SIN 511

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Suppliers' Information Note

For The BT Network

BT Wholesale TV Connect (TVC)
Service & Interface Description

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1. Introduction

This Supplier's Information Note (SIN) 511 provides service description information for customers of the BT Wholesale TV Connect (TVC) family of products. TVC delivers broadcast quality TV over BT Wholesale's dedicated broadband network.

TVC enables ISPs to deliver reliable and cost effective TV services to their end users across the breadth of the BT 21CN broadband network making TV Connect a viable alternative to traditional Satellite and DTT signal transmission. This coverage is achieved through our state of the art, multicast enabled IP based network.

It should be noted that the information contained within this SIN might be subject to change due to either the results of BT testing or feedback from trial participants. Please check with the http://www.btplc.com/sinet/ site to ensure you have the latest version of this document.

Numbers in square brackets [ ] denote further references, as listed in Section 8.

Further information about the commercial aspects of TV Connect can be obtained by contacting your Account Manager or Customer Relationship Manager.

2. Service Outline

2.1 Architecture
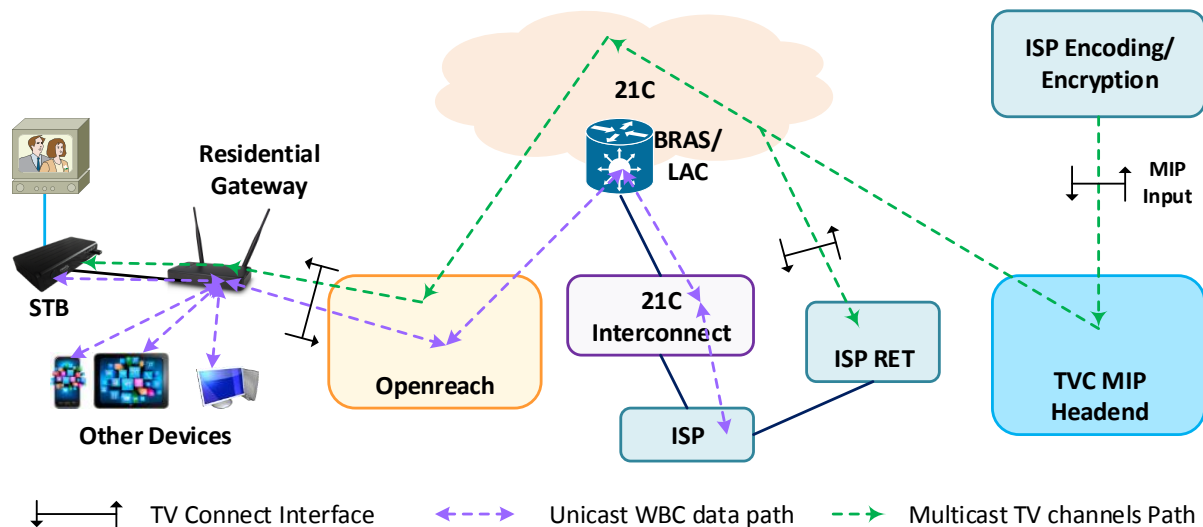
Figure 1 BT TV Connect Service Architecture

The TV Connect Service Architecture is indicated in Figure 1. The TV Connect service is built on top of the underlying Wholesale Broadband Connect (WBC) service.

- An ISP planning to purchase the TV Connect (TVC) service will utilise the WBC PTA or L2TP handover service.

- The TV Connect service will multicast live streaming TV Channels from ingress in the TV Connect Head End at the MIP to end users on the WBC platform.

2.1.1 Content delivery to TV Connect Headend

- The ISP will be expected to provide TV content to the Head End, often in conjunction with a content provider subject to a commercial relationship.

- The ISP will be expected to deliver content to the TV Connect Headend as compressed (encoded IP multicast) content.

- The ISP would provide compressed content, encoding, (optionally) encrypting and conditioning the content themselves, ready for multicast distribution.

- The ISP will be entirely responsible for the encryption of their TV channels for conditional access by end users.

- The ISP is expected to provide aggregated multi channel content to the Head End via the TVC Multicast Ingest Point (MIP) using 1Gb electrical links.

- The ISP will be responsible for the provision, management and ownership of the 1Gbps Electrical Ethernet Links up to the agreed handover port in the MIP. This includes utilisation of bandwidth within these links such that overall bandwidth does not exceed the overall bandwidth envelope agreed with BT Wholesale.

- The TVC MIP offers a Geo-Resilient option whereby the ISP may additionally present their content at the second (Geo-Resilient) site Figure 2 illustrates the three options available wherein:
    - ISP A connects via 2 links to each site (one to each landing point at each site).
    - ISP B connects via 1 link to each site (one to the primary landing point at each site).
    - ISP C connects via 2 links to only the main site, BT Tower (one to each landing point at BT Tower).
- Each of the options clearly offer different levels of physical or geographic resilience.
  Note that the option to connect exclusively at the secondary site is not offered.
- The ISP may elect for different resilient options on a per channel basis, however utilising the same resilient option for all channels provided by the ISP is strongly recommended.
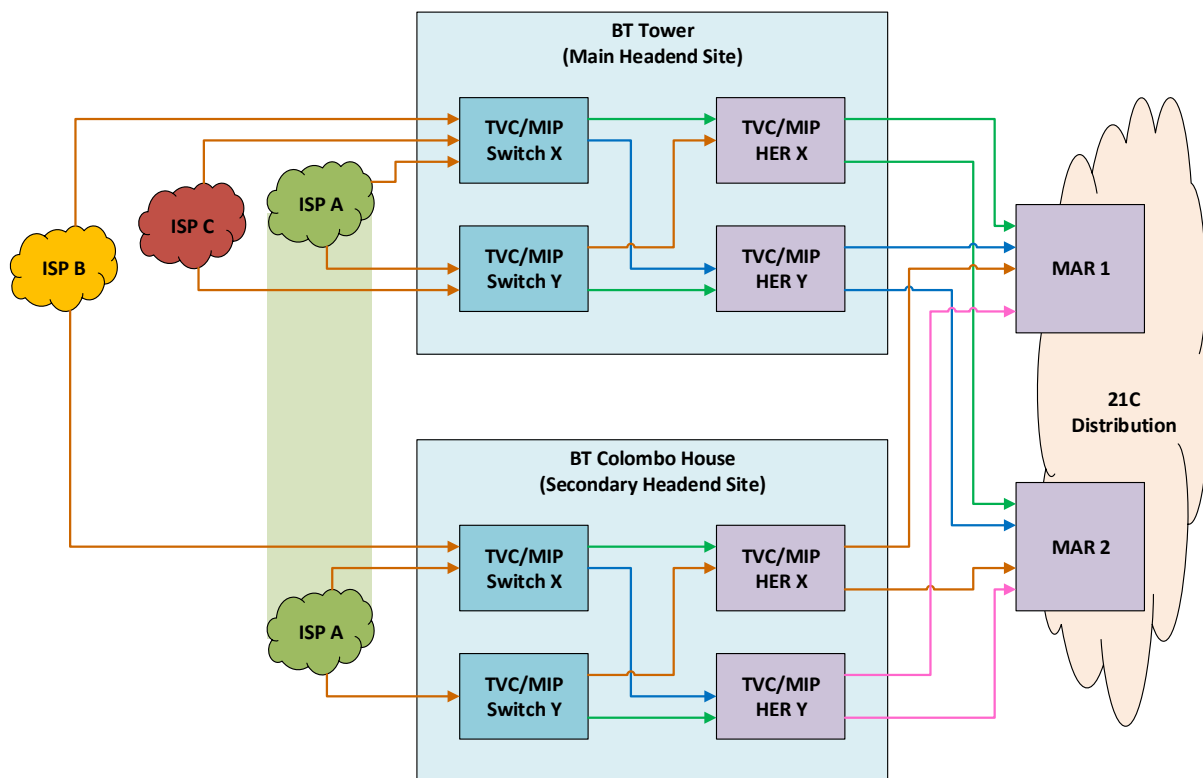
Figure 2 ISP Connectivity Options

2.1.2 Multicast Content Distribution

- The TV Connect traffic will be delivered across the end to end network over a separate logical path from the WBC data traffic. (See Section 2.3.1)

- The ISP may choose to provide its own Retransmission (RET) solution for packet repair. A feed of the full multiplex of their channels may be supplied by BT Wholesale to support such a solution. Details of handover points will be agreed during contract negotiation subject to a successful development and test programme with the ISP. The ISP will be responsible for interconnection to their own equipment from the agreed handover points. The ISP may forward retransmission repair and control traffic via the WBC service.

2.1.3 Home Environment/End User Experience

- The end user access link may be via WBC fibre or copper as provided by Openreach.

- The ISP will be expected to provide the required equipment (e.g. a Residential Gateway (home router) and set top box (STB) or other equipment) to an end user in order to support the live streaming of TV channels.

- The ISP will be responsible for end user packages, end user repair and end user billing.

- BT Wholesale will provide interfaces to support provision, repair, service monitoring and billing.

2.2 ISP Services

The TV Connect product is an optional feature of the WBC service that allows live streamed content to be multicast delivered to End Users from a Head End within the BT Wholesale network.

The WBC SIN is available from http://www.btplc.com/sinet/

TVC Service Configuration

- An ISP will buy TV Connect from BT Wholesale to deliver channels to its WBC broadband end users.

- BT Wholesale takes on the delivery of TV channels to all the WBC end users as part of the product.

- Only a WBC customer (ISP) can take up the TV Connect service.

- The TV Connect service is available to ISPs that take the WBC PTA (PPP termination and aggregation service) and/or the WBC L2TP (Layer 2 Tunnelling Protocol) handover service.

- The ISP will supply TV channel content to the BT Wholesale TV Connect Head End.

- The ISP will be responsible for the Residential Gateway (home router) and set top box (STB) functionality within the end user's environment.

- It is the responsibility of the ISP to provide any TV Channel restrictions to individual WBC broadband end users it deems necessary.

For all requests to provide channel capacity within the current network capacity (as agreed and managed with BT Wholesale) available on the TV Connect network, BT Wholesale will deliver channel capacity to an ISP's end users who are on WBC fibre and copper, in line with forecasted channel demand from the ISP following the process as set out in the TV Connect Product Handbook.

Where there is a need to provide additional channel capacity beyond the current network capacity available, the ISP can submit a request by contacting their account team who will raise a request in to the TV Connect Product Line via the Statement of Requirements (SoR) process. An assessment of such a request will then be carried out to determine if the demand for additional capacity can be accommodated in line with the SoR process timelines.

An ISP can check the availability of Multicast at WBC exchanges by using the Broadband Availability Checker available at http://www.btwholesale.com/ via the Routing and Planning section under the Applications tab.

When the ISP is ready to raise an order to provide/add channels, all of the channel details - including whether or not the channel/s are required on both fibre and copper networks - must be clearly marked in the appropriate fields on the TV Connect CRF.

2.3 TV Connect Infrastructure Description

2.3.1 Overview

An overview of the network infrastructure that supports TV Connect is illustrated in Figure 3.
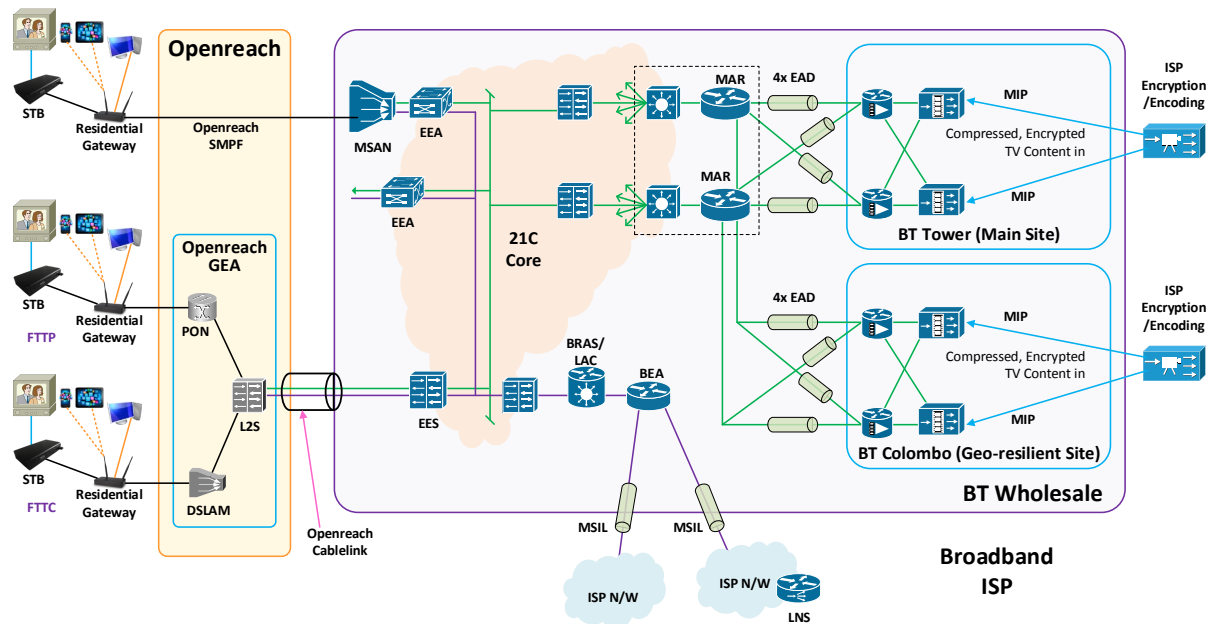
Figure 3 Overview of Network Infrastructure

The TV Connect service accepts TV channels from a TV content provider into the TV Connect Head End as compressed streams via the TVC Multicast Ingest Point (MIP) capability.

Compressed (encoded and optionally encrypted) TV channels are checked and policed at the Multicast Ingest Point (MIP) to ensure that a) the maximum per channel bandwidth, as contracted by the ISP is not exceeded and b) that the maximum overall bandwidth envelope for all channels, as contracted by the ISP is not exceeded. Error recovery via Forward Error Correction (FEC) is not supported, but appropriate Service IP Addressing is provided.

The TV Connect service delivers multicast channels to end users via MSANs and Openreach GEA. A combination of IP and Ethernet Multicast within BT's 21C core, at the MSAN (copper access), and within the Openreach GEA equipment (fibre access, FTTC and FTTP), is then used to replicate and deliver TV Connect Channels to WBC End Users (EUs). WBC End Users will then receive the TV channel(s) when requested using the IGMP protocol, as described in sections 2.3.2 and 2.3.3.

The service is designed for high availability, so TV Connect traffic is delivered over resilient paths into and across the BT Wholesale 21C infrastructure to MSANs and Openreach GEA handover points.

2.3.2 End-To-End Service Flow Example (Fibre access, FTTC and FTTP via Openreach GEA)

An overview of end user end-to-end flows for an end user connected via Openreach GEA is illustrated in Figure 4.
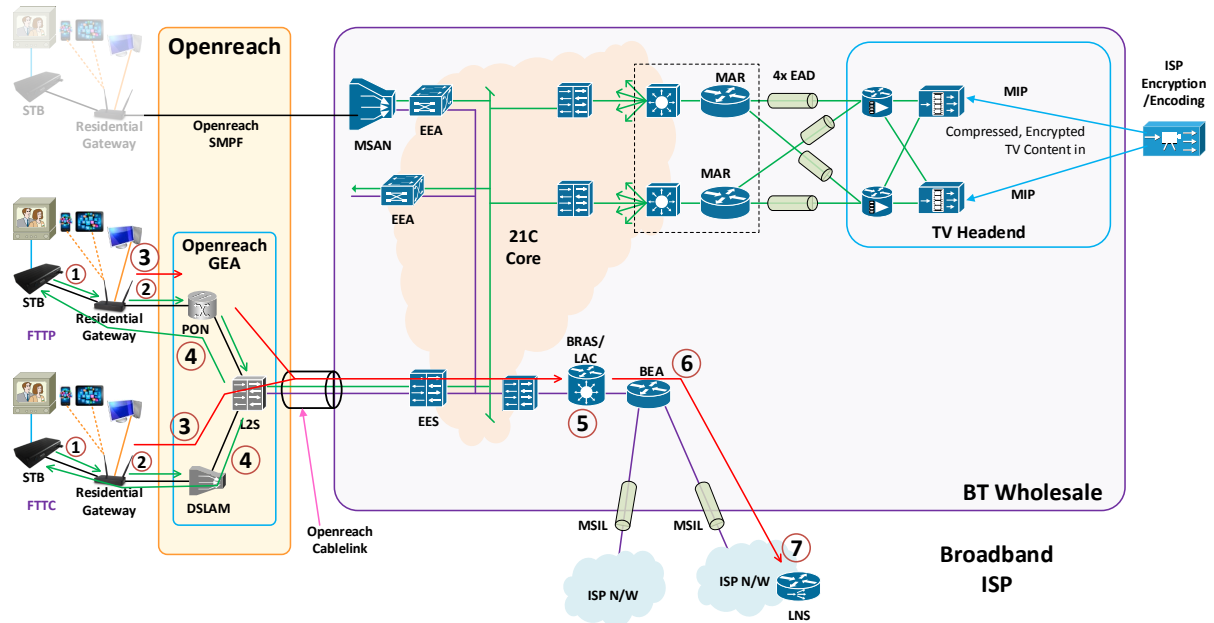
Figure 4 End to End flows for an end user connected via fibre, FTTC and FTTP via Openreach GEA

Channel join request

1. End user issues channel join request via Set Top Box

2. Home router issues proxy request into TV Connect path to Openreach GEA head end

3. Home router replicates proxy request and issues it into PPP path to BRAS

4. Openreach GEA head end receives proxy request from home router and delivers requested channel to end user

5. BRAS receives proxy request from home router and shapes broadband end user broadband PPP session to a rate reduced by an amount equal to requested TV channel bandwidth.

6. In the case of an ISP taking the L2TP handover option for WBC, the home router replicates the proxy request so that it is forwarded via the PPP session over an L2TP tunnel from the LAC within the BT platform to the LNS within the ISP's network.

7. The LNS within the ISP's network receives the proxy request and is expected to shape the broadband end user PPP session to a rate reduced by an amount equal to the requested TV channel bandwidth.

Channel Leave Request

The channel leave request sequence functions in a similar fashion.

1. End user issues channel leave request via Set Top Box

2. Home router issues proxy request into TV Connect path to Openreach GEA head end

3. Home router replicates proxy request and issues it into PPP path to BRAS

4. Openreach GEA head end receives proxy request from home router and stops delivering the specified channel to the end user

5. BRAS receives proxy request from home router and removes the shaping on the broadband end user broadband PPP session by an amount equal to the bandwidth of the TV channel specified in the leave request.

6. In the case of an ISP taking the L2TP handover option for WBC, the home router replicates the proxy request so that it is forwarded via the PPP session over an L2TP tunnel from the LAC within the BT platform to the LNS within the ISP's network.

7. The LNS within the ISP's network receives the proxy request and is expected to remove the shaping on the broadband end user PPP session by an amount equal to the bandwidth of the TV channel specified in the leave request.

2.3.3 End-To-End Service Flow Example (Copper access from an MSAN)

An overview of end user end-to-end flows for an end user connected to an MSAN is illustrated in Figure 5.
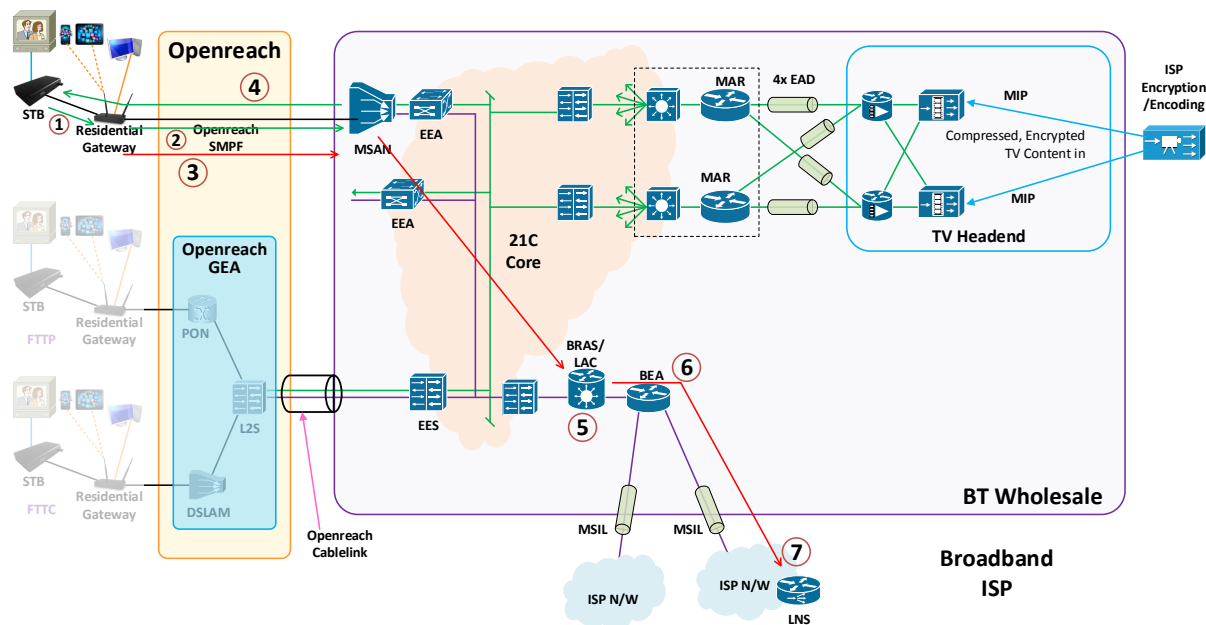

Figure 5 End to End flows for an end user with copper access connected to an MSAN

<u>Channel Join Request</u>

1. End user issues channel join request via Set Top Box.

2. Home router issues proxy request into TV Connect path to MSAN.

3. Home router replicates proxy request and issues it into PPP path to BRAS.

4. MSAN receives proxy request from home router and delivers requested channel to end user.

5. BRAS receives proxy request from home router and shapes the broadband end user's PPP session to a rate reduced by an amount equal to the requested TV channel bandwidth.

6. In the case of an ISP taking the L2TP handover option for WBC, the home router replicates the proxy request so that it is forwarded via the PPP session over an L2TP tunnel from the LAC within the BT platform to the LNS within the ISP's network.

7. The LNS within the ISP's network receives the proxy request and is expected to shape the broadband end user PPP session to a rate reduced by an amount equal to the requested TV channel bandwidth.

<u>Channel Leave Request</u>

The channel leave request sequence functions in a similar fashion.

1. End user issues channel leave request via Set Top Box.

2. Home router issues proxy request into TV Connect path to MSAN.

3. Home router replicates proxy request and issues it into PPP path to BRAS.

4. MSAN receives proxy request from home router and stops delivering the channel down to the end user.

5. BRAS receives proxy request from home router and removes the shaping on the broadband end user's PPP session by an amount equal to the bandwidth of the TV channel specified in the leave request.

6. In the case of an ISP taking the L2TP handover option for WBC, the home router replicates the proxy request so that it is forwarded via the PPP session over an L2TP tunnel from the LAC within the BT platform to the LNS within the ISP's network.

7. The LNS within the ISP's network receives the proxy request and is expected to shape the broadband end user PPP session to a rate reduced by an amount equal to the requested TV channel bandwidth.

3. ISP Multicast Ingestion into TVC

3.1 Channel Ingress to TV Connect Head End.

Presentation of [ISP encoded and encrypted] programme sources from the ISP's network to the TVC Head End will be by Gigabit Ethernet links. The number of links provided will depend on the resilience option selected by the ISP (see Section 2.1.1).

The ISP devices to be connected into the TVC Multicast Ingest Point (MIP) can be located locally (within range of CAT5e cable, 100 metres maximum) or remotely in a location to be agreed with the ISP. For devices that are remotely located the ISP will be responsible for the provision of interconnecting access circuits and any associated security arrangements. BT recommends the use of the Openreach Ethernet Access Direct (EAD) products.

At least two Gigabit Ethernet ports (1000BASE-T) are available on the TVC MIP to accept the programme streams from the ISP [4], the location and number of ports is dependent on the resilient option chosen by the ISP as illustrated in Figure 2.

All signals between the ISP and the Head End will be carried over these physical links.

It is assumed that the programme streams traversing these links will be properly conformed MPEG2 Single Programme Transport Streams [2].

MIP will police ISP ingest bandwidth to ensure that:

- The overall bandwidth offered by the ISP into TVC does not exceed the overall bandwidth envelope agreed with BT Wholesale.

- The individual channel bandwidth of each channel offered by the ISP into TVC does not exceed the individual channel bandwidth agreed with BT Wholesale.

4. <u>IP Multicast Streams</u>

4.1 Maximum Bandwidth

The maximum bandwidth per SPTS Programme Channel shall be 30Mbps in the Wholesale Network

4.2 Channel Aggregation

The TV Connect product will multiplex all the ISP's channels together to deliver as IP Multicast for transport across the core of the 21C network. Each channel is identified by unique group and source IP address and transported together in this multiplex of IP multicast streams.

4.3 Multicast Source and Group IP addresses

The ISP will be expected to complete a Customer Requirements Form (CRF) in conjunction with BT Wholesale. Multicast group and source addresses will be agreed between BT Wholesale and the ISP with regards to allocation for each channel during the order process.

The multicast group IP address is used to uniquely identify a particular TV channel.

The multicast source IP address is used to identify the network source equipment of the TV channel within the TV Connect Head End and is required for multicast routing and geo-resilient failover.

4.4 Retransmission

In order to facilitate packet repair by retransmission by the ISP, a multiplex of all the channels belonging to an ISP may be made available to the ISP at a small set of handover points, which are to be agreed during contract negotiation.

Retransmission repair and control packets may be forwarded via the WBC data service. It is recommended that an ISP make use of the priority best effort traffic marking for retransmission repair and control traffic [5] in order to ensure a good experience for end users.
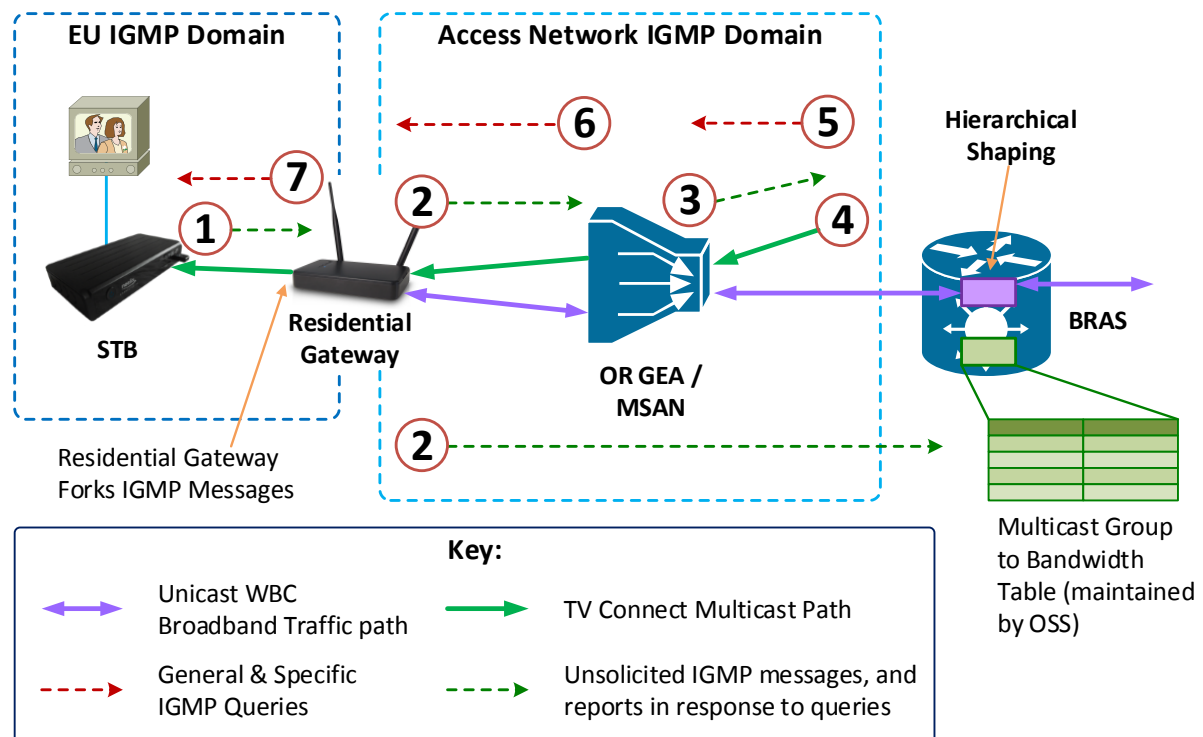
5. TV Connect Customer Premises Equipment (CPE) IGMP Requirements

5.1 Message Sequencing

It is expected that IGMPv3 will be used to signal access to TV Connect channels. An end user will be joined to a selected channel via

- Openreach GEA – fibre to the cabinet (FTTC) or fibre to the home (FTTP).
- MSAN – WBC copper

The IGMP messaging sequence is indicated in Figure 6.

Figure 6 TV Connect IGMP flows

5.2 Set Top Box (STB) Functions

The set top box will generate IGMP join and leave messages in response to end user requests (e.g. channel selection changes) and respond to IGMP query requests (from upstream network equipment).

The set top box may use the WBC service to communicate with retransmission servers for packet repair or access other ISP services.

5.3 Residential Gateway (home router) Functions [3]

- The End user Residential Gateway (RG) acts as an IGMP proxy routing agent, supports IGMP snooping and forks IGMP messages for sending up the TV Connect and Broadband paths

- Support for IGMPv3 is required on the Residential Gateway

- The TV Connect product will only support IGMPv3 [1]

- The TV Connect product will support IGMPv3 Any Source Multicast (*,G).

- The TV Connect product will not support IGMPv3 Source Specific Multicast (S,G).
- The IGMP protocol has no acknowledgements, in consequence
  - Multiple IGMP requests are to be sent by the Residential Gateway. 2 IGMP requests should be sent initially (IGMPv3 default setting). The "robustness variable" setting may be adjusted if required in consultation with BT Wholesale during trials.
  - The "Unsolicited report intervals" should be set to 1 second initially (IGMPv3 default setting).
- The Residential Gateway should prioritise IGMP joins and leaves upstream (802.1p marking of 3 or above)
- Responses to IGMP Queries (keep-alives) by the Residential Gateway shall only be returned over the interface through which the Queries were received.

5.3.1 End user connected via Openreach GEA (FTTC and FTTP)

For an end user connected via Openreach GEA (FTTC and FTTP)

- The Residential Gateway will support
  - IPoE for multicast traffic and PPPoE for BB traffic
  - VLAN tag ID of 0 or no VLAN tag ID for multicast and BB traffic
- Fork IGMP requests for sending up multicast and BB paths. More details on the support of Multicast via Openreach GEA (FTTC and FTTP) including features such as fast leave are described in SIN 503 [6]

The BRAS will adjust the rate of the PPP session on a receipt of an IGMP join/leave by an amount equal to the bandwidth of the channel specified in the join/leave.

- The BRAS will respond to IGMP joins/leaves after a configurable delay with a default setting of 1s.

The BRAS will send IGMP queries independently of the Openreach GEA equipment

- The BRAS will send periodic IGMP queries over the PPPoE session
  - General queries will be sent at a default interval of 125s with a default maximum response time of 10s
  - The BRAS will use a "robustness variable" setting of 3 as default.

Settings for timer values and "robustness variables" may be adjusted in consultation with BT Wholesale during trials.

5.3.2 End user connected to an MSAN (WBC copper)

For an end user connected to an MSAN (WBC copper)

- The Residential Gateway will support a dual VC architecture
  - Accept TV Connect multicast traffic on ATM VP/VC 0/35 with IPoA and broadband traffic on ATM VP/VC 0/38 with PPPoA
  - Fork IGMP requests for sending up multicast and broadband paths
- The MSAN will send periodic IGMP queries

- General queries will be sent at a default interval of 125s with a default maximum response time of 100s.

- Specific queries will be sent at a default interval of 10s with a default maximum response time of 8s.

  The MSAN will use a "robustness variable" setting of 2 as default.

- The MSAN will support the fast leave mode of IGMP.

5.3.3 ISP utilising the L2TP handover service option for WBC

For an ISP utilising the L2TP handover service option for WBC, the ISP will be expected to provide similar IGMP aware line shaping functionality to that of the BT BRAS.

The ISP LNS will adjust the rate of the PPP session on a receipt of an IGMP join/leave by an amount equal to the bandwidth of the channel specified in the join/leave.

- The ISP LNS will respond to IGMP joins/leaves after a configurable delay with a default setting of 1s.

The ISP LNS will send IGMP queries independently of the MSAN

- The ISP LNS will send periodic IGMP queries over the PPPoA session

  - General queries will be sent at a default interval of 125s with a default maximum response time of 10s

  - The LNS will use a "robustness variable" setting of 3 as default.

Settings for timer values and "robustness variables" may be adjusted in consultation with BT Wholesale during trials.

6. Service Availability

Only a WBC customer (ISP) can take up the TV Connect service. The TV Connect service is available to ISPs that take the WBC PTA (PPP termination and aggregation service) or L2TP (Layer 2 tunnelling protocol) handover service.

An ISP can check the availability of Multicast at WBC exchanges by using the Broadband Availability Checker available at http://www.btwholesale.com/ via the Routing and Planning section under the Applications tab.

7. ISP Responsibilities

The ISP will be responsible for End User engagement, including client management (e.g. client streaming, updates, and problem resolution)

The ISP specified Set Top Box will need to be capable of receiving TV Connect Streams, decryption, and error recovery via retransmission.

The ISP will be responsible for the encoding and Conditional Access for their TV Channel content.

The ISP will be responsible for connectivity to the TVC Head End up to the agreed handover port in the MIP.

The ISP will be responsible for live streaming the TV Channel content into the TVC Head End.

The ISP will be responsible for the Residential Gateway (home router) and set top box functionality within the end user's environment. The Residential Gateway (home router) will proxy IGMP requests upstream onto the TV Connect path and into the Broadband PPP path towards the BRAS.

The ISP will participate in collaborative testing to support BT Wholesale with provision and repair of the TVC service.

The ISP will ensure that all technical details required to complete the CRF are provided.

The ISP will be responsible for packet repair via Retransmission.

For an ISP that takes the L2TP handover service the ISP will be responsible for IGMP aware PPP session shaping functionality.

8. References

Protocol Standards:

[1]	IGMPv3	IETF RFC 3376 Internet Group Management Protocol Version3 http://datatracker.ietf.org/doc/rfc3376/
[2]	MPEG2 – TS	ETSI TS 102 034 (V1.4.1): "Digital Video Broadcasting (DVB); Transport of MPEG-2 TS Based DVB Services over IP Based Networks".
[3]	TR101	Technical Report DSL Forum TR101 Migration to Ethernet based DSL Aggregation April 2006– section 6 Multicast
[4]	Gigabit Ethernet	IEEE http://www.ieee802.org IEEE 802.3ab – 1000BASE-T
[5]	SIN 472	BT Wholesale Broadband Connect (WBC) Products Service Description http://www.btplc.com/sinet/
[6]	SIN 503	Generic Ethernet Access Multicast, Service and Interface Description http://www.btplc.com/sinet/

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

9. <u>Abbreviations</u>

21CN	21st Century Network
ATM	Asynchronous Transfer Mode
AVC	Advanced Video Coding
BB	Broadband
BEA	Broadband Edge Aggregator
BRAS	Broadband Remote Access Server
BT	British Telecommunications plc
BTW	BT Wholesale
CA	Conditional Access
CAT5	Category 5 cable
CPE	Customer Premises Equipment
CRF	Customer Requirements Form
DSL	Digital Subscriber Line
DSLAM	Digital Subscriber Line Access Multiplexer
DTT	Digital Terrestrial TV
DVB	Digital Video Broadcast
EAD	Ethernet Access Direct [Openreach]
EEA	Ethernet Edge Aggregator
EES	Ethernet Edge Switch
EMM	Entitlement Management Messages
EU	End User
FEC	Forward Error Correction
FTTC	Fibre To The Cabinet
FTTH	Fibre To The Home
GE	Gigabit Ethernet
GEA	Generic Ethernet Access (Openreach product)
HD	High Definition
HE	Head End
IEA	Inner Ethernet Aggregator
IEEE	Institute of Electronic and Electrical Engineers
IETF	Internet Engineering Task Force
IGMP	Internet Group Management Protocol
IP	Internet Protocol
IPoA	IP over ATM
IPoE	IP over Ethernet
ISP	Internet Service Provider
ITU	International Telecommunications Union

L2S	Layer 2 switch
L2TP	Layer 2 Tunnelling Protocol
LFE	Low Frequency Effects (Channel used in surround sound)
LAC	L2TP Access Concentrator
LNS	Layer Two Network Server
MIP	Multicast Ingest Point
MPEG2	Motion Picture Experts Group compression algorithm
MSAN	Multi-Service Access Node
MSIL	Multi-Service Interconnect Link
OSS	Operational Support System
PON	Passive Optical Network
PPP	Point-to-Point Protocol
PPPoA	Point-to-Point Protocol over ATM
PPPoE	Point-to-Point Protocol over Ethernet
PTA	Point to Point Termination and Aggregation
RET	Retransmission (packet repair)
RFC	Request For Comment
RG	Residential Gateway
s	Seconds
SD	Standard Definition
SIN	Supplier Information Note
SMPF	Shared Metallic Path Facility
SMPTE	Society of Motion Picture and Television Engineers
SPTS	Single Programme Transport Stream
STB	Set Top Box
STIN	Supplier Trial Information Note
TV	Television
TVC	TV Connect
UDP	User Datagram Protocol
UHD	Ultra High Definition
VC	Virtual Circuit
VLAN	Virtual Local Area Network
VP	Virtual Path
WBC	Wholesale Broadband Connect

10. History

Issue	Date	Changes
STIN 1.0	13th January 2012	First Issue for Publication on http://www.sinet.bt.com
STIN 1.1	14th September 2012	STIN updated to reflect learning from Product Trials
SIN 1.0	18th December 2012	STIN raised to SIN
SIN 1.1	25th January 2013	SIN updated to clarify availability of TV Connect over WBC Copper
SIN 1.2	26th March 2013	SIN updated to include L2TP handover option
SIN 1.3	25th July 2013	SIN updated to include alternative Head End trial and clarification to audio description options
SIN 1.4	10th October 2013	SIN updated to include channel resilience via alternative Head End as firm option
SIN 1.5	7th November 2013	SIN updated to include additional information on channel capacity management and service availability
SIN 1.6	9th May 2014	SIN updated to include option for SDI egress connection from Head End Change of SINet site references from http://www.sinet.bt.com to http://www.btplc.com/sinet/
SIN 1.7	23th July 2015	SIN updated to include UHD channel Specifications
SIN 1.8		SIN Updated to extend TVC offering to incorporate options to ingest pre-encoded (ISP encoded) content. 16/10/2015. Reviewed and updated 29/10/2015.
SIN 1.9	November 2016	SIN updated to extend TVC offering to support the ingest of Audio Description Broadcaster Mix for encoding to delivery an alternative Audio Description format to Receiver Mix. Minor editorial updates for clarity on specification.
SIN 1.10	October 2017	TV Connect Protect option withdrawn. Minor editorial updates to clarify diagrams. Removed invalid example of product option from section 5.
SIN 2.00	December 2017	Withdrawal of the encoding capability of TV Connect. Documentation correction to requirements of End User connectivity to MSAN WBC Copper (section 5.3.2)

-END-