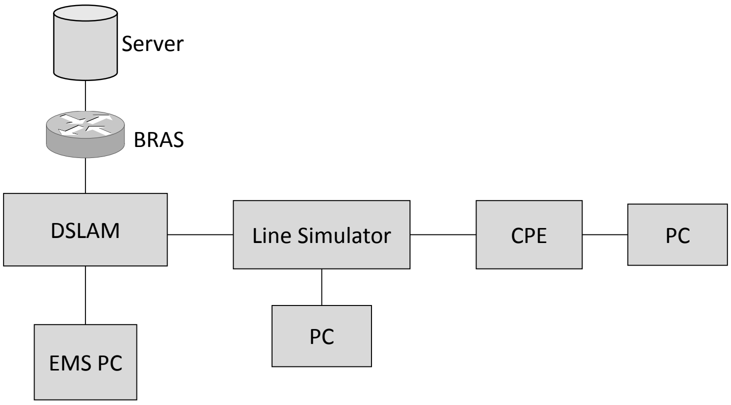

Figure 39 : Test Configuration for Checking Basic Synchronisation

1. Configure DSLAM to implement an ESEL value of 30dB and ensure that the default GEA over ADSL2+ band profile is loaded onto a port.
2. Set line simulator to a loop length of 2000m with noise injection disabled (i.e. noise free).
3. Connect the CPE modem to that port and check that it reaches synchronisation within 90 seconds.
4. If synchronisation is attained, check that the modem stays in synchronisation for a minimum of 120 seconds.
5. Check that end-to-end connectivity has been achieved by launching an Internet session using the PC connected to the CPE. This will confirm whether the modem has established a DHCP or PPP session with the server.

Expected Outcome – This test will be deemed a “Pass” if the modem attains synchronisation within 90 seconds, stays trained up for a minimum of 120 seconds and can achieve an end to end connection with the external server, else the test will be deemed a “Fail”. This test also verifies that the physical layer interface on the CPE modem is wired correctly (Requirement R.PHY.1).

B.4.1.2 Network Interference

Description – The modem shall not cause adverse interference to other systems operating in the same cable binder. In order to validate this, the modem shall only implement the A43 or A43c tone sets defined in G.994.1[4], and comply with the requirements of Part C of the BT Access Network Frequency Plan[9].

Test Procedure – Measure upstream PSD on two different line lengths (2000m, and 3000m) to check that system complies with Part C of the BT.

1. Configure DSLAM to implement an ESEL value of 30dB and configure a port with the default GEA over ADSL2+ band profile.
2. Connect the DSLAM and the CPE using the Test Configuration shown in Figure 18.
3. Set line simulator to simulate a loop length of 2000m with noise injection disabled (i.e. noise free)
4. During train-up, capture the handshake tones generated by each end of the transmission system.

5. Compare tones against those defined for A43 and A43c to check that tones other than A43/A43c are NOT being used.
6. Once the CPE has attained synchronisation, capture upstream PSD and wideband power and compare against Part C of the BT ANFP.
7. Repeat for both a warm start and a cold start[††]
8. Repeat for 3000m loop length.

Note that this test also covers requirements R.ADSL2+.3 (Compliance with Part C of the BT ANFP), R.ADSL2+.4 (Use of upstream band between 25 and 138kHz)) and the upstream part of R.ADSL2+.5 (Support of Cabinet Based Operation).

Expected Outcome - If the upstream transmit spectrum complies with the spectrum limits defined in Part C of the BT ANFP over the various loop lengths tested, the upstream transmit power does not exceed 14.5dBm and only tone-sets A43 and A43C are used, then this will be deemed a "Pass", else the result will be a "Fail".

B.4.2 SIN 498 Modem Conformance Tests

See Section 4 for details of the specific GEA over ADSL2+ requirements to which these conformance tests refer.

B.4.2.1 Physical Layer Tests

Each of the following sections defines the test required to demonstrate compliance to a particular requirement of SIN 498. The requirement number is shown in brackets after the title of the test.

B.4.2.1.1 <u>Physical Connection (R.PHY.1)</u>

Description - The socket on the CPE modem connecting to the Openreach UNI (i.e. WAN port) shall be either a RJ11 or RJ45 type to enable it to be connected to the VDSL2 filter using standard leads. The ADSL2plus connection is presented on the middle two pins - i.e. pins 3&4 (RJ11) or pins 4&5 (RJ45). The other pins are not connected. Pin numbering is from the left, looking into the socket with the contacts uppermost. Polarity is unimportant.

Test Procedure – Visual inspection.

Expected Outcome – The basic synchronisation and network interference tests will confirm whether the DSL socket on the CPE modem has been wired correctly (see Section A.4.1).

[††] *A warm-start is when the modem is disconnected from the line but remains powered up. Resynchronisation occurs when the modem is reconnected. A cold start is when the modem is powered off and then powered on again (i.e. a full restart).*

B.4.2.2 ADSL2plus Layer

B.4.2.2.1 <u>Support of Mandatory Requirements of G.992.3 and G.992.5 (R.ADSL2+.1)</u>

Description – The CPE modem used shall fully comply with the mandatory requirements of G.992.3[8] and G.992.5[23].

Test Procedure – Vendor derived, in line with G.992.3 and G.992.5. Copy to be provided to BT on request.

Expected Outcome – Vendor to confirm (in writing) via the Modem Conformance Test Request form, that their modem complies with the mandatory requirements of G.992.3 and G.992.5.

B.4.2.2.2 <u>Support of ADSL2plus non-overlapped spectrum (R.ADSL2+.2)</u>

Description – The Modem shall support ADSL2plus non-overlapped spectrum operation as defined in Annex A of G.992.5[23] (i.e. ADSL2plus over POTS)

Test Procedure – For each value of ESEL to be evaluated, measure downstream PSD on a 2000m line to check that full ADSL2plus band is being utilised and that downstream transmit power does not exceed 14.5dBm.

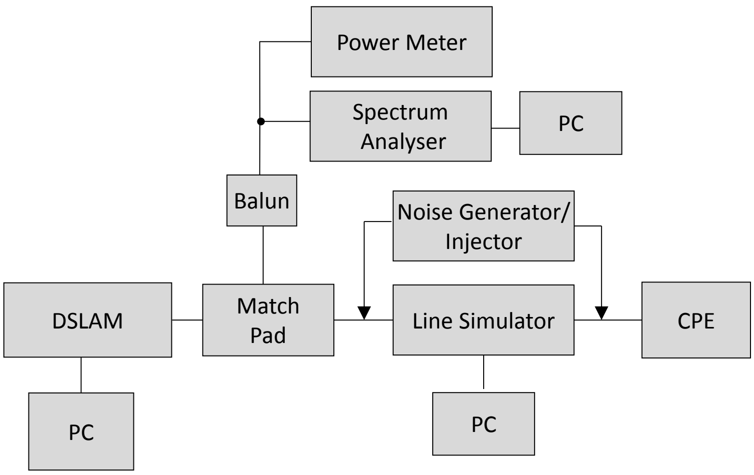

Figure 40 : Test Configuration for Measuring Downstream PSD

Details of the impedance matching pad used are shown in Figure 15.

1. Configure DSLAM to implement an E-side electrical length (ESEL) value of 30dB and configure a port with the default GEA over ADSL2+ band profile.
2. Set line simulator to a loop length of 2000m with crosstalk injected at each end of the system.
3. Connect CPE to DSLAM using the Test Configuration shown in Figure 40.
4. Ensure that CPE has attained synchronisation.
5. Capture downstream PSD and wideband power and compare against Part B of the BT ANFP.
6. Repeat for a minimum of two other ESEL values (nominally 10dB and 50dB).

Expected Outcome – This test will be deemed a "Pass" if the non-overlapped ADSL2plus spectrum is observed (i.e. use of downstream band between 138kHz and 2.208MHz) and that the downstream transmit power does not exceed 14.5dBm. If these criteria are not met, then the result is a "Fail".

B.4.2.2.3 Compliance with BT ANFP Part C (R.ADSL2+.3 and R.ADSL2+.4)

Description – The Modem shall comply with the requirements of Part C of the BT Access Network Frequency Plan[9].

Test Procedure – Measure upstream PSD on two different line lengths (2000m and 3000m) to check that system complies with Part C of the BT ANFP.

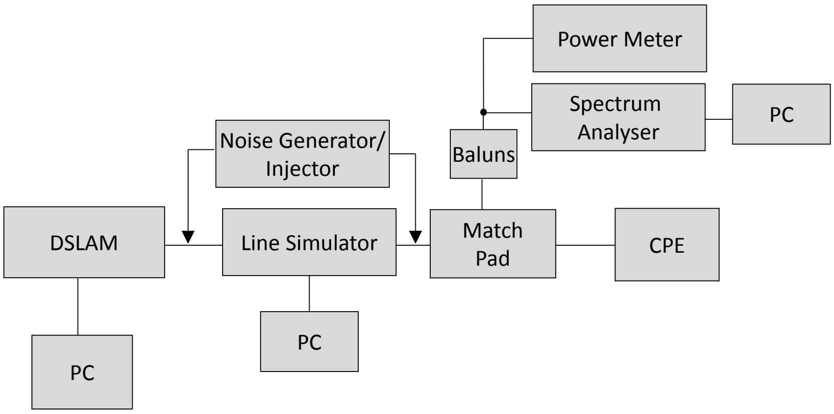

Figure 41 : Test Configuration for Measuring Upstream PSD

Details of the impedance matching pad used are shown in Figure 15.

1. Configure DSLAM to implement an ESEL value of 30dB and the default GEA over ADSL2+ band profile.
2. Connect CPE to DSLAM using the Test Configuration shown in Figure 41.
3. Set line simulator to a loop length of 2000m with crosstalk injected at each end of the system.
4. Ensure that CPE has attained synchronisation.
5. Capture upstream PSD and wideband power and compare against Part C of the BT ANFP.
6. Repeat for 3000m loop length.

Expected Outcome - If the upstream transmit spectrum complies with the spectrum limits defined in Part C of the BT ANFP between 25kHz and 138kHz over the various loop lengths tested and the total upstream transmit power measured does not exceed 14.5dBm then this will be deemed a "Pass", else the result will be a "Fail".

B.4.2.2.4 Support of Cabinet based ADSL2plus Operation (R.ADSL2+.5)

Description – The Modem shall support operating with cabinet based ADSL2plus. This requires the support of tone-sets (or carrier sets) A43 and A43C (as defined in G.994.1 Amendment 1[4] and shown in Table 15), plus downstream PSD shaping as defined in G.997.1[5] and G.992.5[23]. In order to achieve synchronisation, the modem must also support these tone-sets.

Carrier Set Designation	Upstream Carrier Sets		Downstream Carrier Sets	
	Tone Numbers	Maximum power level/carrier (dBm)	Tone Numbers	Maximum power level/carrier (dBm)
A43	9 17 25	-1.65	40 56 64	-3.65
A43c	9 17 25	-1.65	257 293 337	-3.65

Table 15 : Carrier Sets A43 and A43c

Note that use of additional tone-sets (B43, B43c, V43 etc.) is not permitted as these may cause the spectral limits defined in Parts B and C of the BT ANFP to be breached, resulting in adverse interference to other DSL systems operating in the same cable binder.

Test Procedure – The Test Configuration shown in Figure 40 shall be used for this test.

1. Set spectrum analyser for a start frequency of 10kHz and a stop frequency of 5MHz.
2. Configure DSLAM to implement an E-side electrical length (ESEL) value of 30dB and the default GEA over ADSL2+ band profile.
3. Connect CPE to DSLAM using the Test Configuration shown in Figure 40.
4. Set line simulator to a loop length of 2000m with noise injection disabled (i.e. noise free).
5. During train-up, capture the handshake tones generated by each end of the transmission system.
6. Compare tones against those defined for A43 and A43c.
7. Plot captured downstream tones against ANFP Part B spectral limit to check that PSD shaping has been applied to the tones and that tones other than A43/A43c are NOT being used.
8. Repeat for both a warm start and a cold start.
9. Repeat for a minimum of two other ESEL values (nominally 10dB and 50dB).

Expected Outcome - This test will be deemed a "Pass" only if A43/A43c tone sets are being used and that the correct amount of downstream PSD shaping is being applied to the tone to ensure compliance with the appropriate limit masks defined in Part B of the BT ANFP for each value of ESEL evaluated and for both a warm start and a cold start. If these criteria are not met, then the result is a "Fail".

B.4.2.2.5 Support of Extended Framing Parameters (R.ADSL2+.6)

Description – The Modem shall support the extended framing parameters as defined in Annex K of G.992.5[23] and in ETSI TS 105 388[24]. The maximum achieveable downstream rates with and without the extended framing parameters are summarised in Table 16 for various interleaver settings.

Dmax (ms)	Impulse Noise Protection (Symbols)	Maximum Downstream Net Data Rate (kbit/s)	
		Without Extended Framing Parameters	With Extended Framing Parameters
16	8	1472	8112
8	4	3008	14,455
4	2	3008	21,093
16	2	7552	22,244

Table 16 : Downstream Net Data Rate Limits

Test Procedure –

1. Configure DSLAM to implement an ESEL value of 30dB and the GEA over ADSL2+ interleaved profile lraD120_001_16_08U004_001_08_02.
2. Connect CPE to DSLAM using the test setup shown in Figure 42.
3. Set line simulator to a loop length of 500m with the appropriate crosstalk injected at each end of the system.
4. Wait 2 minutes for system to stabilise then record key transmission performance parameters (data rate, margin etc.) from EMS.
5. Repeat steps 3 and 4 using the GEA over ADSL2+ interleaved profiles
   lraD120_001_08_04U004_001_08_02
   lraD120_001_04_02U004_001_08_02
   lraD120_001_16_02U004_001_08_02

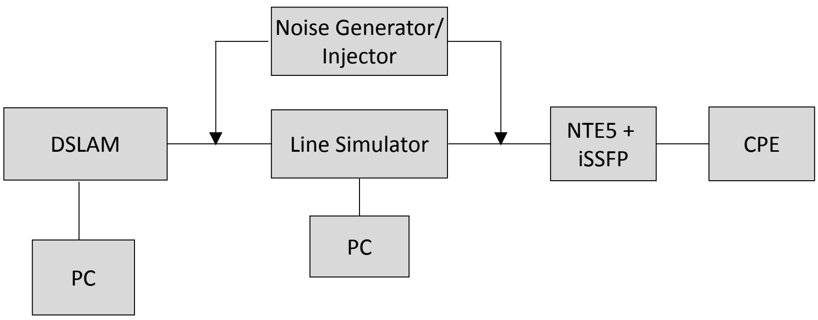

Figure 42 : Test Configuration for Checking Support of Extended Framing Parameters

Expected Outcome - This test will be deemed a "Pass" only if the downstream rate recorded in interleaved mode exceeds the maximum net downstream data rate **without the extended framing parameters** shown in Table 16 as this indicates that the extended framing parameters have been enabled at each end of the system. Downstream rates less than this shall be a "Fail".

B.4.2.2.6 Support of Bit Swap (R.ADSL2+.7)

Description – The Modem shall support bit swap as defined in G.992.3[8].

Test Procedure –

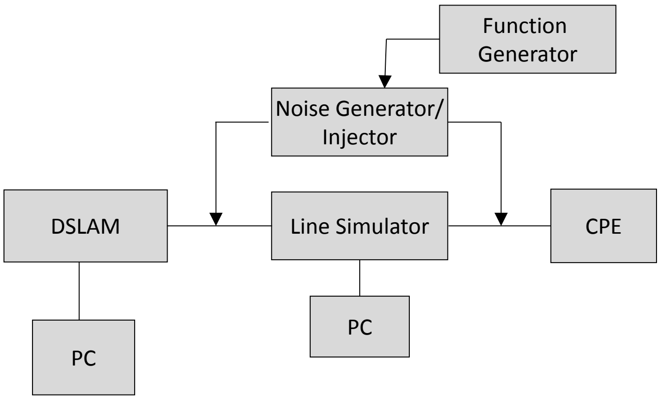

Figure 43 : Test Configuration for Checking Bit Swap

1. Configure DSLAM to implement an ESEL value of 30dB and the default GEA over ADSL2+ band profile.
2. Connect CPE to DSLAM using the Test Configuration shown in Figure 43.
3. Set line simulator to a loop length of 2000m with crosstalk injected at each end of the system.
4. Ensure that CPE has attained synchronisation.
5. Capture bit allocation table (both upstream and downstream) from element manager.
6. Inject a narrow band RFI source at the CPE end of the link using the function generator – this simulates a broadcast AM transmission. Set frequency to 1.518MHz and set power at -50dBm and increase over 1 minute to -20dBm in 2dB steps.
7. Recapture downstream bit allocation table from element manager.
8. The downstream bit allocation table should reveal a reduction in the bit allocation data at 1.518MHz (ie tone #352).
9. Inject a narrow band RFI source at the DSLAM end of the link using the function generator – this simulates a broadcast AM transmission. Set frequency to 69kHz and set power at -50dBm and increase over 1 minute to -10dBm in 2dB steps.
10. Recapture upstream bit allocation table from element manager.
11. The upstream bit allocation table should reveal a reduction in the bit allocation data at 69kHz (ie tone #16).
12. The system should not retrain during this test.

Expected Outcome – "Pass" if bit swap is observed in the upstream and downstream bit allocation tables around the frequency of the interfering tone and modem does not lose synchronisation, else "Fail".

B.4.2.2.7 Support of Seamless Rate Adaptation (R.ADSL2+.8)

Description – The Modem shall support seamless rate adaptation (SRA) as defined in Section 7.11 of G.992.3[8] and G.992.5[23].

Test Procedure – Configure system to operate in the presence of crosstalk, reduce level of crosstalk at each end and then check whether SRA is implemented. Note that this will require a dedicated profile (SLRD120_001_00_00U013_001_00_00) which is basically the same as the default profile but with SRA enabled and some additional parameters defined as shown in Table 17.

Parameter	Downstream	Upstream
Minimum upshift time (s)	10	0
Minimum downshift time (s)	10	0
Upper threshold margin (dB)	9	9
Lower threshold margin (dB)	3	3

Table 17 : Settings for LR Seamless Rate Adaptation Profile

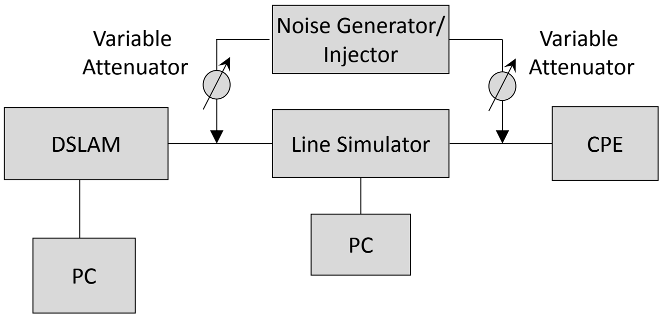

Figure 44 : Test Configuration for Checking Seamless Rate Adaptation

1. Configure DSLAM to implement an ESEL value of 30dB and the dedicated GEA over ADSL2+ SRA profile.
2. Connect CPE to DSLAM using the Test Configuration shown in Figure 19.
3. Set line simulator to a loop length of 2000m with crosstalk injected at each end of the system.
4. Ensure that CPE has attained synchronisation.
5. Record upstream and downstream margin and data rates as reported by the DSLAM.
6. Reduce crosstalk injected at CPE end of link (i.e. downstream) by 1dB and record downstream rate and noise margin.
7. Reduce downstream crosstalk in 1dB steps, recording the downstream margin and data rates for each step. After a 5dB reduction in crosstalk (i.e. a 5dB improvement in margin), the upper margin threshold value will be exceeded and the data rate should change.
8. Repeat for the upstream direction.
9. The CPE should not lose synchronisation during this test.

Expected Outcome – This test will be a “Pass” if the system is found to change data rate in each direction when the noise margin improves by 5dB without losing synchronisation. If the rate does not change or if the system retrains, then the result will be a “Fail”.

B.4.2.2.8 Correct Reporting of Vendor Information (R.ADSL2+.9)

Description – The Modem shall support the correct reporting of Vendor ID, Version Number and Serial Number as described in section 11.2.3.6 of G.992.3[8].

Test Procedure – The CP shall provide the information shown in Table 18 and Table 19 to Openreach prior to the start of any testing. This will be as part of the Openreach Customer Establishment Process – details can be found at: http://www.openreach.co.uk.

CPE Manufacturer
CPE Product Name/Model
CPE Software Release Number
CPE Serial Number
System Vendor ID
Chipset Manufacturer
Chipset Hardware Version
Chipset Firmware Version

Table 18 : CPE Information

Splitter Manufacturer
Product Name/Model
CPE Software Release Number
Version Number
Serial Number
Type (Centralised/Distributed)

Table 19 : CPE Splitter Information

The element manager on the DSLAM will be used to validate the CPE Information. This should reflect the information provided in Table 18. CPE splitter information will be verified visually if possible against the information provided in Table 19.

Expected Outcome – If the reported data matches the information provided in Table 18 then this will be deemed a "Pass", else the CPE will be deemed to have failed the test.

B.4.2.2.9 Correct Reporting of Key Test and Diagnostic Parameters (R.ADSL2+.10)

Description – The Modem shall support the correct reporting of key ADSL2plus test and diagnostic parameters according to G.997.1[5]. These parameters are listed in Table 1 (see Section 3.2.2).

Test Procedure -

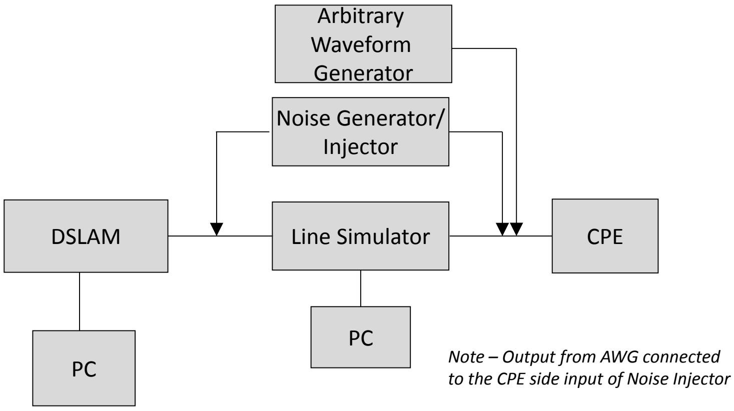

Figure 45 : Test Configuration for Checking Test and Diagnostic Parameters

1. Configure DSLAM to implement an ESEL value of 30dB and the default GEA over ADSL2+ band profile.
2. Connect CPE to DSLAM using the Test Configuration shown in Figure 45.
3. Set line simulator to a loop length of 2000m with no crosstalk injected at either end of the system.
4. Ensure that CPE has attained synchronisation and then leave the system running for 20 minutes.
5. Capture 15 minute performance data from element manager and check that key parameters are reported.
6. Now turn crosstalk noise on at each end of system and repeat test.
7. Capture 15 minute performance data and compare with that recorded previously.
8. Check that reported data rate, maximum attainable line rate and noise margin have changed in each direction.
9. Now configure noise generator to inject a 5ms micro-interrupt onto the CPE end of the link every 10 seconds and leave to run for 20 minutes.
10. The 15 minute data should now show a number of errored seconds (~90), severely errored seconds and/or FEC seconds.
11. Now turn micro interrupts off and configure the arbitrary waveform generator (AWG) to generate REIN comprising 100µs bursts every 10ms at an amplitude of -110dBm/Hz (measured at 1MHz) and inject onto the line using the noise injector. Leave system to run for 20 minutes
12. The 15 minute data should now show a number of errored seconds (ES), severely errored seconds (SES) and/or forward error correction (FEC) seconds. The error counts should NOT exceed 900 for any given 15 minute period. If no SES are observed, the amplitude of the signal should be increased until SES are observed. Note that the system may retrain during this test – this behaviour is expected.
13. Now configure the DSLAM with an interleaved profile lraD120_001_16_02U004_001_08_02 (see Table 21 in Section B.4.3.1 for details) and repeat Steps 9 through 12.

14. The 15 minute data should now report interleaver settings (INPmin and Dmax) for each direction in addition to errored second (ES), severely errored seconds (SES) and/or FEC seconds.

Expected Outcome – If the reported data matches the information provided in Table 1 and error counts do not exceed 900 during any 15 minute period then this will be deemed a “Pass”, else the CPE will be deemed to have failed the test.

B.4.2.2.10 Verification of Hlog and QLN (T2R Capability)

Description – This test is defined to test whether a GEA over ADSL2+ CPE interworks with the GEA DSLAMs sufficiently well to report Hlog and QLN back to the DSLAM in a deployment scenario using micro-filters and home wiring. This data is used for test and diagnostic purposes to reduce time to repair. The presence of the extension wiring in this case should cause deep nulls to appear in the Hlog data.

Test Procedure –

1. Set the line simulator to 2000m length (This equates to a kl0 value of 36dB measured at 1MHz) with the appropriate crosstalk injected at each end of the system.
2. Connect the spectrum analyser as shown in Figure 46 and capture the reference Hlog spectrum on the line. This will form the Hlog template required for this test.

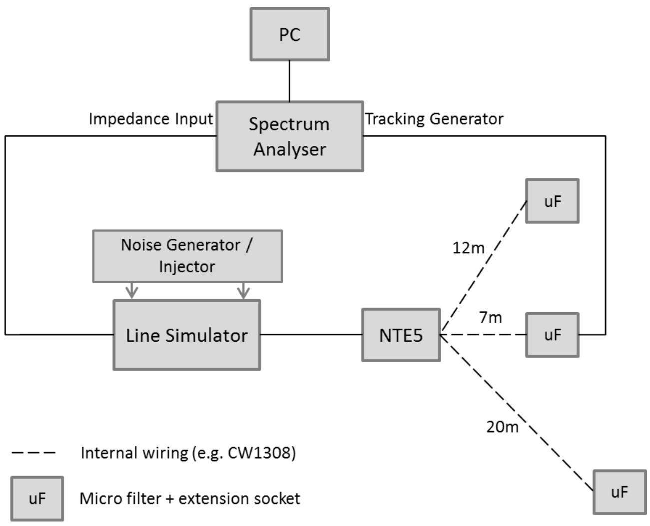

Figure 46 : Test Configuration for Hlog reference

1. Connect the test setup as shown in Figure 47A and B and capture the reference QLN on the line for both upstream and downstream directions. This will form the QLN templates required for this test.

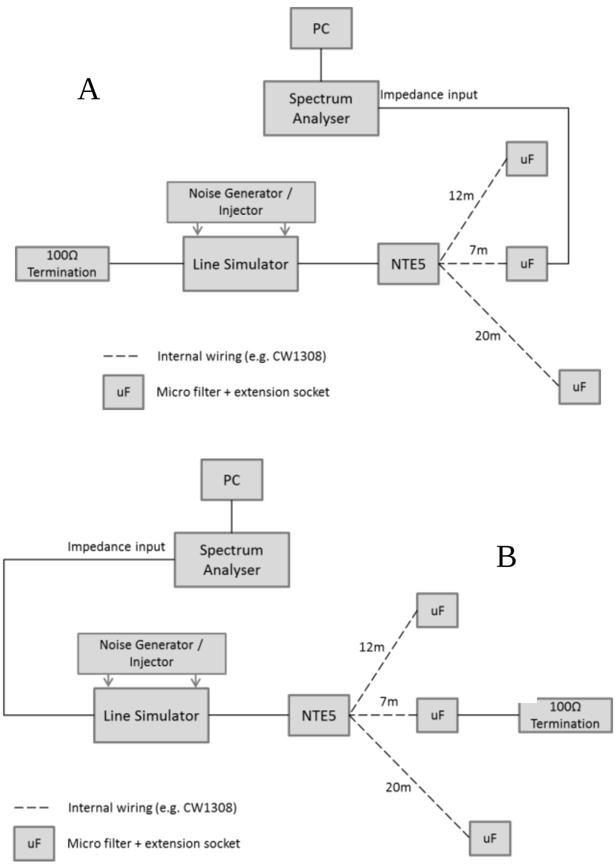

Figure 47 : Test Configuration for QLN capture

2. Connect CPE to DSLAM using the test setup shown in Figure 48.

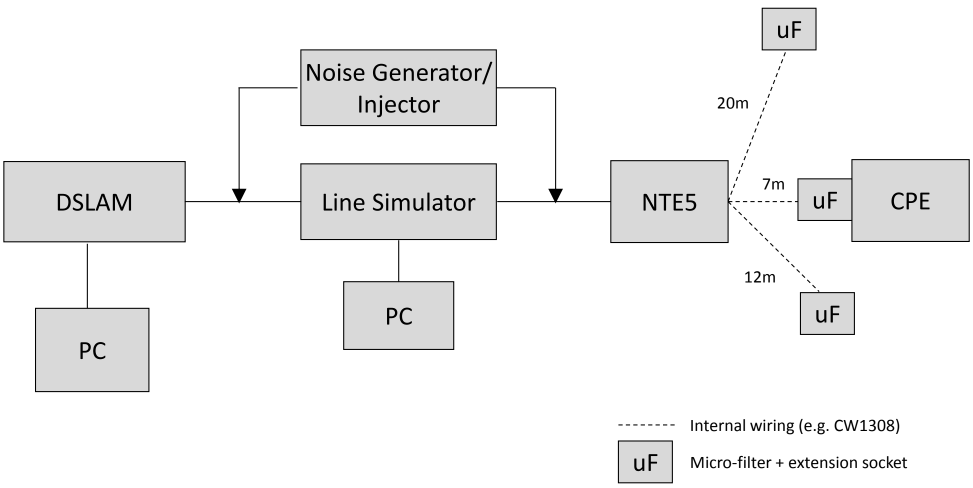

Figure 48 : Test Configuration for Hlog/QLN test

3. Configure DSLAM to implement an ESEL value of 30dB and apply an AELEM enabled GEA over ADSL2+ profile to the line.
4. Inject the appropriate crosstalk at each end of the system.
5. Record Hlog/QLN data from the DSLAM element manager.

6. Compare the Hlog and QLN data to the reference templates captured previously in Steps 2 and 3 above.
7. Note: for the QLN reference plot:
8. Upstream bands use trace from Figure 47A
9. Downstream bands use trace from Figure 47B
10. Convert the power (in dBm) reference QLN measured by the spectrum analyser to dBm/Hz using the correct bandwidth correction factor/dB.

Expected Outcome - The Hlog test will be deemed a "Pass" if the Hlog falls within a mask of +/- 3.5dB of the reference PSD captured in step 3. The QLN test will be deemed a "Pass" if the upstream and downstream QLN data falls within a range of +/- 3.5dB of the reference value captured in step 4.

B.4.2.2.11 Support of Downstream Retransmission (R.ADSL2+.12)

Description – The GEA over ADSL2+ modem shall support downstream PHY layer retransmission as defined in G.998.4[6].

Test Procedure -

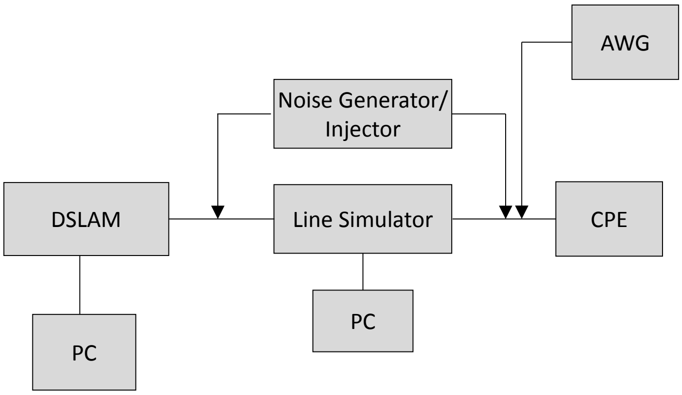

Figure 49 : Test Configuration for Verifying Downstream Retransmission

1. Configure DSLAM to implement an ESEL value of 30dB and retransmission profile lraD120_001_R08_01U014_001_R08_02. Note that this open retransmission/interleaved profile is used to facilitate automated testing and is not used in the BT network. The retransmission parameters used in this profile are defined in Table 20.
2. Connect CPE to DSLAM using the Test Configuration shown in Figure 49.
3. Set line simulator to a loop length of 2000m with no crosstalk injected at either end of the system.
4. Ensure that CPE has attained synchronisation, check whether downstream retransmission is implemented and then leave the system running for 20 minutes.
5. Capture 15 minute performance data from element manager and check that key parameters are reported

6. Now turn crosstalk noise on at each end of system and repeat test. Note that level of crosstalk noise should be attenuated by 6dB in both upstream and downstream for this test.
7. Capture 15 minute performance data and compare with that recorded previously.
8. Check that reported data rate, maximum attainable line rate and noise margin have changed in each direction.
9. Now configure the arbitrary waveform generator (AWG) to generate REIN comprising 100 µs bursts every 10 ms at an amplitude of -110dBm/Hz (measured at 1MHz) and repeat steps 7 and 8.
10. The 15 minute data should now show a number of parameters including uptime, number of retrains, errored seconds , severely errored seconds and/or FEC seconds. The error counts should NOT exceed 900 for any given 15 minute period.
11. Now configure the arbitrary waveform generator (AWG) to generate REIN comprising 9 ms bursts every second at an amplitude of -110dBm/Hz (measured at 1MHz) and repeat steps 7 and 8.
12. Once again the 15 minute data should show a number of parameters including Actual INP, RTX_USED_ds, uptime, number of retrains, errored seconds , severely errored seconds and/or FEC seconds. The error counts should NOT exceed 900 for any given 15 minute period.
13. Now reconfigure the DSLAM to use the equivalent open interleaved profile (lraD120_001_08_01U014_001_08_02) and repeat steps 4 to 12. Note that the system may retrain during this test when operating in interleaved mode – this behaviour is expected.
14. This test can be repeated for 3000m if required using the aforementioned open profiles. However, in order to reduce test time, only the 2km test is mandatory.

Parameter	**lraD120_001_08_01U014_001_08_02**	
	D/S	**U/S**
RTX_MODE	1	1

MAXNDR_RTX	12288	1408
MAXETR_RTX	12288	1408
MINETR_RTX	128	32
DELAYMIN_RTX	0	0
INPMIN_REIN_RTX	1	2
INPMIN8_REIN_RTX	N/A	N/A
DELAYMAX_RTX	8	8
INPMIN_SHINE_RTX	32	32
INPMIN8_SHINE_RTX	N/A	N/A
SHINERATIO_RTX	5	5
IAT_REIN_RTX	0	0
LEFTR_THRESH	0	0

Table 20 : Parameters Used For Open Retransmission Profile

Note: If the modem performance exceeds the upper or lower rates in the interleaved banded profiles (i.e. excessive margin or failure to reach synchronisation) then an alternative profile should be selected with different rates.

Expected Outcome – The CPE shall implement downstream retransmission. In addition, with downstream retransmission enabled, during any 15 minute period the system should report <10 errored seconds and no retrains in the downstream direction. If both the feature enablement and the feature behaviour are met as defined, then this will be deemed a "Pass", else the modem will be deemed to have failed the test. In general, the error performance of the modem with retransmission enabled should be better (i.e. fewer errors and retrains) than that achieved using the interleaved profile.

B.4.2.2.12 Support of Upstream Retransmission (R.ADSL2+.13) - Optional

Typically a system would not just implement upstream retransmission so this test is designed to verify the operation of downstream and upstream retransmission running concurrently.

Description – The modem shall support downstream and upstream PHY layer retransmission as defined in G.998.4[6].

Test Procedure -

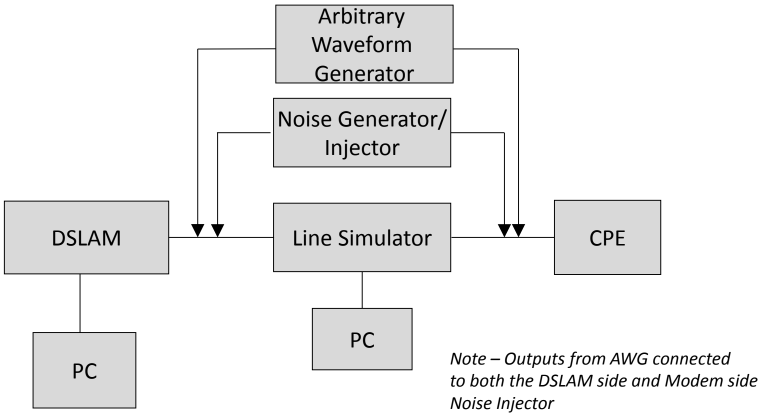

Figure 50 : Test Configuration for Verifying Downstream and Upstream Retransmission

1. Configure DSLAM to implement an ESEL value of 30dB and the open retransmission profile lraD120_001_R08_01U014_001_R08_02. Note that this open retransmission/interleaved profile is used to facilitate automated testing and is not used in the BT network.
2. Connect CPE to DSLAM using the Test Configuration shown in Figure 50.
3. Set line simulator to a loop length of 2000m with no crosstalk injected at either end of the system.
4. Ensure that CPE has attained synchronisation, check whether downstream and upstream retransmission are implemented and then leave the system running for 20 minutes.
5. Capture 15 minute performance data from element manager and check that key parameters are reported
6. Now turn crosstalk noise on at each end of system and repeat test. Note that level of crosstalk noise should be attenuated by 6dB in both upstream and downstream for this test.
7. Capture 15 minute performance data and compare with that recorded previously.
8. Check that reported data rate, maximum attainable line rate and noise margin have changed in each direction.
9. Now configure the arbitrary waveform generator (AWG) to generate REIN comprising 100 µs bursts every 10 ms at an amplitude of -110dBm/Hz (measured at 1MHz) on both channels and repeat steps 7 and 8.
10. The 15 minute data should now show a number of parameters including uptime, number of retrains, errored seconds , severely errored seconds and/or FEC seconds. The error counts should NOT exceed 900 for any given 15 minute period.

11. Now configure the arbitrary waveform generator (AWG) to generate REIN comprising 9 ms bursts every second at an amplitude of -110dBm/Hz (measured at 1MHz) and repeat steps 7 and 8.
12. Once again the 15 minute data should show a number of parameters including Actual INP, RTX_USED_ds, RTX_USED_us, uptime, number of retrains, errored seconds , severely errored seconds and/or FEC seconds. The error counts should NOT exceed 900 for any given 15 minute period.
13. Now reconfigure the DSLAM to use the equivalent open interleaved profile (lraD120_001_08_01U014_001_08_02) and repeat steps 4 to 12. Note that the system may retrain during this test when operating in interleaved mode – this behaviour is expected.
14. This test can be repeated for 3000m if required using the aforementioned open profile. However, in order to reduce test time, only the 2km test is mandatory.

The retransmission parameters used in this profile are defined in Table 21.

Note: If the modem performance exceeds the upper or lower rates in the interleaved banded profiles (i.e. excessive margin or failure to reach synchronisation) then an alternative interleaved profile should be selected.

Expected Outcome – The GEA over ADSL2+ CPE shall implement downstream and should implement upstream retransmission. In addition, with downstream and upstream retransmission enabled, during any 15 minute period the system should report <10 errored seconds and no retrains in both the downstream and upstream direction. If these criteria are met, then this will be deemed a “Pass”, else the modem will be deemed to have failed the test. In general, the error performance of the modem with retransmission enabled should be better (fewer errors and retrains) than that using an interleaved profile.

B.4.2.3 ATM Layer

B.4.2.3.1 <u>Encapsulation of Ethernet traffic in ATM cells (R.ATM.1)</u>

Description – All Ethernet traffic on the Openreach UNI (ingress and egress) shall be encapsulated within ATM cells using ATM Adaptation Layer 5 (AAL5).

Test Procedure - .

1 Login to Huawei U2000 EMS.

2 Configure VLAN on DSLAM/IL2S as follows:-

(a) In left pane of "DSLAM" tab, select: VLAN, In "VLAN" sub-tab, click on the "Find" button.

(b) Now, in the "VLAN" sub-tab: 'Right Click' – Add, In that pop-up window, enter/select the following:

VLAN ID: vlan-1 (Range: 3 - 4074) Type: Smart VLAN Attribute: Stacking VLAN Priority: 2

(c) Then, click "Next", In the tab "Sub Port", expand "Physical Port List", and drag the back-haul Ethernet port <Y/Y/Y of DSLAM <ENXXXX to "Sub Port List" towards right.

(d) Now, select the tab "Extended Info" in the same pop-up window, and browse against "VLAN Service Profile".

(e) In that pop-up window, select "Service_Profile_DSLAM_DA" and click "OK". And, click "Done" in pop-up window, "Added VLAN" will be in the back-ground.

3 Use the "DSLAM" tab to configure service-port for data flow as follows:-

(a) In left pane of "DSLAM" tab, select: Connection - Service Port, In Service Port sub-tab, click on the Find button.

(b) In the same sub-tab: 'Right Click' – Add. In that pop-up window, select/enter the following:-

In Attributes Section:

Connection Type: LAN-VDSL2

In User Side Section:

Interface Selection: X/X/X (Frame/Slot/VDSL Port)

Channel Mode: ATM

Service Type: Multi-Service VLAN

User VLAN: 101

VPI/VCI:

In Network Side Section:

VLAN Choice: Smart VLAN

VLAN ID: svlan-1 (browse the same SVLAN as configured earlier)

In Basic Info Section:

(c) In the same pop-up window, under Traffic Profile Info section, browse the downstream traffic profile (Parameter: Downstream Traffic Name) as:-

Downstream Traffic Name: E_DSLAM_Data_Open

(d) In the same section, browse the correct upstream traffic profile (Parameter: Upstream Traffic Name) and then click OK.

4 Configure cross-connect between hand-over port X/X/X and access side port Y/Y/Y of IL2SOLT ENYYYY as follows:-

(a) Right-click on IL2SOLT (ENYYYY) icon in the left pane of Main Topology tab and select Device Management .

(b) In left pane of IL2SOLT tab, select: "Connection - Service Port", In Service Port sub-tab, click on the "Find" button.

(c) Now, in the same sub-tab: 'Right Click' - Add, In that pop-up window, select/enter the following:-

In Attributes Section:

Connection Type: SPUA-ETHER/SPUA

In User Side Section:

Interface Selection: Y/Y/Y

Service Type: Double Layer User VLAN

User Outer VLAN ID: svlan-1 (same as configured earlier)

User Inner VLAN ID: cvlan-1 (same as configured earlier)

In Network Side Section:

Interface Selection: X/X/X

Service Type: Multi-Service VLAN

User VLAN: Any VLAN from Range: 2 - 4074

(d) In the same pop-up window, under "Traffic Profile" Info section, browse the upstream and downstream traffic profiles as:-

Upstream Traffic Name: E_GEAC_up_OFFp_OFFc

Downstream Traffic Name: I_GEAC_dn_xxMp_yyMc_STH. And, then click OK .

5 Provision the IXIA Traffic Generator Port chassisY/slotY/portY connected to the hand-over port X/X/X of IL2SOLT ENYYYY and LAN port of device :-

(a) In the left pane of Explore Network Resources window of IxExplorer GUI, select the IXIA port chassisY/slotY/portY by following the navigations 'Resources - Chassis ChainXX'. Then, right click on the Port chassisY/slotY/portY and select "Reset Factory Defaults". After that, again right click on the port chassisY/slotY/portY and select "Properties".

(b) In Ixia port properties pop-up window, under the "Transmit Modes" tab select the following:

Modes: Advanced Stream Scheduler PHY Modes: Fiber

(c) Again, in the same pop-up window, under the "Auto Negotiation" tab un-check all the check-boxes except Gigabit Full Duplex in Auto Negotiate Section. After this, click OK .

(d) Now, in left pane of Explore Network Resources window, again select: IXIA port chassisY/slotY/portY - Advanced Streams.

(e) Now, double click on the 'Stream' in the right pane of the Explore Network Resources window.

(f) In stream properties pop-up window, under "Frame Data" tab enter the following:-

Frame Size (includes CRC): 1028 under Fixed Mode Destination Address (in SA/DA sub-tab): valid-mac-address-2 Source Address (in SA/DA sub-tab): valid-mac-address-1.

(g) In the same "Frame Data" tab , select the sub-tab "Protocols" and, enter the following:-

(1) Ethernet Type: Ethernet II

(2) Check the check-box against the VLAN(s) - Click VLAN(s)

(3) In that pop-window, select/enter the following:-

VLAN Type: Single VLAN VLAN Id: As configured And, then click OK .

(h) In the same stream properties pop-up window, under Stream Control tab select percent Max. Rate in Rate Control section and enter the data rate value (in percentage of the total link capacity) for downstream direction as per the Data Product. And, then click OK

6 Start transmitting end-to-end L2 bi-directional test traffic simultaneously from both the IXIA ports chassisX/slotX/portX and chassisY/slotY/portY provisioned as follows:-

(a) In the left pane of Explore Network Resources window of IxExplorer GUI, select: Global Views - Statistic Views - Right click on Statistics View - New.

(b) Drag the Ixia ports chassisX/slotX/portX and chassisY/slotY/portY from the left pane of the same pop-up window into right pane. And, then click OK .

(c) In 'StatView-XX' window select Start Transmit .

7 Keep traffic running. Login into the GUI of the GEA over ADSL2+ devices using gateway IP address, and in the mirroring tab select Mirror DSL port Ethport1 - the port in which you are planning to capture.

8 Connect ethport1 to a local PC and run traffic analyser Wireshark on the port of the PC which is connected to ethport1 of the GEA over ADSL2+ device and capture packets that are send downstream from DSLAM

9 Using Wireshark check the packet for the ATM encapsulation over Ethernet header.

Expected Outcome -

1 Login should be successful.

2 Configuring VLAN on DSLAM/IL2S:

(a) In right pane of "DSLAM" tab, a sub-tab "VLAN" should appear.

(b) A pop-up window "Add VLAN" should appear, Correct parameter values should be entered/selected.

(c) In the right pane of the same pop-up window, a tab "Sub Port" should appear the correct back-haul Ethernet ports should be dragged in "Sub Port List".

(d) New Pop-up window "Select VLAN Service Profile" should appear, correct VLAN Service Profile should be selected and both the pop-up windows should be closed successfully

(e) Added VLAN should be visible in the background window.

3 Configuring Service profile on the DSLAM:

(a) In the right pane of "DSLAM" tab, a sub-tab "Service Port" should appear and the details of all service ports present on DSLAM should appear on the right-side pane.

(b) A pop-up window "Add Service Port" should appear and then correct parameter values should be entered/selected.

(c) Correct downstream traffic profile should be selected.

(d) Correct upstream traffic profile should be selected and the pop-up window "Add Service Port" should be closed successfully and a new row corresponding to newly configured 'Service Port' should be visible in the same sub-tab "Service Port".

4 Configuring cross-connect between access port and Handover port of IL2S:

(a) A new tab should appear for IL2SOLT with the title as ENXXXX.

(b) In right pane of "IL2SOLT" tab, a sub-tab "Service Port" should appear. The details of all service ports present on IL2SOLT should appear on the right-side pane.

(c) A pop-up window "Add Service Port" should appear and the correct parameter values should be entered/selected.

(d) The correct traffic profile should be selected and the pop-up window "Add Service Port" should be closed successfully. A new row corresponding to newly configured 'Service Port' should be visible in the same sub-tab "Service Port".

5 Provisioning IXIA traffic generator port:

(a) A pop-up window stating the properties of IXIA Port should appear.

(b) Correct options should be selected.

(c) Correct check-boxes should be un-checked. And, after clicking "OK", Ixia port properties pop-up window should be closed.

(d) The details of IXIA Port should appear in the right pane of "Explore Network Resources" window.

(e) A pop-window stating 'Stream Properties' should appear.

(f) "Frame Size", "Destination Address", "Source Address" and 'Data Link Layer Protocol Type' should be correctly entered/selected.

(g) Ethernet and VLAN details should be entered in case of the Hand over Port side and VLAN not required for access side connectivity

(h) The correct data rate should be entered. And, after clicking "OK", stream properties pop-up window should be closed.

6 Start transmitting end to end traffic:

(a) "Select Port" pop-up window should be opened.

(b) A new window 'StatView-XX' should be opened.

(c) Traffic should be started successfully.

7 Traffic should be running. Login via the GUI to the device and mirroring of DSL to ethport1 should be successful

8 Wireshark and capture on the port connected to ethport1 should be started successfully

9 Captured packet should have the ATM header within which the Ethernet packet should be encapsulated

B.4.2.3.2 <u>Multicast Support for GEA over ADSL2+ (R.ATM.2)</u>

Description – Where the CP intends to use Multicast for GEA, the GEA over ADSL2+ modem shall be capable of simultaneously supporting Multicast and Unicast over the same VPI/VCI.

Test Procedure -

1 Login to Huawei U2000 EMS using the correct credentials

2 Configure VLAN on DSLAM/IL2S as follows:-

(a) In left pane of "DSLAM" tab, select: VLAN, In "VLAN" sub-tab, click on the "Find" button.

(b) Now, in the "VLAN" sub-tab: 'Right Click' – Add, In that pop-up window, enter/select the following:

VLAN ID: vlan-1 (Range: 3 - 4074) Type: Smart VLAN Attribute: Stacking VLAN Priority: 2 (For MC vlan 3)

(c) Then, click "Next", in the tab "Sub Port", expand "Physical Port List", and drag the back-haul Ethernet port <Y/Y/Y of DSLAM <ENXXXX to "Sub Port List" towards right.

(d) Now, select the tab "Extended Info" in the same pop-up window, and browse against "VLAN Service Profile".

(e) In that pop-up window, select "Service_Profile_DSLAM_DA"(If MC vlan select multicast profile) and click "OK". And, click "Done" in pop-up window "Added VLAN" will be in the back-ground.

3 Use the DSLAM tab to configure service-port for data flow as follows:-

(a) In left pane of DSLAM tab, select: Connection - Service Port, In Service Port sub-tab, click on the Find button.

(b) In the same sub-tab: 'Right Click' - Add, In that pop-up window, select/enter the following:-

In Attributes Section:

Connection Type: LAN-VDSL2

In User Side Section:

Interface Selection: X/X/X (Frame/Slot/VDSL Port)

Channel Mode: ATM

Service Type: Multi-Service VLAN

User VLAN: 101

VPI/VCI:

In Network Side Section:

VLAN Choice: Smart VLAN

VLAN ID: svlan-1 (browse the same SVLAN as configured earlier)

In Basic Info Section:

(c) In the same pop-up window, under Traffic Profile Info section, browse the downstream traffic profile (Parameter: Downstream Traffic Name) as:-

Downstream Traffic Name: E_DSLAM_Data_Open

(d) In the same section, browse the correct upstream traffic profile (Parameter: Upstream Traffic Name) and then click OK.

4 Configure data cross-connect between hand-over port X/X/X and access side port Y/Y/Y of IL2SOLT ENYYYYas follows:-

(a) Right-click on IL2SOLT (ENYYYY) icon in the left pane of Main Topology tab and select Device Management .

(b) In left pane of IL2SOLT tab, select: Connection - Service Port, In Service Port sub-tab, click on the Find button.

(c) Now, in the same sub-tab: 'Right Click' – Add. In that pop-up window, select/enter the following:-

In Attributes Section:

Connection Type: SPUA-ETHER/SPUA

In User Side Section:

Interface Selection: Y/Y/Y

Service Type: Double Layer User VLAN

User Outer VLAN ID: svlan-1 (same as configured earlier)

User Inner VLAN ID: cvlan-1 (same as configured earlier)

In Network Side Section:

Interface Selection: X/X/X

Service Type: Multi-Service VLAN

User VLAN: Any Vlan from Range: 2 - 4074

(d) In the same pop-up window, under Traffic Profile Info section, browse the upstream and downstream traffic profiles as:-

Upstream Traffic Name: E_GEAC_up_OFFp_OFFc

Downstream Traffic Name: I_GEAC_dn_xxMp_yyMc_STH and then click OK .

5 To configure Multicast on IL2S - expand Multicast

(a) Create multicast VLAN in 3001 – 3050 range by using the steps described in Step 2.

(b) Select Cascading Port - Press find button on the Cascading Port window.

(a) On Cascading port window right click on it and select Add.

(b) Enter the following details on the Cascading port window

Frame:, Slot:, Port:, click and check the Quick leave checkbox. Leave other fields as default and Press OK.

(c) Under Multicast ,Select Multicast VLAN - Press Find on the Multicast VLAN window.

(a) Right click on the Multicast window and select Add.

(b) Enter the following details on the Add Multicast VLAN window

Alias:, Program Match Mode: Disabled, IGMP Version: IGMPV3, IGMP Work Mode:igmp_proxy.

(c) Press Next and enter the following details in to the next screen

IGMP Report Priority:6

(d) press Next and add the MC VLAN created earlier and press Finish.

(d)Under Multicast, select Virtual Uplink Port - Press find on the Virtual Uplink Port window.

(a) Right click on the Virtual Uplink Port window and select Add.

(b) Enter the following details on the Add Virtual Uplink Port window

VLAN ID: MC Vlan created earlier, Frame:, Slot:, Port:, Press OK button

6 To configure multicast service port on IL2S - Press Find on the Service Port window.

(a) Right click on the Service Port window and select Add.

Enter the following details on the Add Service Port window

Connection Type :SPUA-LAN, Alias:, VLAN Choice:Smart VLAN, Tag Transform :-- ,VLAN ID: <MC VLAN, Interface Selection:, Service Type:Multi-Service VLAN
User VLAN: <MC VLAN>, UpStream Traffic Profile:E_MC_FTTx_up_OFFp_OFFc, Downstream Traffic Profile: I_MC_dn_100Mp_100Mc or as per requirement.
Press Apply and OK button.

(b) Right click again on the Service Port window and select Add.

Enter the following details on the Add Service Port window

Connection Type :LAN-ETHER, Alias:, VLAN Choice:Smart VLAN, Tag Transform :--, VLAN ID: <MC VLAN>, Interface Selection:, Service Type:Multi-Service VLAN
User VLAN: <MC VLAN>, UpStream Traffic Profile:E_MC_FTTx_up_OFFp_OFFc,

DownStream Traffic Profile: I_MC_dn_100Mp_100Mc or as per requirement.
Press Apply and OK button.

7 To configure multicast and binding service port on DSLAM, on NE window select VLAN and press Find button.

(a) Create multicast VLAN as same as the one created in IL2S using the steps described in step 2

(b) On NE window expand Multicast and select Multicast VLAN - Press find onto the Multicast VLAN window.

(a) Right click on the Multicast window and select Add.

(b) Enter the following details on the Add Multicast VLAN window

Alias:, Program Match Mode: Disabled, IGMP Version: IGMPV3, IGMP Work Mode:igmp_proxy,

(c) Press Next and enter the following details in to the next screen

Frame:, Slot:, Port:, IGMP Report Priority:6

(d) Press Next and add the multicast VLAN created in the above step and press finish.

(c) Under Multicast ,select Virtual Uplink Port - Press find on the Virtual Uplink Port window.

(a) Right click on the Virtual Uplink Port window and select "Add".

(b) Enter the following details on the Add Virtual Uplink Port window

VLAN ID: MC VLAN created earlier, Frame:, Slot:, Port:, Press OK button

(d) Under Multicast ,select Multicast User - Press find on the Multicast User window.

(a) Right click on the Multicast User window and select "Add".

(b) Enter the following details on the Add Multicast User window.

Select and Check the Unlimited Bandwidth option, Quick Leave Mode: mac-based, Press find button and select existing LAN-VDSL service port (data connection already created with VPI/VCI values).
Press Finish button

8 To configure unicast and multicast streams in Ixia using IxLoad

(a) Connect Ixia ports on the IOLT CP hand over port and on Modem end.

(b) Configure the IOLT Handover ports tester port as a server for IPTV & FTP and modem tester port as client for IPTV & FTP.

(c) Add video streams and data stream under IPTV server and FTP server respectively

(d) Add multicast and data vlan, set timelines details and add Ixia port for the hand over port (HoP) tester port

9 Running the test using an Ixia tester

(a) Run test by using the start button, so that both Multicast and Unicast stream will be started

(b)Verify the Ixia tester capturesfor both the Data and Multicast traffic.

Expected outcome -

1 Login should be successful

2 Configuring VLAN on DSLAM/IL2S:

(a) In right pane of "DSLAM" tab, a sub-tab "VLAN" should appear.

(b) A pop-up window "Add VLAN" should appear, Correct parameter values should be entered/selected.

(c) In the right pane of the same pop-up window, a tab "Sub Port" should appear. The correct back-haul Ethernet ports should be dragged in "Sub Port List".

(d) New Pop-up window "Select VLAN Service Profile" should appear, Correct VLAN Service Profile should be selected and both the pop-up windows should be closed successfully

(e) Added VLAN should be visible in the background window.

3 Configuring Service Profile on the DSLAM:

(a) In right pane of "DSLAM" tab, a sub-tab "Service Port" should appear and the details of all service ports present on DSLAM should appear on the right-side pane.

(b) A pop-up window "Add Service Port" should appear and the correct parameter values should be entered/selected.

(c) Correct downstream traffic profile should be selected.

(d) Correct upstream traffic profile should be selected and the pop-up window "Add Service Port" should be closed successfully. A new row corresponding to newly configured 'Service Port' should be visible in the same sub-tab "Service Port".

4 Configuring cross-connect between access port and Handover port of IL2S:

(a) A new tab should appear for IL2SOLT with the title as ENXXXX.

(b) In right pane of "IL2SOLT" tab, a sub-tab "Service Port" should appear. The details of all service ports present on IL2SOLT should appear on the right-side pane.

(c) A pop-up window "Add Service Port" should appear, Correct parameter values should be entered/selected.

(d) Correct traffic profile should be selected and the pop-up window "Add Service Port" should be closed successfully and a new row corresponding to newly configured 'Service Port' should be visible in the same sub-tab "Service Port".

5 To configure Multicast on IL2S

(a) Multicast VLAN should be created properly

(b) Cascading ports should be created properly

(c) Multicast VLAN should be created properly

(d) Virtual uplink port should be created properly

6 To configure multicast service port on IL2S

(a) SPUA-LAN multicast service port should be created in the Network side

(b)LAN-ETHER multicast service should be created in Access side

7 To configure multicast and binding service port on DSLAM

(a) Multicast VLAN should be created successfully

(b) Multicast VLAN should be configured with all the parameters mentioned

(c) Virtual uplink port should be created successfully

(d) Multicast user should be created successfully

8 To configure unicast and multicast streams in Ixia using IxLoad

(a) Ixia port should be successfully connected to IOLT CP hand over port and on Modem end.

(b) IOLT Handover ports tester port and modem tester port should be successfully configured for IPTV/FTP server and IPTV/FTP client respectively.

(c) Video stream and data stream should be added to IPTV and FTP server respectively

(d) Multicast and data VLAN, set timelines details and add ixia port for the Hand over Port (HoP) tester port should be successful

9 Checking test results

(a) Test should get started successfully for both Multicast and Unicast.

(b) Both data and Multicast traffic should get received by the Ixia tester.

B.4.2.3.3 GEA Data and Multicast for GEA over ADSL2+ Services (R.ATM.3)

Description – Where the CP intends to use GEA data and Multicast for GEA over ADSL2+ services the VPI/VCI shall be set to 0/38 (ingress and egress). Traffic without a correct VPI/VCI will be dropped.

Test Procedure -

1 Login to Huawei U2000 EMS using the correct credentials

2 Configure VLAN on DSLAM/IL2S as follows:-

(a) In left pane of "DSLAM" tab, select: VLAN, In "VLAN" sub-tab, click on the "Find" button.

(b) Now, in the "VLAN" sub-tab: 'Right Click' – Add, In that pop-up window, enter/select the following:

VLAN ID: vlan-1 (Range: 3 - 4074) Type: Smart VLAN Attribute: Stacking VLAN Priority: 2

(c) Then, click "Next". In the "Sub Port" tab, expand "Physical Port List", and drag the back-haul Ethernet port <Y/Y/Y of DSLAM <ENXXXX to "Sub Port List" towards right.

(d) Now, select the tab "Extended Info" in the same pop-up window, and browse against "VLAN Service Profile".

(e) In that pop-up window, select "Multicast_profile" and click "OK". And, click "Done" in pop-up window "Added VLAN" will be in the back-ground.

3 Configuring cascading port in IL2S

(a) On NE window expand Multicast and select Cascading Port.

(b) Press find button on the Cascading Port window.

(c) On Cascading port window right click on it and select Add.

(d) Enter the following details on the Cascading port window

Frame: /Slot:/Port:, Click and check the Quick leave checkbox. Leave other fields as default and Press OK.

4 Mapping multicast VLAN in IL2S:-

(a)Under Multicast ,select Multicast VLAN.

(b) Press find onto the Multicast VLAN window.

(c) Right click on the Multicast window and select Add.

(d) Enter the following details on the Add Multicast VLAN window

Alias: Program Match Mode: Disabled, IGMP Version: IGMPV3, IGMP Work Mode:igmp_proxy

(e) Press Next and enter the following details in to the next screen

IGMP Report Priority:6

(f) Press Next and add the MC VLAN created earlier and press finish.

5 Configuring Virtual uplink port in IL2S

(a)Under Multicast ,select Virtual Uplink Port.

(b) Press find onto the Virtual Uplink Port window.

(c) Right click on the Virtual Uplink Port window and select Add.

(d) Enter the following details on the Add Virtual Uplink Port window

VLAN ID: MC VLAN created earlier, Frame:/Slot:/Port:, Press OK button

6 Configuring service port in IL2S

(a) On NE window expand Connection and select Service Port.

(b) Press find onto the Service Port window.

(c) Right click on the Service Port window and select Add.

Enter the following details on the Add Service Port window

Connection Type :SPUA-LAN, Alias: ,VLAN Choice:Smart VLAN

Tag Transform :-- VLAN ID: <MC VLAN>,

Interface Selection:

Service Type:Multi-Service VLAN

User VLAN: <MC VLAN>

UpStream Traffic Profile:E_MC_FTTx_up_OFFp_OFFc

DownStream Traffic Profile: I_MC_dn_100Mp_100Mc or as per requirement.

Press Apply and OK button.

(d) Right click again on the Service Port window and select Add.

Enter the following details on the Add Service Port window

Connection Type :LAN-ETHER

Alias:

VLAN Choice:Smart VLAN

Tag Transform :--

VLAN ID: <MC VLAN>

Interfact Selection:

Service Type:Multi-Service VLAN

User VLAN: <MC VLAN>

UpStream Traffic Profile:E_MC_FTTx_up_OFFp_OFFc

DownStream Traffic Profile: I_MC_dn_100Mp_100Mc or as per requirement.

Press Apply and OK button.

7 Configuring Service port in DSLAM

(a) In left pane of DSLAM tab, select: Connection - Service Port, In Service Port sub-tab, click on the Find button.

(b) In the same sub-tab: 'Right Click' - Add, In that pop-up window, select/enter the following:- In Attributes Section:

Connection Type: LAN-VDSL2

In User Side Section:

Interface Selection: X/X/X (Frame/Slot/VDSL Port)

Channel Mode: ATM

Service Type: Multi-Service VLAN

User VLAN: 101

VPI/VCI: 0/38

In Network Side Section:

VLAN Choice: Smart VLAN

VLAN ID: svlan-1 (browse the same SVLAN as configured earlier)

In Basic Info Section:

(c) In the same pop-up window, under Traffic Profile Info section, browse the downstream traffic profile (Parameter: Downstream Traffic Name) as:-

Downstream Traffic Name: E_DSLAM_Data_Open

(d) In the same section, browse the correct upstream traffic profile (Parameter: Upstream Traffic Name) And then click OK.

8 Adding Multicast VLAN in DSLAM

(a)On NE window expand Multicast and select Multicast VLAN.

(b) Press find onto the Multicast VLAN window.

(c) right click on the Multicast window and select Add.

(d) Enter the following details on the Add Multicast VLAN window

Alias:, Program Match Mode: Disabled, IGMP Version: IGMPV3, IGMP Wrok Mode:igmp_proxy

(e) Press Next and enter the following details in to the next screen

Frame:/Slot:/Port:, IGMP Report Priority:6

(f) press next and add the VLAN created in the above step 6 and press finish.

9 Adding Virtual Uplink port in DSLAM

(a)Under Multicast ,select Virtual Uplink Port.

(b) Press find onto the Virtual Uplink Port window.

(c) right click on the Virtual Uplink Port window and select Add.

(d) Enter the following details on the Add Virtual Uplink Port window

VLAN ID: MC VLAN created earlier

Frame:/Slot:/Port:, Press OK button

10 Adding Multicast user in DSLAM

(a)Under Multicast ,select Multicast User.

(b) Press find onto the Multicast User window.

(c) right click on the Multicast User window and select Add.

(d) Enter the following details on the Add Multicast User window

Select and Check the Unlimited Bandwidth option

Quick Leave Mode: mac-based

Press Find button and select existing LAN-VDSL service port, then press Finish button

11 Provisioning Ixia tester for traffic test

(a) Connect ixia port on the Hand over Port (HoP) of IOLT and Ethernet port of the modem

(b) In IxLoad Add a Video Stream under IPTV Server.

Add MC Vlan.Set Timelines and add Ixia ports.

(c) Add a data stream under FTP Server with data vlan set and add Ixia ports

12 Start transmitting end to end traffic

(a) Click start button in IxLoad

(b) A new window 'StatView-XX' should be opened.

(c) Traffic should be started successfully.

13 Keep traffic running Data and Multicast traffic in IxLoad, Login into the GUI of the GEA over ADSL2+ devices using gateway IP address, and in the mirroring tab Mirror DSL port Ethport1 - the port in which you are planning to capture.

14 Connect Ethport1 to a local PC and run traffic analyser Wireshark on the port of the PC which is connected to ethport1 of the GEA over ADSL2+ device and capture packets that are send in downstream from DSLAM

15 Using Wireshark check the packet for the correct VPI/VCI values.

Expected Outcome –

1 Login should be successful

2 Configuring VLAN on DSLAM/IL2S:

(a) In right pane of "DSLAM" tab, a sub-tab "VLAN" should appear.

(b) A pop-up window "Add VLAN" should appear, Correct parameter values should be entered/selected.

(c) In the right pane of the same pop-up window, a tab "Sub Port" should appear. The correct back-haul Ethernet ports should be dragged in "Sub Port List".

(d) New Pop-up window "Select VLAN Service Profile" should appear. The correct VLAN Service Profile should be selected and both the pop-up windows should be closed successfully

(e) Added VLAN should be visible in the background window.

3 Configuring cascading port in IL2S:-

(a) Cascading port window should have appeared successfully.

(b) All existing port should be displayed on the screen successfully.

(c) Add Cascading Port window should be displayed successfully on the screen.

(d) Access side SPUA card port should be successfully added into the cascading ports.

4 Mapping multicast VLAN in IL2S:-

a) Multicast VLAN window should have appeared successfully.

(b) All the existing Multicast VLAN should have appeared successfully.

(c) Add Multicast VLAN window should have appeared successfully

(d) Multicast VLAN should be added successfully.

5 Configuring Virtual uplink port in IL2S

(a) Virtual Uplink Port window should have appeared successfully.

(b)All the existing Virtual Uplink Port should have appeared successfully.

(c)Add Virtual Uplink Port window should have appeared successfully.

(d)Virtual Uplink Port should be created successfully.

6 Configuring service port in IL2S

(a) Service Port window should have appeared successfully.

(b) All the existing service Ports should have appeared successfully.

(c) SPUA-LAN Service port created successfully.

(d) LAN-SPUA Service port created successfully.

7 Configuring Service profile on the DSLAM:

(a) In right pane of "DSLAM" tab, a sub-tab "Service Port" should appear and the details of all service ports present on DSLAM should appear on the right-side pane.

(b) A pop-up window "Add Service Port" should appear, Then correct parameter values should be entered/selected.

(c) Correct downstream traffic profile should be selected.

(d) Correct upstream traffic profile should be selected and the pop-up window "Add Service Port" should be closed successfully. And, a new row corresponding to newly configured 'Service Port' should be visible in the same sub-tab "Service Port".

8 Adding Multicast VLAN in DSLAM

(a) Multicast VLAN window should have appeared successfully.

(b) All the existing Multicast VLAN should have appeared successfully.

(c) Add Multicast VLAN window should have appeared successfully.

(d) Multicast VLAN should be added successfully.

9 Adding Virtual Uplink port in DSLAM

(a) Virtual Uplink Port window should have appeared successfully.

(b) All the existing Virtual Uplink Port should have appeared successfully.

(c) Add Virtual Uplink Port window should have appeared successfully.

(d) Virtual Uplink Port should be created successfully.

10 Adding Multicast user in DSLAM

(a) Multicast User window should have appeared successfully.

(b) All the existing Multicast User should have appeared successfully.

(c) Add Multicast User window should have appeared successfully.

(d) Selected services should be added successfully in Multicast user.

11 Provisioning Ixia for traffic test

(a) Ixia port should be connected

(b) Video stream should get created

(c) Data stream should be selected and Ports should be added

12 Start transmitting end to end traffic:

(a) Traffic should be started

(b) Statistics viewer should get opened once you click the start button

13 Traffic should be running, GUI login to the device and mirroring of DSL to ethport1 should be successful.

14 Wireshark and capture on the port connected to ethport1 should be started successfully

15 The captured packet should have the expected VPI/VCI value in it.

B.4.2.4 Ethernet Layer

B.4.2.4.1 <u>Ethernet Frame Size (R.ETH.1)</u>

Description – The modem shall support an Ethernet frame size of between 68 and 1534 bytes. For clarity, this figure includes 4 bytes for the C-VLAN, and excludes bits allocated to pre-amble, Inter-Frame Gap, and Frame Check Sequence at the user network interface (UNI). Support for frame sizes above 1534 bytes (inclusive of C-VLAN) is not guaranteed.

Test Procedure - Configure the system as shown in Figure 31 and Figure 32.

Note: This test procedure incorporates tests for:

- R.ETH.1
- R.WAN.1
- R.WAN.2
- R.WAN.4

- R.WAN.5
- R.WAN.6

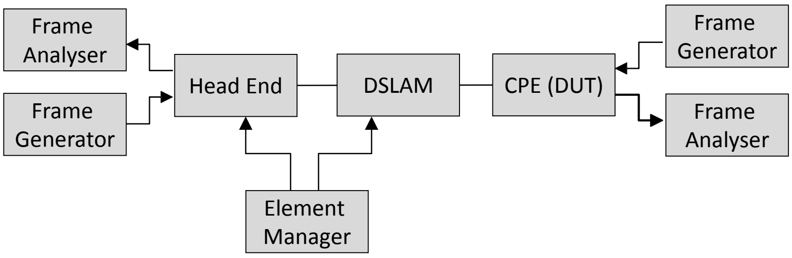

Figure 51: Ethernet Test Configuration (Logical)

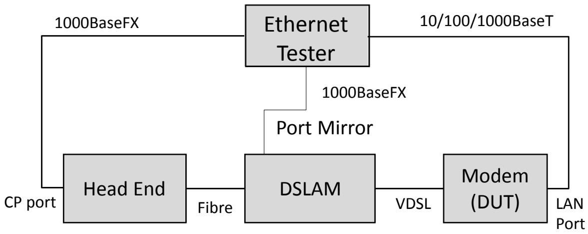

Figure 52: Ethernet Test Configuration (Physical)

1. Login to the Element Manager and verify that the service configuration is present.
2. Using Element Manager, configure default GEA over ADSL2+ line profile (lraD120_001_00_00U013_001_00_00) and apply the profile on the Headend and DSLAM. The profile must be applied on the GEA over ADSL2+ port connected between the DSLAM and the modem.
3. Configure the Ethernet tester port connected to the Head End and provision it to generate downstream traffic with the following attributes:
   (a) Port speed set to 1 Gbps
   (b) Source address set to "Valid Source MAC-address” and Set Destination address to "Valid Destination MAC-address”.
   (c) Enable VLAN by configuring outer and inner VLAN tag as appropriate.
   (d) Set Rate Control to less than the traffic profile applied to the ADSL2+ line connected between DSLAM and Modem.
   (e) Set Frame Size as Fixed Mode and set to 1534 bytes. Note that the modem shall support an Ethernet frame size of between 68 and 1534 bytes.
   (f) Set the Tag Protocol Identifier as 0X8100 .
4. Configure the Ethernet tester port connected to modem with the following attributes:
   (a) Set port speed 100 Mbps.
   (b) Source address set to " valid Source MAC-address” and Destination address set to " valid Destination MAC-address”.
   (c) Set Rate Control according to the traffic profile applied to the ADSL2+ line connected between DSLAM and Modem .
   (d) Set Frame Size as Fixed Mode and set to 1534 bytes.

5. Start Transmitting end-to-end L2 bi-directional test traffic from simultaneously from the tester ports configured in earlier steps and Stop Transmitting after the specified duration (for example 60 seconds)
6. For the port connected to the Headend ,Set Rate Control to be more than the traffic profile applied to the ADSL2+ line connected between DSLAM and Modem.
7. Start transmitting from the ports again.
8. Stop the traffic after a specified duration e.g. 2minutes. Record the tester results/statistics at the receiving port of the tester.
9. Capture the packets at the ingress of DSLAM by applying port mirroring and verify VLAN ID as 101. The modem shall support IEEE 802.1q VLAN encapsulation and all ingress frames shall be encapsulated within 802.1q VLAN. Traffic without a correct VLAN ID will be dropped.
10. Verify Tag Protocol Identifier (Ethertype) and CFI in the Packet. Apply packet capture at CP HoP side also and verify the packet captures.
11. Logout from Element Manager.

Expected Outcome –

(step 1) The login should be successful and Headend, DSLAM and modem configured correctly.
(step 2) Default VDSL2 line profile is configured and applied successfully.
(step 3) Provisioning should be completed successfully for the Headend connected port on the Ethernet tester
(step 4) Provisioning should be completed successfully for the modem connected port on the Ethernet tester. The maximum Ethernet frame size supported should be between 68 and 1534 bytes.
(step 5) No packet loss should be observed.
(step 6) Rate control on the Headend must be successfully updated.
(step 7) Packet loss should be observed.
(step 8) Only 12Mbps traffic i.e. equivalent to PIR rate should get received on the receiving port of the tester as traffic should get policed at the ingress port of the Headend as per the policy applied.
(step 9) VLAN ID 101 should be present in captured packets with 802.1q tag. Incorrect VLAN ID traffic should be discarded.
(step 10) Ethertype must be set to 0x8100 and CFI value as 0 on 802.1q tag. Openreach will set CFI to 0 towards the modem.
(step 11) Logout from Element Manager should be successful.

Note1 : If there is a serious configuration error or if IEEE 802.1q VLAN encapsulation (R.WAN1 and R.WAN2) is not supported, the test configuration should be verified by repeating the test using a known "good" modem. If the test is passed successfully, then the problem must be with the CP modem under test; either it is not correctly setup or IEEE 802.1q VLAN encapsulation is not supported. Note that it is the CP's responsibility to provide the CPE pre-configured for use with GEA over ADSL2+.

Note 2: This test is intended to show that only VLAN 101 is used. Any other VLANs used will be identified to feedback incorrect usage to CP.

B.4.2.5 WAN/VLAN Layer

See Section 3.2.4 for detailed test requirements.

B.4.2.6 OAM Layer

See Section 3.2.5 for detailed test requirements.

B.4.2.7 CPE Filters

See Section 3.2.6 for detailed requirements.

B.4.3 GEA over ADSL2+ testing

B.4.3.1 Transmission Performance Testing

In addition to the SIN 498 tests defined above, the transmission performance of the CPE will also be measured against the current Live GEA over ADSL2+ reference models. This will involve the modem performance being evaluated with the DSLAM configured to implement both fast and interleaved profiles. These follow the generic syntax shown in Table 21.

lraDAAA_BBB_CC_DDUEEE_FFF_GG_HH		
Parameter	**Downstream Setting**	**Upstream Setting**
Maximum Data Rate	AAA/10 Mbit/s	EEE/10 Mbit/s
Minimum Data Rate	BBB/10 Mbit/s	FFF/10 Mbit/s
Minimum Noise Margin	0dB	0dB
Target Noise Margin	6dB	6dB
Maximum Noise Margin	31dB	31dB
Dmax	CC ms	GG ms
INP min	DD symbols	HH symbols
Adaption Mode	Adapt at start up	Adapt at start up
Operating Mode	G.992.5	
Band Plan	Non-overlapped ADSL2plus over POTS (G.992.5 Annex A)	

Table 21 : Generic GEA over ADSL2+ Profile Syntax

B.4.3.1.1 Deployment Scenario 1 : SSFP With No Home Wiring

Description – This test gives an indication of how a CPE would perform if connected to the Openreach GEA over ADSL2+ network as part of a SSFP based deployment scenario (i.e no home wiring). It is also used to record a bench-mark of the CPE modem's performance against the current (i.e. LIVE) network firmware which can then be used to check whether the transmission performance of the CPE modem is adversely affected by future network upgrades. Testing should be performed using both FAST and INTERLEAVED operation.

Test Description (FAST) –

1. Configure DSLAM to implement an ESEL value of 30dB and the default GEA over ADSL2+ profile.
2. Connect CPE to DSLAM using the test setup shown in Figure 53.
3. Set line simulator to a loop length of 2000m with the appropriate crosstalk injected at each end of the system.
4. Record time taken for the CPE to attained synchronisation. This shall be <90s on all loops regardless of line length.
5. Wait 2 minutes for system to stabilise then record key transmission performance parameters (data rate, margin etc.) from EMS.
6. Repeat steps 3 to 5 for 2500m and 3000m cable lengths.
7. Repeat for ESEL values of 10 and 50dB.
8. Repeat for all current combinations of Openreach DSLAMs and line cards that support GEA over ADSL2+.

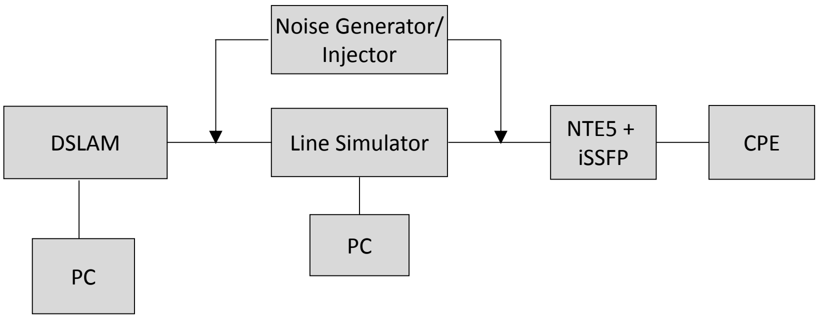

Figure 53 : Test Configuration for Measuring Transmission Performance (SSFP with no home wiring)

Test Description (INTERLEAVED) –

As for FAST operation but using the following interleaved profiles for each loop length and ESEL value shown in Table 22:

lraD120_001_08_01U004_001_08_02
lraD120_001_16_02U013_001_08_02

ESEL values	Lengths
10 dB, 30 dB, 50 dB	2000m, 2500m, 3000m

Table 22 : ESEL values and Loop Lengths for GEA over ADSL2+ Interleaved Testing

Expected Outcome – This test will provide an indication on how the CPE performs when connected to the current Openreach GEA over ADSL2+ network for both fast and interleaved operation.

B.4.3.1.2 Deployment Scenario 2 : Microfilter With Home Wiring

Description – This test gives an indication of how a CPE would perform if connected to the Openreach GEA over ADSL2+ network as part of a deployment scenario using microfilters and home wiring). Comparing the results against those obtained from an SSFP based deployment scenario (i.e. no home wiring) will give an indication on how the CPE performance is affected by bridged taps caused by telephony extensions in the customer's premises. In this configuration, the three lengths of cable (7m, 12m and 20m) connected to the NTE5 (the demarcation point in the customer's premises where the Openreach network terminates) are representative of telephony wiring extensions and are specifically chosen to introduce notches in the VDSL downstream and upstream frequency bands. Testing should be performed using both FAST and INTERLEAVED operation.

Test Description (FAST) –

1. Configure DSLAM to implement a ESEL value of 30dB and the default GEA over ADSL2+ profile.
2. Connect CPE to DSLAM using the test setup shown in Figure 54.
3. Set line simulator to a loop length of 2000m with the appropriate crosstalk injected at each end of the system
4. Record time taken for the CPE to attained synchronisation. This shall be <90s on all loops regardless of line length.
5. Wait 2 minutes for system to stabilise then record key transmission performance parameters (data rate, margin etc.) from EMS.
6. Repeat steps 3 to 5 for 2500m and 3000m cable lengths.
7. Repeat for ESEL values of 10 and 50dB.
8. Repeat for all current combinations of Openreach DSLAMs and line cards that support GEA over ADSL2+.
9. Compare results against those obtained for a SSFP based deployment scenario to determine impact of telephony extension wiring on CPE modem performance.

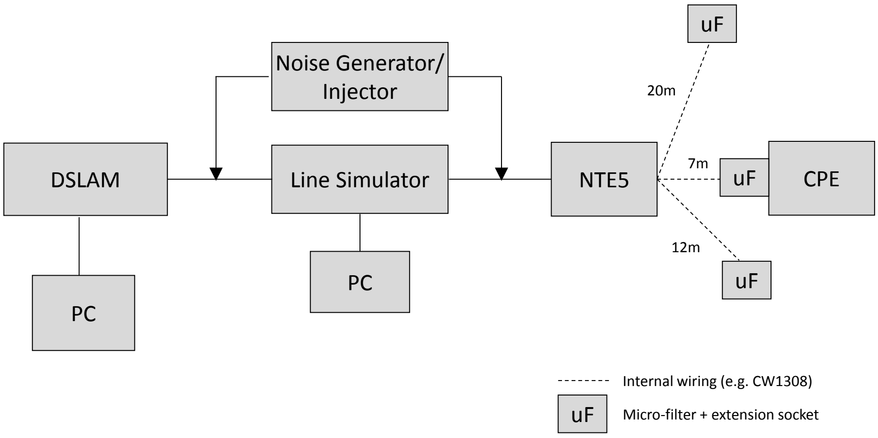

Figure 54 : Test Configuration for Measuring Transmission Performance (Microfilter with home wiring)

Test Description (INTERLEAVED) –

As for FAST operation but using the following GEA over ADSL2+ interleaved profiles for each loop length and ESEL value shown in Table 22:

lraD120_001_08_01U004_001_08_02
lraD120_001_16_02U013_001_08_02

Expected Outcome – This test will provide an indication on how the CPE performs when connected to the current Openreach GEA over ADSL2+ network for both fast and interleaved operation.

<END>