VALUE PARTNERS
MANAGEMENT CONSULTING

BBC | Trust

REPORT

REPORT TO ASSESS IMPACT OF CANVAS ON ISP COSTS

London, December 2009

Contents

1 Glossary of terms

Access – the 'last mile' of a broadband network between the exchange and customer premises. Currently served by ADSL copper lines, with the exception of Virgin Media

ADSL – Asynchronous Digital Subscriber Line: data communications technology that enables faster data transmission over copper telephone lines than a conventional voice band modem can provide. It does this by utilizing frequencies that are not used by a voice telephone call

Backhaul – the intermediate links in a broadband network between the core of the network and local exchanges

Bandwidth – the rate of data transfer, defined in bits per second, bps, either required to deliver a service on a network, or potentially available for services

BRAS – Broadband Remote Access Server; aggregates subscriber traffic from a DSLAM and routes onto an ISPs backbone network

Busy hour – the time of day that has the highest amount of bandwidth demanded on the broadband network. ISPs typically dimension their networks to support the traffic demanded during this time

Cable Broadband –broadband provided using coax rather than copper lines or fibre in the local loop. In the UK, this is provided by Virgin Media

Canvas-enabled – a set-top box or idTV that has Canvas technology built in, therefore providing the consumer with an option to consume IPVoD (provided they have a suitable broadband connection)

CDN – Content Delivery Network; a distribution system on the Internet that accelerates the delivery of Web pages, audio, video and other Internet-based content to users around the world. The CDN replicates the content provider's files in servers, called "caching servers" or "edge servers," located in geographically dispersed datacenters

CODEC – device or computer program capable of encoding and/or decoding a digital data stream or signal

Compression – the process of encoding information, such as video content, to reduce file size and required bandwidth

Contention – the sharing of given network connection between multiple users. The higher the contention ratio, the greater the number of users that may be trying to use the actual bandwidth at any one time and, therefore, the lower the effective bandwidth offered, especially at peak times

Core – main "trunk" connections of the Internet. The Core is made up of a large collection of interconnected high-capacity data routes and core routers that carry data both nationally and internationally

Customer cost – non-network costs accrued by ISPs including subscriber acquisition costs, and customer services

Customer Premises Equipment – any terminal and associated equipment located at a subscriber's premises and connected with a carrier's telecommunication channel(s) at a demarcation point. The demarcation point is a point established in a building or complex to separate customer equipment from telephone company equipment

Digital Britain – a set of government policy proposals, addressing digital infrastructure, content and education requirements for the UK. These proposals were set out in a final report released in June 2009

Exchange – the point of aggregation of multiple consumer access lines and transfer of traffic to and from the backhaul network. It is also the location for the equipment necessary to support unbundling as well as equipment to support some potential content management services

FTTC – Fibre to the Curb; a telecommunications system based on fibre-optic cables to street cabinets located between the customer premises and local exchanges, with copper wires providing the remaining connectivity to the premises

iDTV – integrated digital television; a television incorporating a digital tuner

IPStream – the most widely-used wholesale broadband Internet service in the United Kingdom. BT Wholesale sells the service to ISPs, who use it to provide ADSL services to customers. The IPstream product covers the transport of data between the end-user's premises and an interconnect point of the ISPs choice. IPStream broadband provision allows ISPs to have flexibility in the amount of bandwidth they provision, and avoid significant up-front capex investments

IPVoD – Internet Protocol Video on Demand; on demand video content delivered over the broadband network. Such content can either be streamed from a content server, or provider, and watched in real-time, or downloaded to the users own computer which then stores the content

IPVoD enabled – a set-top box or idTV that has a broadband connection capable of delivering IPVoD content (i.e. the broadband connection is capable of delivering the bandwidth, and the consumer has paid an ISP to deliver the required bandwidth) to stream VOD to the TV

ISP – Internet Service Provider; a company providing a broadband service to consumers. The service can be provisioned via LLU, IPStream, WBC or cable using one or a mixture of these methods

LLU – Local Loop Unbundling; the process of allowing competing telecoms providers to use the physical copper wire between a local exchange and the customer's premises, known as the "local loop." To unbundle an ISP must invest in their own switching equipment at the exchange, arrange backhaul connectivity and lease the "local loop" connection from BT. LLU gives an ISP more flexibility in services and pricing as well the potential to achieve significant economies of scale if enough subscribers can be acquired

MPEG 2 – compression standard that provides the broadcast-quality image of 720x480 resolution that is used in most Standard Definition DVD movies

MPEG 4 – MPEG-4 is a graphics and video compression algorithm standard that is based on MPEG-1, MPEG-2 and specifically designed to support streaming of video and audio content

Openreach – a BT subsidiary company, which installs, services, supports and maintains the wiring, fibres and connections of the UK fixed line telephone and broadband network between consumers' premises and their communication providers' networks. Openreach was established in 2006 to ensure that all communications operators had equal access to BT's local network

VOD-enabled – a Set Top Box or iDTV through which users can consume IPVOD; this would include Canvas enabled sets, Sky's Darwin set, and the next generation of Freeview sets with DBook6 standards. Differs from IPVoD-enabled devices in that not all VoD enabled devices will either be connected to broadband or to a broadband connection of sufficient bandwidth to support video streaming

WBC – Wholesale Broadband Connect; BT Wholesale's 21st Century Network (21CN) next generation broadband service offering greater economies of scale than IPstream

WCC – Wholesale Content Connect; a product BT Wholesale is developing to support a content delivery capability in the Broadband network, to host content and allow ISPs to offer managed content delivery services to their customers

2 Executive Summary

The BBC Trust commissioned Value Partners to provide an independent view on the potential market impact of Canvas on the TV, VoD and ISP markets. This report addresses the impact on the network costs for ISPs

To assess the impact of Canvas, across these markets Value Partners developed a comprehensive model of the TV, VoD and residential broadband markets in the UK and compared a 'counterfactual' view of how these markets would develop without the launch of Canvas to a 'factual' view of how the market would develop with Canvas.

The report discusses the broadband market context into which Canvas would be launched, explains the modelling approach, sets out the modelling assumptions, and discusses the outcomes and implications for ISPs.

Market Context

The broadband market in the UK is highly dynamic and undergoing rapid change. Since its introduction in 2000, broadband has all but replaced narrowband internet and driven internet penetration from 33% of households in 2000 to 67% in 2008; broadband penetration is forecast to grow to 79% by 2015.

Following major regulatory intervention in 2005 the wholesale market has grown significantly with Local Loop Unbundling (LLU), allowing ISPs greater ability to differentiate their broadband offer by price, speed and quality of service.

Prices have fallen, resulting in ARPUs for broadband access in 2008 at approximately one-third of those in 2000. Increasingly operators have sought to counter-balance this with product bundling with telephone line rental, calls and television, in order to cross promote services and reduce churn. Over 15% of customers now take a triple play bundle of voice, TV services and broadband.

Broadband speeds – both headline speeds and actual speeds – have increased and will continue to increase as operators continue to invest in upgrades to their networks. Improvements such as ADSL2+ , which allows for access speeds of up to 24 Mbps on the copper network, DOCSIS 3.0 which supports speeds of up to 50 Mbps in the cable network have significantly increased the headline speeds available to customers. Further investment in capacity bottlenecks, in backhaul and core networks, is improving the actual speeds delivered. Recent surveys from Ofcom suggest that average broadband speed achievable is 4.1 Mbps.

Further developments such as BT's commitment to rollout fibre to the cabinet (FTTC), and to provide a new wholesale product, Wholesale Broadband Connect, should further increase the speeds customers experience. However, it also the case that the broadband speeds available to consumer differ widely across the UK. In part this is due to physical limitations, such as distance from an exchange but in part it is the economics to justify investment. Virgin Media's cable network only passes c.50% of homes. Only c.1900[1] exchanges, covering c.84.3%[2] of homes have been unbundled, and BT has given no commitment yet to FTTC deployment beyond 40% of homes. This was recognised by the recent Digital Britain report which announced a number of initiatives to support investment in broadband delivery to whole of the UK.

[1] Samknows
[2] Ofcom Communications Market Review 2009

Market Impact

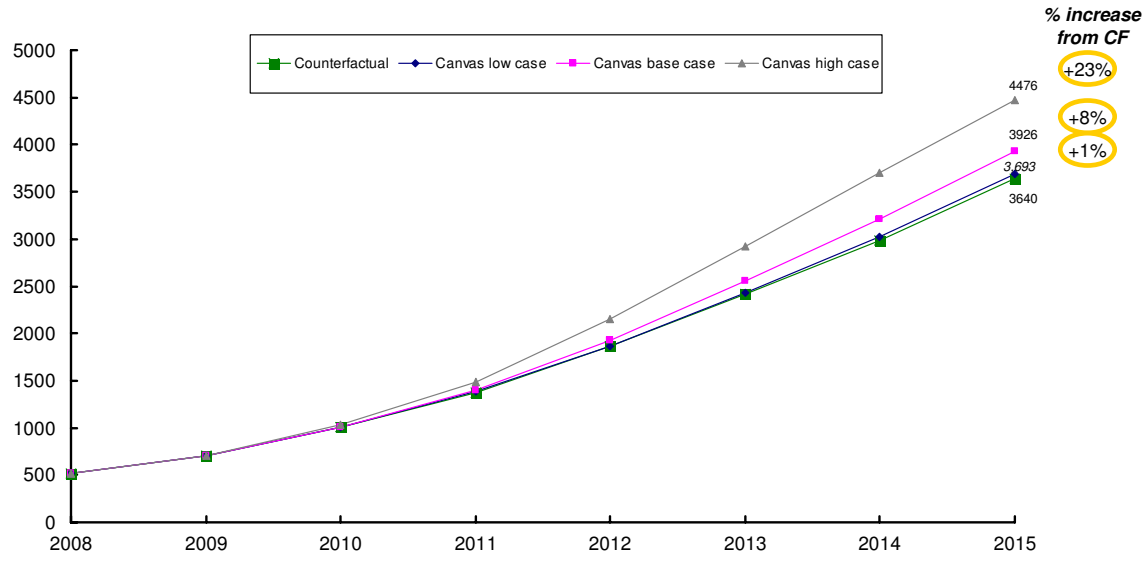
The growth in connectivity and the increase in broadband speeds has supported a growth in bandwidth intensive services and applications. Value Partners estimates that total UK consumer internet traffic of 650 – 700 Gbit/s in 2009 will grow over five fold to over 3,600 Gbit/s by 2015. Most of this growth will come from an increase in video traffic driven by increased consumption of video content over the internet, both delivered to the PC, such as YouTube and iPlayer or delivered to the television set. By 2015 the model forecasts that over 70% of the internet traffic in the UK in peak hour will be video content.

There are already several initiatives to bring Internet VoD to the home TV, such as Virgin's VoD service, Sky's project Darwin as well as a number of initiatives around the DTT platform. A key conclusion of the analysis is that the impact of Canvas will be to accelerate this trend. This has three main effects on the ISP market:

- Firstly, Canvas will drive wider take up and usage of VoD enabled set-top boxes. In the base case Canvas results in 2.1 million more VoD enabled sets by 2015
- Secondly this will result in a greater amount of video content delivered to the TV over the internet, and hence an increase in overall traffic. Streaming services to the TV account for 34% of total peak internet traffic in the base case by 2015 an increase of 27% from the counterfactual scenario
- Thirdly, Canvas will encourage the take-up of broadband amongst households which might otherwise not have subscribed. In the base case, Canvas results in 470,000 more households subscribing to broadband. In the high case, broadband penetration increases by 870,000. Hence, Canvas will increase broadband penetration relative to the counterfactual by between 2-3% , from 79% to 81-82%

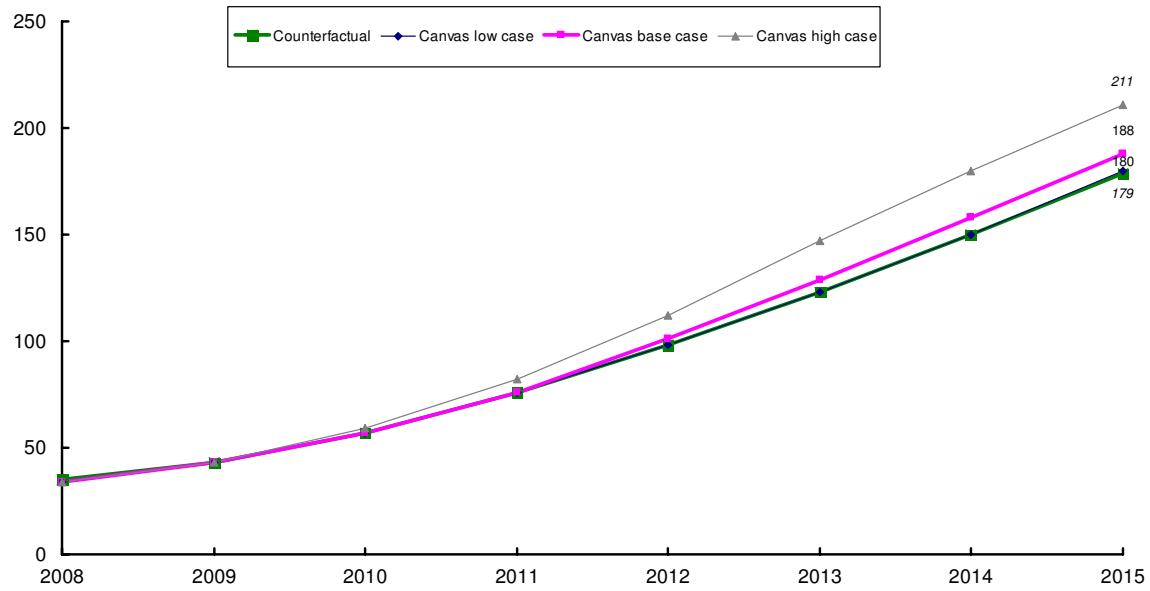
The combined impact of these trends is a total growth of peak hour traffic in the base case of 8% from the counterfactual case.

Exhibit 1: Total peak hour traffic, Gbits/s



Translating this traffic into a per subscriber figure as a proxy for the network dimensioning requirements for an ISP, Canvas grows peak hour bandwidth per subscriber, by 5% in the base case, from 179kbit/s to 188kbit/s, in 2015.

Exhibit 2: Peak hour bandwidth per subscriber, 2009 – 2015, Kbits/s

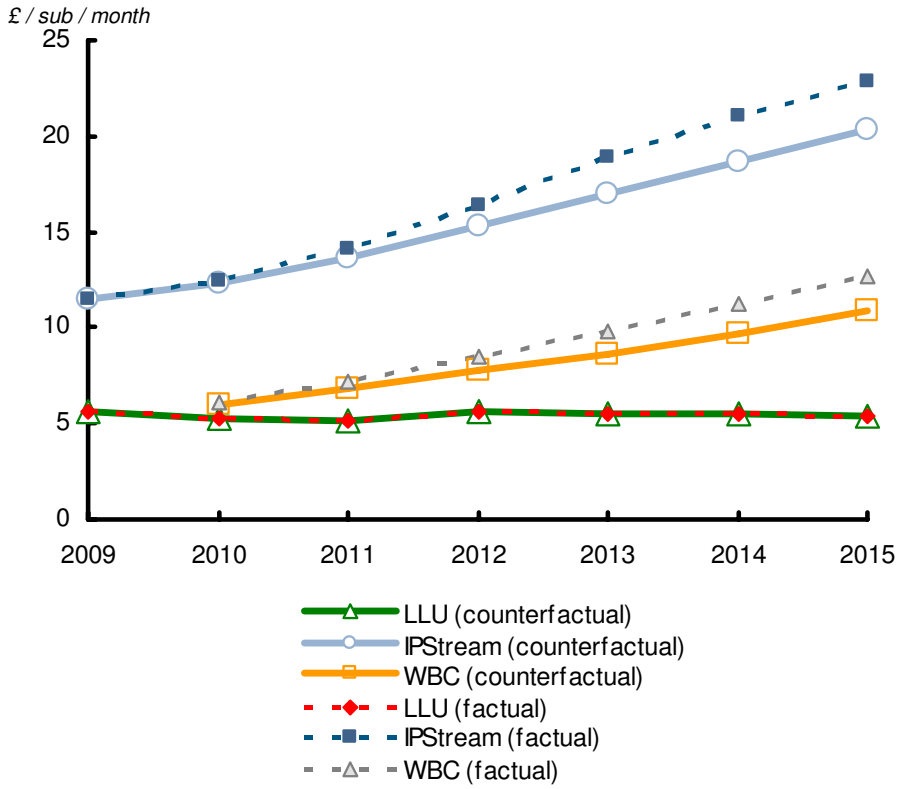


Impact on Network Costs

The model compares the costs for an ISP to dimension its network to meet this peak bandwidth, using three different wholesale services: LLU, IPstream or Wholesale Broadband Connect (WBC). The model assumes that ISPs dimension their network to meet this demand for peak bandwidth. These cost profiles have been modelled for three different ISP profiles, small medium and large and a network cost per user has been derived. Only network related capex and opex costs are included.

The exhibit below shows the variation in monthly costs per line for the medium ISP profile over time, and compares the three wholesale models and counterfactual and Canvas scenarios.

Exhibit 3: Impact of Canvas on medium LLU, IPStream and WBC ISPs (CF vs. High case)



This analysis shows that operators basing their network around LLU, or WBC, are likely to have a significant cost advantage over those using IPstream. This has been widely confirmed by interviews with ISPs. The current range of Ethernet enabled backhaul products for LLU provide very scalable capacity. This compares to IPstream where costs of backhaul increase with traffic volumes. WBC is a new service and, while current pricing offers a comparable cost to LLU for today's traffic volume, WBC costs will increase with bandwidth requirements. Most ISPs noted that they expected the continued growth in internet traffic to drive a migration away from IPstream towards LLU or WBC.

The impact of Canvas to the costs per user, due to wider traffic growth are small. By 2015 the impact is almost negligible for an LLU operator in all cases. At maximum, in the high case, there is a 13% increase for IPstream and 16% increase for WBC costs, compared to the counterfactual. This assumes no changes in the wholesale prices.

The exhibit below compares the NPV of the incremental cost over six years of delivering broadband with each technology between the counterfactual and Canvas scenarios.

Exhibit 4: NPV impact of Canvas over six years on medium LLU, IPStream and WBC ISPs (CF vs. 3 Canvas scenarios)

	Counterfactual	Canvas Low case		Canvas Base case		Canvas High case	
ISP size	£	£ impact	% impact	£ impact	% impact	£ impact	% impact
Large LLU ISP	282.8	-0.2	-0.1%	-0.7	-0.2%	-1.1	-0.4%
Medium IPStream ISP	823.8	1.8	0.2%	18.4	2.2%	66.9	8.1%
Medium WBC ISP	420.7	5.6	1.3%	15.2	3.6%	45.1	10.7%

This shows that in the Canvas base case, the largest cost variation is for IPstream and WBC and this still only represents a 2.2% to 3.6% increase in total network costs respectively. Even in the Canvas high case, incremental costs are only 8.1% to 10.7%. As a result, the model does not forecast any major network cost implications arising from the introduction of Canvas in the UK.

Strategies to Manage Network Costs

To date most internet services are offered on a 'best efforts' basis, with most catch up TV propositions such as BBC I-Player competing with other internet traffic known as 'over the top' delivery. In practice this can lead to variability in the customer experience, especially in peak hour.

Canvas, and other VoD to the TV services are expecting to complement, or substitute, consumers' existing viewing behaviour, and from the discussion with stakeholders, providing a TV quality viewing experience is seen as a key part of the proposition. This implies a continuous video stream, without interruptions, and clear high quality picture.

The impact of Canvas in terms of traffic growth over and above the counterfactual scenario is minimal. However, as Canvas is designed as a TV services, issues of quality of customer experience are likely to be major concerns for customer, ISPs and content owners.

There are a number of possible strategies that could be deployed by ISPs to mitigate any cost increases and potential quality of service (QoS) issues from the growth in IPVoD service. These fall into three areas:

- Encouraging more efficient use of the available network capacity: e.g. via traffic shaping, or deployment of a content delivery network (CDN) involving caching within an ISPs network
- Collaborating with content providers to minimise the traffic generated by VoD: eg by encouraging deployment of improved compression Codecs ; intelligent use of push VoD services; managing the customer experience , via CDN and other QoS solutions, and sharing the costs of the service
- Developing specific VoD commercial propositions for customers: e.g. offering 'Internet TV' services with a guarantee of experience at a premium price, or managing their expectations and only streaming if bandwidth allows

Several of these initiatives are already deployed or under discussion and from conversations with ISPs it is likely that some or all of these techniques may be deployed.

3 Background to this report

3.1 Background to Value Partners

Value Partners is a strategic management consultancy, focusing on media and telecoms. Its work covers strategy and business plan development, operational improvement, and regulatory and government policy work. Value Partners has 13 offices around the world, including the UK, Italy, Germany, China, India, Singapore, Brazil, and Turkey. Value Partners has extensive experience in working for regulators, public service providers and commercial companies in the UK and European media and telecoms sectors.

3.2 Objective of report

The BBC Trust commissioned Value Partners to provide an independent view on the potential market impact of Canvas on ISPs' network costs. This report discusses the broadband market context into which Canvas would be launched, explains the modelling approach, sets out the modelling assumptions, and discusses the outcomes and implications for ISPs. This report should be read in conjunction with other reports prepared by Value Partners on the TV and VoD markets to understand fully assumptions on demand and usage of various TV and VoD services via Canvas devices.

4 Broadband market context

This section of the report provides some context to the broadband market; it is aimed to assist readers who are less familiar with the broadband market, and covers the following topics:

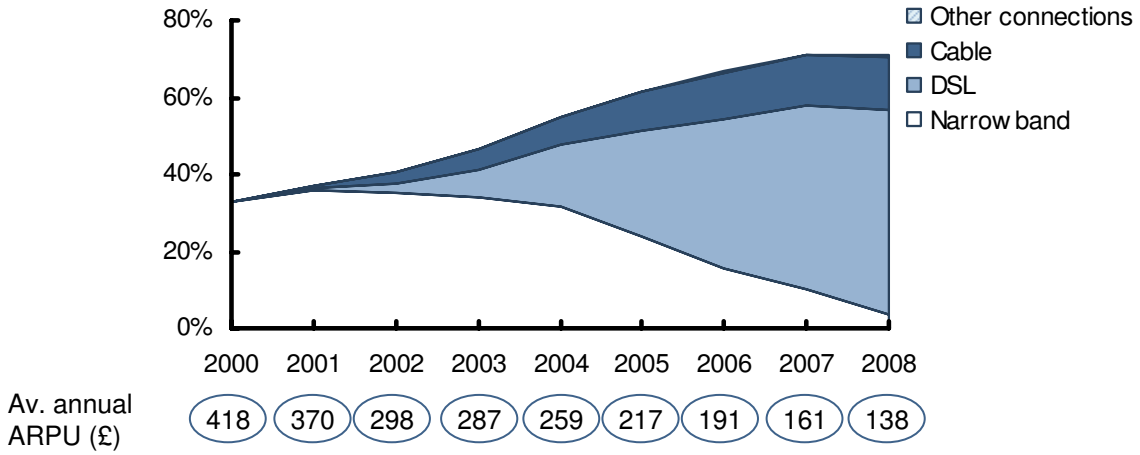
- Evolution of the broadband market
- Broadband technical infrastructure and wholesale models
- Factors affecting broadband speeds
- Factors affecting bandwidth requirements
- Regulation of broadband wholesale market
- Expected future developments in broadband provision

4.1 Evolution of the broadband market

4.1.1 Growth in internet penetration

Internet penetration has grown very quickly since 2000, driven by a combination of price decreases and technological improvements, to reach 67% of households in 2008. Initially, the majority of internet connections were narrowband 'dial-up' connections, with speeds up to 128kbit/s. Over time, DSL technology has been introduced over the copper telephony network to enable widespread availability of broadband services. This is generally defined as an internet connection which is 'always on' and providing bandwidth greater than narrowband[3]. In addition, Virgin Media has developed a cable broadband service on its coaxial cable network. More recently mobile broadband propositions have been launched by mobile telecoms operators.

Exhibit 5: Historic narrowband and broadband household penetration

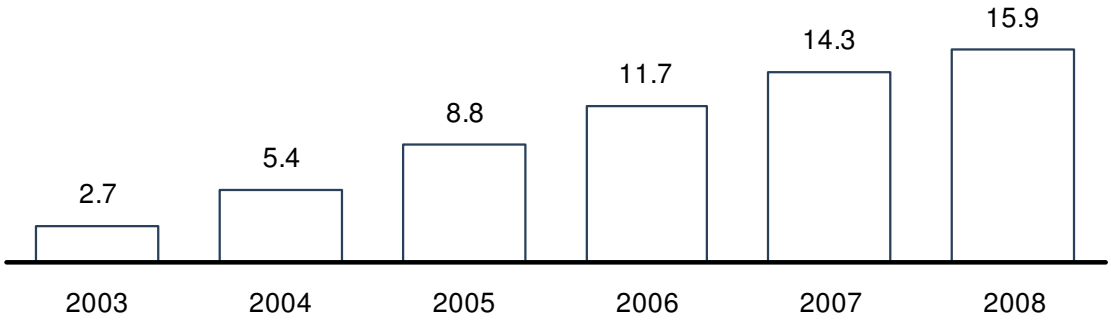


Source: Screen Digest

[3] Ofcom, UK Broadband Speeds 2009, Glossary

In terms of absolute number, the number of residential broadband connections in the UK has grown from 2.7m in 2003 to 15.9m in 2008.

Exhibit 6: UK residential broadband connections (m)[4]



Source: Ofcom Communications Market Review (Telecoms) August 2009

As broadband penetration has increased, consumer usage demands have also risen. Going forward, consumer internet traffic is forecast to grow strongly, with video streaming playing a key role in this growth:

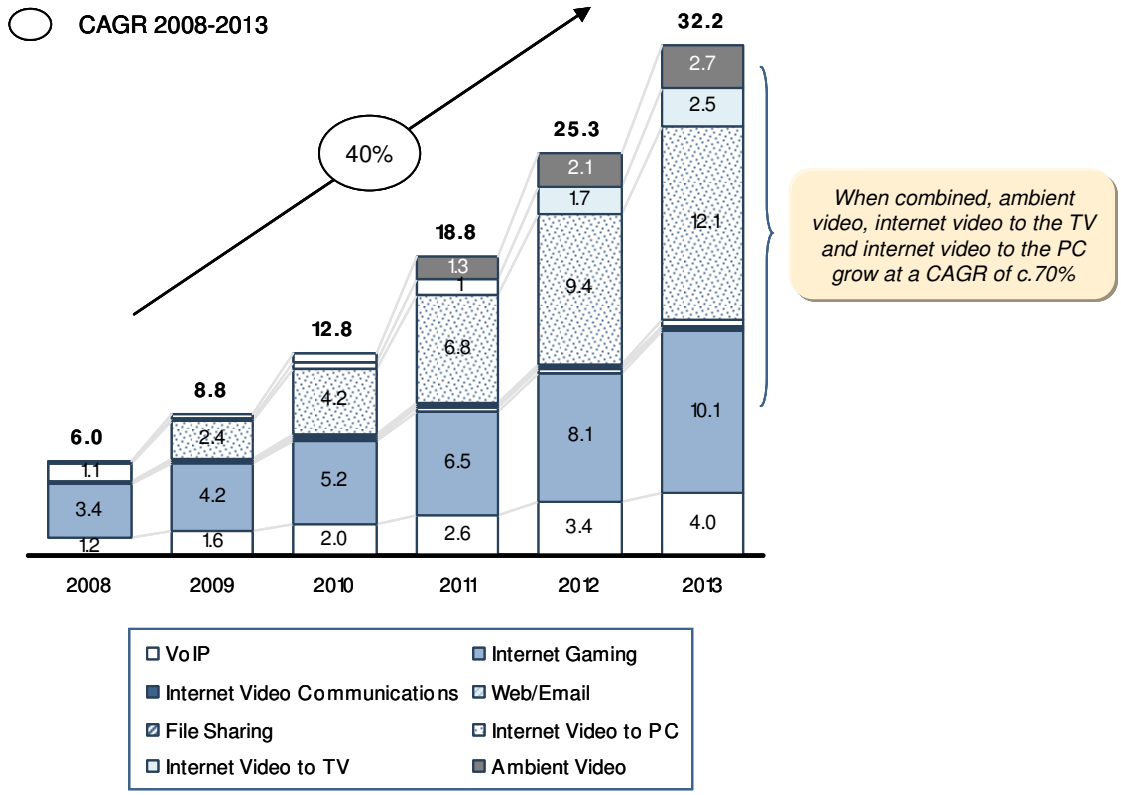
- In recent public reports the Carphone Warehouse Group, owner of the Talk Talk ISP, estimates that consumer IP traffic could quadruple in four years, with the increase driven by video streaming, DVD digital rental, and a switch to HD delivery over IP
- Analysys Mason forecast that there will be a c.6 to 22 fold increase in bandwidth per subscriber by 2015, largely driven by video streaming traffic
- Cisco is forecasting a 40% year on year growth in consumer internet traffic between 2008 and 2013, largely driven by growth in internet video content (video traffic alone is forecast to grow at a CAGR of c.70%)

Inputs from the ISP industry reveal that increased usage of streaming services are already driving total bandwidth requirements

- Talk Tak's peak hour bandwidth demand increased by 22% between 2007 and 2008, This was partly driven by an increase in streaming which rose from 17% to 27% of peak usage between December 2007 and March 2008. Within online streaming, there was also an increase in the amount that was Flash video, from 0% to 27%, due to the popularity of BBC iPlayer.
- Plusnet saw a 21% increase in monthly streaming traffic per user between 2007 and 2008.

[4] Morgan Stanley, EIU

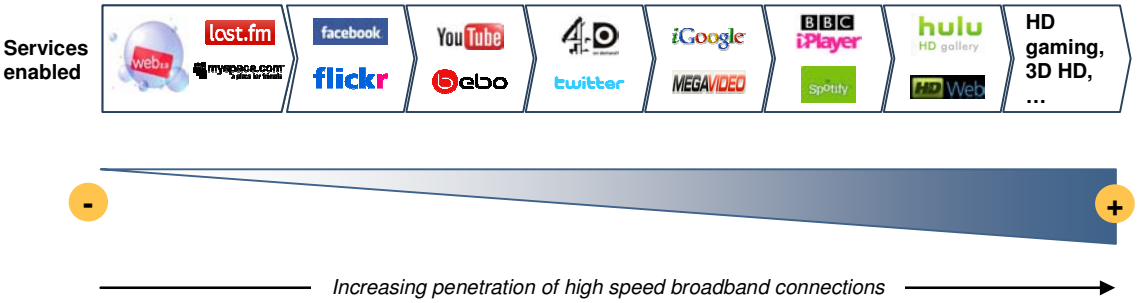
Exhibit 7: Cisco's forecast in global consumer internet traffic



Source: Cisco

High speed broadband is an enabler of new and innovative services - as broadband penetration has grown and increased in speed, so has the type and range of internet applications and services.

Exhibit 8: Examples of services enabled by increasing broadband speeds



- Enabled by advancements in broadband technology, the penetration of high speed broadband connections continues to grow, driven by increasing consumer demand for greater bandwidth
- The widespread availability of increased broadband speeds has resulted in introduction as well as take up of several rich-media services and applications including social networking, video streaming, online gaming, etc

Source: Value Partners analysis

4.1.2 Competitive dynamics

a) UK ISP market: consolidation

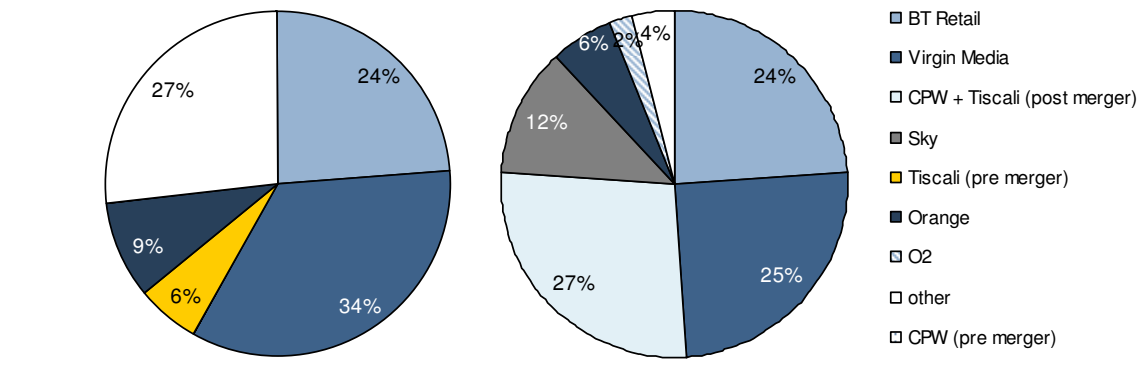
The UK ISP market is characterised by ISPs offering fixed broadband services on two main networks, the copper network owned by BT and Virgin Media's cable network[5]. ISPs on the copper network use some combination of the two main wholesale services, IPstream and LLU across their customer base, these services are discussed in section 4.2.

The ISP market has undergone several stages of consolidation. At present, the largest four ISPs (BT Retail, Virgin Media, Carphone Warehouse/Tiscali[6], and Sky) have 88% of broadband market share, with remaining market share being split between a wide range of smaller ISPs, including providers such as Tesco and the Post Office. This contrasts with the top 4 ISPs having 73% market share in 2004, with many more small players in the market.

[5] Mobile network ISPs are not included here as current, and future, network capabilities are unlikely to support cost effective delivery of video services to TV. This is discussed further later in this section

[6] [6] In Juy 2009 Talk Talk part of the Carphone Warehouse Group completed the purchase of the UK assets of Tiscali to become the largest retail ISP

Exhibit 9: ISP market share – 2004 and 2009

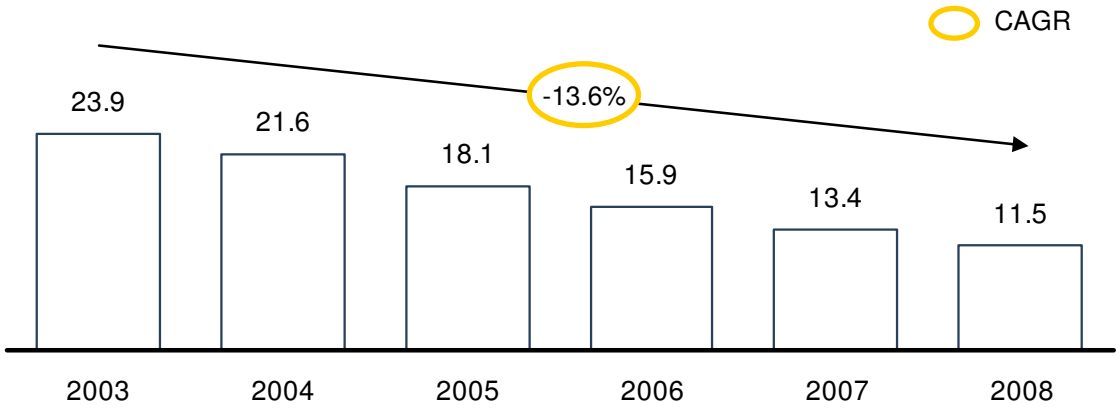


Source: Informa WBIS, Enders, Value Partners analysis

b) Broadband pricing and proposition

The broadband market is highly competitive, which has helped to drive down retail prices. This has led to reducing broadband ARPUs at a CAGR of -13.6% between 2003 and 2008.

Exhibit 10: Historic reduction in UK monthly broadband ARPU, £



Note: ARPUs taken as the average across all broadband platforms and across "basic", "standard", and "premium" tier services
Source: Screen Digest

Broadband providers now attempt to differentiate their broadband products and control churn through complex pricing, nuanced differences between the products offered, and product bundling with fixed line telephony or pay TV.

Exhibit 11: Summary of broadband offers from major ISPs, August 2009

	BB package tiers		Product bundling with broadband				
	Tiered by usage	Tiered by speed	BB + line rental(1)	BB + phone calls	BB + phone line + calls	BB + TV bundle	Triple play
BT	✓	✗	✓	✓	✓	✓	✓
Virgin Media	✗	✓	✗(2)	✓	✓(4)	✓	✓
Carphone Warehouse	✓	✓	✓	✓	✓	✗	✗
Sky	✓	✓	✓	✗	✗	✓	✓
Tiscali	✗	✗	✓	✓	✓	✗(5)	✓
Orange	✓	✗	✓(3)	✓	✓	✗	✗
O2	✗	✓	✗	✗	✗	✗	✗

Note: (1) Broadband + line rental means ISP sells line rental in addition to broadband service (vs. requiring customers to have existing line, e.g. from BT); (2) line rental not required for Virgin's non-bundled BB product; (3) line rental only included for Home Max, otherwise require BT line; (4) line rental is required for Virgin phone products; (5) TV only available with phone

Source: Value Partners analysis, company websites

Broadband prices vary greatly depending on the advertised speeds and the maximum monthly usage; there is also added complexity around the cost when bundled with other products. To illustrate the variance the table below show some recent prices for broadband by key players.

Exhibit 12: Example ISP broadband propositions and pricing[7]

ISP	Low package	Medium package	High package
BT	**£15.65 per month** 20Mbit/s speed 10GB usage	**£20.54 per month** 20Mbit/s speed 20GB usage	**£24.46 per month** 20Mbit/s speed Unlimited usage
TalkTalk	**£6.49 per month** 8Mbit/s speed 40GB usage		**£14.99 per month** 24Mbit/s speed Unlimited usage
sky	**£0.00 per month** 2Mbit/s speed 2GB usage	**£5.00 per month** 10Mbit/s speed 10GB usage	**£10.00 per month** 20Mbit/s speed 40GB usage
Virgin media	**£20.00 per month** 10Mbit/s speed	**£30.00 per month** 20 Mbit/s speed	**£38.00 per month** 50 Mbit/s speed

[7] As at November 2009. As far as possible the broadband-only price is taken. All Sky packages and base/medium Talk Talk packages do not include line rental. Note Sky broadband can only be taken by Sky TV customers

The impact of varying network economics (discussed in detail in section 7) for LLU and IPStream can be seem in consumer pricing - some ISPs charge customers a different price depending if the customer is living in an LLU or non-LLU area of the network. Sky, for example, charges a customer in a LLU area of its network £10 per month for an 8Mbit/s service, whilst a customer in a non-LLU area would have to pay £17 per month for Sky's IPStream product Sky Connect, Carphone Warehouse and Orange follow a similar pricing policy outside their LLU areas. BT Retail, as it sells an IP Stream product regardless of geographic location, charges a consistent price across areas all areas.

4.2 Broadband technical infrastructure and wholesale models

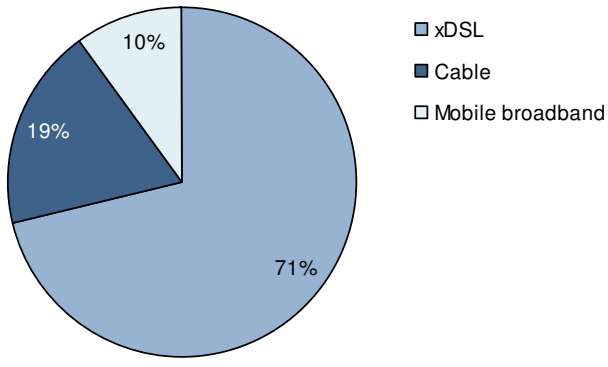
4.2.1 Types of broadband delivery network

Broadband in the UK can be delivered using one of three types of infrastructure:

- **Asynchronous Digital Subscriber Lines (ADSL)** over copper networks to the home.
- the Virgin **cable** network.
- via **3G mobile networks** using an upgrade known as High Speed Downlink Packet Access (HSDPA) typically through a dongle modem attached to a laptop.

The majority of UK broadband connections are currently via ADSL. This report focuses on assessing the cost implications for ISPs delivering broadband over ADSL[8], and does not model the cost impacts on the cable network. This is due to the fact that, as of the date of this report, Virgin Media have stated that they will not be including Canvas in their set top boxes. Virgin already offers a VoD and catch up service with access to a wide range of content partners, including members of the Canvas consortia, eg BBC, ITV, C4. As a result penetration and usage of Canvas enabled sets in Virgin households is expected to be minimal.

Exhibit 13: Broadband delivery by type of broadband delivery network, 2009



Source: Screendigest

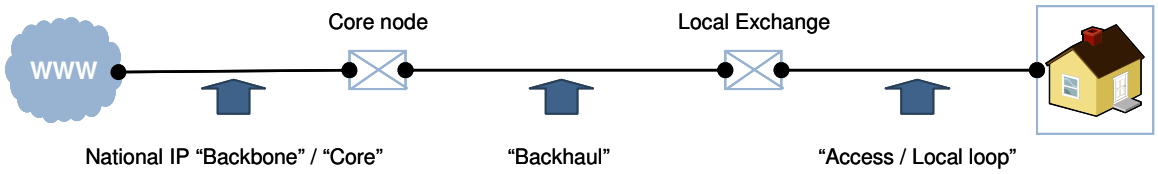
Note: Mobile broadband users may also have fixed line (xDSL or Cable) internet connections

[8] Virgin Media does not offer wholesale services to other ISPs, nor is there public information on its network architecture and cost structure

4.2.2 ADSL network infrastructure

ADSL broadband networks can be divided into three elements: **core, backhaul** and **access.**

Exhibit 14: Schematic of Broadband Network



- **Core** refers to an ISPs main aggregation nodes, the connections between them, and interconnection to the wider internet.
- **Backhaul** is the intermediate leg aggregating traffic from several access networks; it delivers traffic from the the edge of an ISP's core network to the local exchange. This may include aggregation through a number of intermediate links depending on specific network design.
- **Access** refers to the final connection to the home from the local exchange; this is sometimes referred to as the 'last mile' or 'local loop'.

Theoretically, an ADSL based ISP can offer speeds of up to 8Mbits/s to users based on DSL infrastructure and up to 24Mbits/s to users on DSL2+ infrastructure, however actual speeds differ significantly, this is discussed in section 4.3.

There are a number of competing wholesale providers for elements of the core network, and several large ISPs have invested to build their own core networks. However, the majority of ISPs depend on BT's subsidiaries, Openreach and BT Wholesale, for backhaul services. All ADSL ISPs depend on Openreach or BT Wholesale for last mile access services.

4.2.3 ADSL broadband business models

Currently, there are three wholesale models[9] for DSL Broadband: **Local Loop Unbundling (LLU**), **IPStream** and the recently launched **Wholesale Broadband Connect (WBC)**.

- **LLU** involves an ISP investing to install its own equipment at a BT local exchange[10], and leasing access and backhaul capacity from Openreach. By doing so it can achieve some economies of scale and has greater control over the products it can offer. The key elements are:
  - Access (the copper line to each home) which is rented from Openreach; individual copper lines to the customer premises are 'unbundled' when customers switch to the ISP and traffic is re-routed to the ISP's own switching equipment; this can be either broadband only traffic (partial unbundling), or both voice and broadband traffic (full unbundling)
  - Backhaul is rented from Openreach, or other providers. The level of backhaul capacity required is determined by expected customer numbers, estimates of usage and the customer experience the ISP wishes to offer. Most Openreach Backhaul Extension Circuits (BES) are based on the Ethernet protocol which offer significant economies of scale with growing traffic

[9] An alternative to IPStream is DataStream. However as take up is not that wide, and most of its features are included in the new WBC products Datasteam is not explicitly modelled as an option

[10] There are 5,500 local exchanges in the UK; the larger cover 5,000-10,000 homes, the smaller (typically rural), cover a few hundred homes)

  - LLU requires upfront investment and minimum customer numbers at each exchange for break even. Of the 5,500 exchanges in the UK only ~c.1900 currently have the scale to justify LLU investment. These cover ~80% of the population[11].

- **IPStream** is an 'end-to-end' service covering both access and backhaul which then connects into the ISP's own core network
  - It is an alternative model to LLU requiring minimal capex investment. It is used by ISPs where they do not wish to invest in their own infrastructure or where LLU is not economically viable.
  - IPstream is available across the BT network, and is used by BT Retail nationwide
  - The wholesale products for access and backhaul are provided by BT Wholesale. There are a number of variants depending on ISPs requirements
  - Backhaul capacity is delivered via circuits known as BT Centrals, based on ATM technology, and is priced flexibly, but offers limited economies of scale compared to Ethernet based backhaul services
- **WBC** is a relatively new wholesale broadband product being rolled out by BT Wholesale as an alternative to IP Stream / Datastream
  - Based on BT Wholesale's 21st Century Network (21CN)
  - Currently available to 10 million homes (40% of the population); planned to be available to 75% of the population by March 2011[12].
  - The backhaul capacity is based on Ethernet products and offers greater economies of scale than the BT Central product
- **Wholesale broadband managed connect (WBMC):** BT has announced that it will provide the WBMC product as part of its 21CN network rollout. WBMC is a fully managed version of WBC. This will offer the advantages and cost scalability of WBC, without the requirement to invest in the infrastructure to connect to 20 core nodes, instead requiring connection to just one core node.

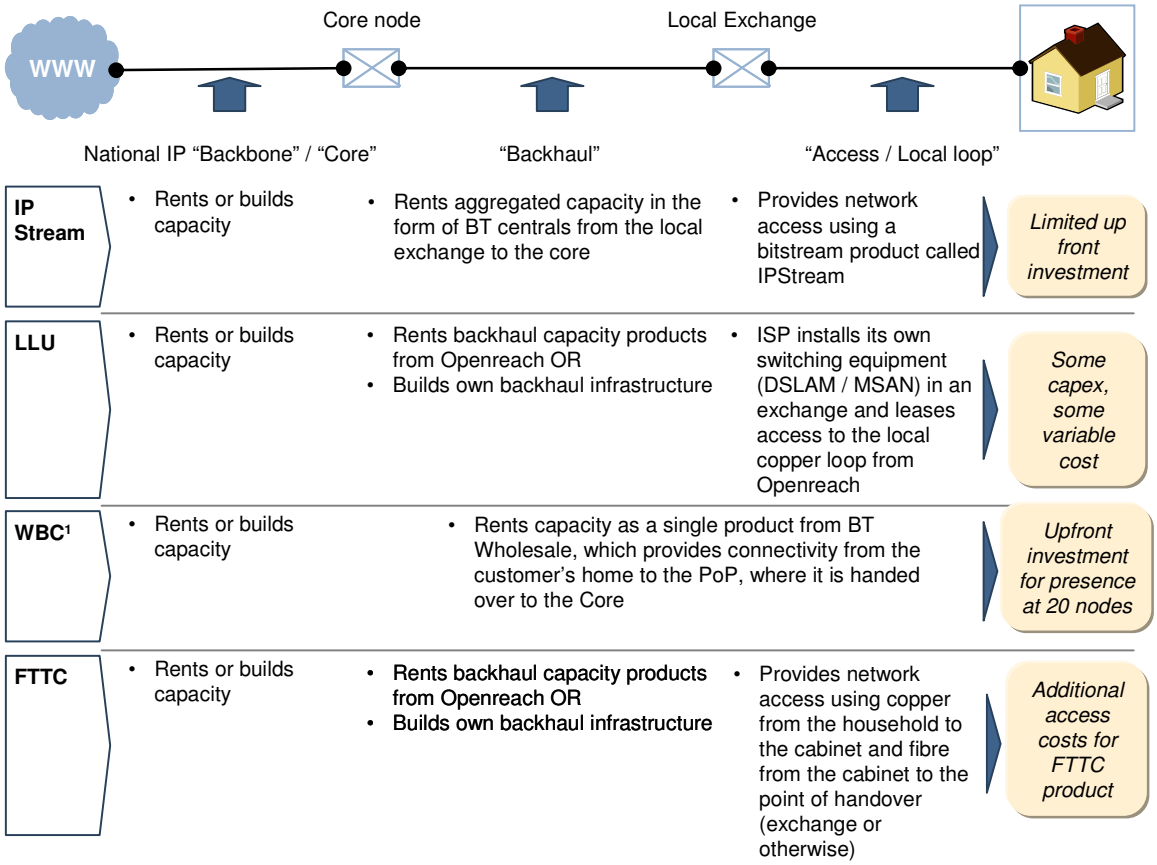
In addition BT has announced plans for £1.5bn of investment in a next generation fibre based access network

- **Fibre to the cabinet (FTTC):**. Is a hybrid solution based on high capacity fibre links between the exchange and street cabinets, typically connecting a few hundred homes, and VDSL technology over the existing copper line from the cabinet to the home.
  - Higher theoretical peak downlink speeds of 40 Mbps are achievable, and because of closer proximity to the home actual delivered speeds should be closer to this peak than for ADSL
  - Existing copper lines currently used for voice and DSL remain, customers must actively choose to migrate to FTTC, and pay an additional rental fee
  - Backhaul will continue to be rented from Openreach, or other providers as required
  - BT are intending to have built this FTTC network to pass c.1.5m homes by 2010, and c.40% of UK homes (10 million homes) by 2012
  - In addition BT expect to build out dedicated fibre connections (FTTH) to a proportion of these homes passed, typically if they are new build developments. These will offer higher peak speeds of over 100Mbps

The characteristics of LLU, IPStream, WBC and FTTC are outlined in the exhibit below:

[11] Samknows
[12] Source: BT Wholesale Company briefing June 2009

Exhibit 15: Characteristics of LLU, IPStream, WBC, FTTC and WBMC based networks



Note: (1) Wholesale Broadband Managed Connect (WBMC) is the managed variant of WBC. This product offers the advantage of lower up-front investment as it does not require ISPs to invest in capacity to 20 core nodes
Source: Value Partners analysis, company websites

4.2.4 *Cable broadband infrastructure*

Virgin Media's cable broadband network is the major alternative access infrastructure solution to BT's copper network, and covers approximately 50% of the UK population.

Virgin currently offers a service with a maximum bandwidth of 50Mbit/s in some areas and a standard offer of 20 Mbit/s. This compares to a maximum theoretical bandwidth of 8Mbit/s on ADSL, and 24Mbit/s for ADSL2+ infrastructure. Cable broadband is delivered via a coaxial cable, which, with DOCSIS 3.0 technology, can support significantly higher speeds in the 'local loop'. Virgin Media are currently rolling out DOCSIS 3.0 across their existing cable footprint on a region-by-region basis.

The structure of a cable network is different from the traditional copper network used for DSL. The 'last mile' is in effect a loop passing a number of homes connected back to an Optical Networking Terminal , equivalent to a local exchange for the copper network. Within this cable loop the available bandwidth or spectrum, on the coaxial cable is allocated between different uses, linear TV, downlink internet access, uplink internet access and services such as VoD. The linear TV signal is effectively broadcast to all homes allowing many homes simultaneously to watch the same programme. The broadband bandwidth is shared between all homes connected to a loop. This means that the greatest contention is actually in the 'last mile' to individual homes. Typically within each loop several hundred homes are connected.

However, currently the reported evidence suggests that Virgin homes are offering higher 'average' speeds at peak times than are available from most DSL based ISPs. This suggests that the current network is not suffering the bottlenecks of contention that the DSL based ISPs experience.

As discussed earlier the impact of Canvas on Virgin's network costs has not been modelled directly, for the following reasons:

- Virgin Media have indicated to the BBC Trust that they do not intend to incorporate Canvas into their set top boxes.
- As a result the penetration of Canvas devices in Virgin homes will be very low, primarily limited to secondary sets. The modelling assumes that that only c.21% of Canvas secondary sets will be in Virgin homes, compared to 79% in DSL households.
- The viewing of Canvas VoD services on secondary sets is assumed to be much lower than for primary sets (total secondary Canvas set viewing is assumed, on average, to be c. 12% of primary set viewing). This implies that on average, the viewing across Virgin homes is likely to be significantly lower than DSL homes In practice actual on demand viewing on secondary sets in Virgin homes may be even lower given the range of VoD services already available to Virgin homes on their primary set.
- The incremental impact of Canvas on peak traffic for a DSL based ISP assumed to support Canvas is of the order of 8% in the base case (see section 7.3). Given the relatively small amount of viewing expected from Canvas boxes in Virgin HH, the incremental traffic per sub due to Canvas in a Virgin homes is expected to be minimal, and not expected to lead to significant cost increases for Virgin
- In addition, Virgin Media, in common with all ISPs has the ability to manage the traffic on its network (see section 8).

4.2.5 Mobile broadband infrastructure

An alternative solution for broadband provision is via 3G HSPA enabled mobile networks. Since their launch in 2007 HSPA mobile broadband services, using a USB 'dongle' as a modem have proved very popular with several million sold in the UK. The peak speed is limited by the modem capability, and available spectrum. The current generation of modems claim peak speed capabilities of 14 Mbps, and most of the current base of modems can support 8 Mbps.

However, actual speeds are significantly lower, and can be below 1 Mbps[13]. There are a number of reasons for low delivered speeds, including: weaker radio signals in buildings and with distance from the radio base station; spectrum constraints mean that there is significant sharing of capacity in a cell site, and potential under provision of backhaul capacity from a base station.

While some of these are being addressed as mobile operators upgrade their infrastructure there are likely to be spectrum constraints in the short term. However, significant additional spectrum is due to become available in the UK – both from the award of as yet unused bands (2.6 GHz) and as a result of the switch off of analogue television – the so-called 'Digital Dividend', which will release spectrum in the 800MHz band. In addition the next generation of radio technology – Long Term Evolution (LTE) claims to offer higher data throughput for a given spectrum allocation.

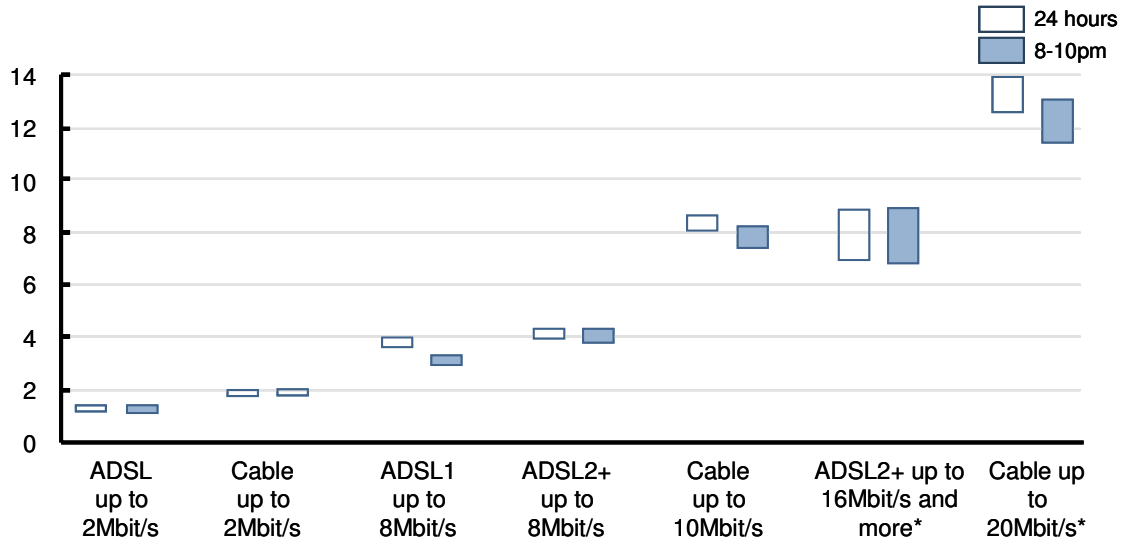
It is therefore theoretically possible that mobile data networks could offer average data speeds comparable to those of current DSL networks and even some cable or FTTC networks. However, actual performance will be highly dependent on levels of customer take up – as speeds can fall rapidly with increasing users.

[13] Mostly Mobile, Ofcom, 8 July 2009, p 134

4.3 Factors affecting actual ADSL broadband speeds

Over 95% of homes in the UK can in theory receive a headline speed of 2Mbps with most homes able to access connections with much higher peak speeds ranging from 8 – 50 Mbps. However, actual broadband speeds vary widely, both geographically and depending on time of day. In April 09, the average broadband speed experienced in the UK was 4.1Mbps[14]. However, both average speeds, and speeds during peak hours are much lower than advertised headline speeds.

Exhibit 16: Average download throughput speeds by technology and headline package, April 2009



Notes: (1) Data for ADSL1 up to 2Mbit/s and ADSL1 and ADSL2+ up to 8Mbit/s have been weighted by distance from exchange; data for ADSL2+ services up to 16Mbit/s and all cable services have been weighted by region and rural/urban; (2) The 'error margin; shown represents a 95% confidence interval
Caution: * Small sample size (<50)
Source: Ofcom; based on SamKnows measurement data fro all panel members with a connection in April 2009

This section sets out some of the factors that affect actual broadband speed.

4.3.1 Access Network

The access network comprises dedicated copper lines between the customers' homes and the exchanges. As such there is no sharing of capacity at the access level. The actual speed available to at this level in the network is constrained by the access technology, the distance from the exchange, and wiring in the home. According to analysis in the recent Digital Britain report, 11% of all access lines in the UK, covering 2.75m homes, were unable to deliver a peak 2 Mbps service.

[14] Ofcom, UK Broadband Speeds 2009, p8

a) Access Technology

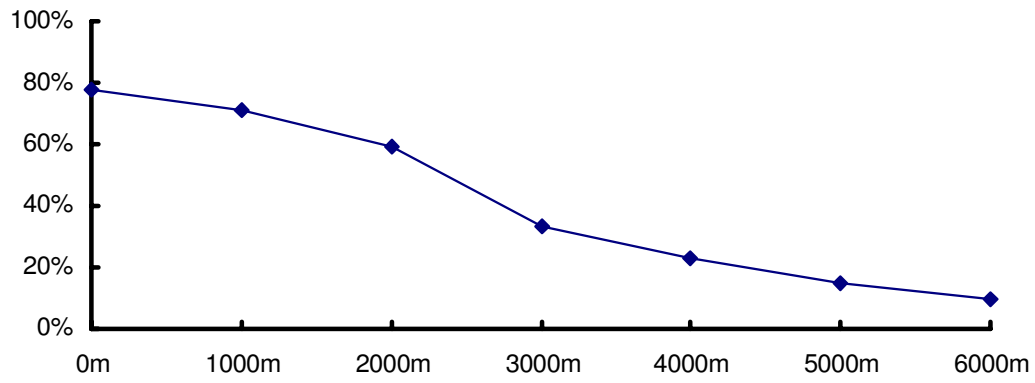
First generation DSL enables a theoretical peak speed of 8 Mbit/s at the access level, whereas second generation ADSL 2+ equipment enables peak speeds of 24 Mbit/s at the access level. From discussions with ISPs most of the larger ISPs, have or are in the process of, replacing their ADSL equipment in exchanges with ADSL2+.

b) Distance from the exchange

The further a home is from an exchange the lower the maximum peak speed achievable due to the length of the copper between the exchange and the home.

- Homes over 4 kilometers from exchanges are unlikely to receive peak speeds of 2 Mbps on DSL despite headline speeds of 8 Mbps; this includes many rural homes
- Only 10% of 'headline speed' is being delivered to homes 6km or more from an exchange.

Exhibit 17: Percentage of 'headline speed' received depending on distance from the exchange[15]



The Digital Britain report estimated that 550,000 homes are too far from the exchange, and as such can not receive speeds of 2 Mbps. A further 300,000 could not receive 2 Mbps due to 'random network effects'.

c) Wiring in the Home

Broadband speed can decrease in the customer premises depending on internal wiring. The Digital Britain report estimated that in 1.9 m homes, wiring in the home reduced the maximum speed below 2 Mbps. The report also noted other areas of possible improvements in home connections such as switching from a Service Specific Face Plate (SSFP) to an Interstitial Plate (i-plate).

One of the recommendations of the Digital Britain Report was to set a Universal Service Commitment (USC) to make broadband available at 2 Mbps to virtually everyone in the UK by no later than 2012. To achieve this, Digital Britain identified a number of initiatives to address the specific causes identifed above, and several sources of funding to support their roll out. The USC will be delivered by a new body the Network Design & Procurement Group (the NDPG) tasked with structuring and running the procurement process, overseeing

[15] Samknows, Ofcom: Broadband Speed Report 2008

delivery, ensuring active stakeholder engagement, and ensuring value or money for all direct public contribution to the USC.

4.3.2 *Backhaul Network*

Backhaul networks are typically the first stage of the network at which traffic from multiple customers is aggregated and the available capacity is shared between users. For many networks this is currently the main limit on peak hour speeds experienced by users. Much of the recent debate about the impact of BBC iPlayer on network costs, and who should pay for increased network costs, has focussed on the backhaul capacity.

- The 'sharing' of backhaul capacity between a number of different users on a given exchange is known as 'contention'
- ISPs must determine the appropriate average capacity per customer and therefore the level of backhaul capacity that is required to optimise the trade off between network cost and effective bandwidth speeds experienced by their customers. This is typically based on their usage during peak hours (usually 8-10 pm)
- Usage of, and therefore demand for, backhaul capacity is growing due to the growth in internet usage in terms of subscribers, time spent on-line and richness of web site content. In particular, the growth in video content from sites such as You Tube and BBC iPlayer, have had a major impact on peak traffic requirements.

a) ATM (BT Central)

Backhaul for BT Wholesale's IPstream product is provided on a product known as BT Central. ISPs are able to aggregate capacity across all exchanges and buy sufficient Central circuits to meet their overall capacity. This gives a ISPs a high degree of flexibility in buying capacity as demand increases. However, the backhaul cost structure increases in line with total traffic, with limited economies from buying more Central connections.

b) Ethernet (BES, WBC)

The majority of LLU providers now use Ethernet based circuits for their backhaul. Ethernet is a highly scalable technology, and as such offers significant economies to ISPs as they increase capacity. The basic price to rent Ethernet based Backhaul Extension Services (BES) from Openreach is set out in the figure below.

Exhibit 18: Openreach pricing for Backhaul Extension Services (BES), October 2009

Service	Annual rental (£)
BES 100 (100 Mbps)	£1,830
BES 1000 (1Gbps)	£4,137
BES 10000 (10Gbps)	£12,875

From these prices, it can be seen that a tenfold increase in backhaul capacity (from BES 100 to BES 1000) only results in approximately double the annual rental cost; increasing backhaul capacity a hundredfold (from BES 100 to BES 10000) only results in annual rental costs increasing sevenfold. On this basis, LLU based ISPs can exploit a more efficient cost per unit capacity ratio available from Ethernet based backhaul to obtain significant cost advantages

BT's WBC rollout is based on Ethernet backhaul. Although current pricing structure does not fully reflect these economies of scale, recent press releases from BT as well as the inputs of several interviewees indicate that over time, the pricing would develop to a structure comparable to LLU. This is discussed further in Section 6.

4.4 Factors affecting bandwidth requirements

There are two primary types of internet content delivered over broadband networks:

- **Non-time critical activities** - (e.g. web browsing, email, downloading or uploading files) use bandwidth in bursts, typically a few seconds of download for every minute spent consuming content. Consequently, the bandwidth can be shared among many users without discernible impact on end user experience
- **Time-critical activities** – (e.g. streaming of video) typically requires continuous allocation of bandwidth. If capacity drops below the speed needed to deliver the content, the consumer experiences a stalled picture as their computer buffers the content (ie fills up memory with content). Fluctuations in bandwidth that lead to stopping and starting for buffering can significantly reduce the customer experience and make longer video streams unwatchable.

Average bandwidth requirements vary depending on the service that is being used, ranging from a low 15kbps for mainly text-based web surfing to 1.5 Mbps to stream high quality iPlayer video. Currently iPlayer content for viewing on a PC streams at between 500 kbps and 1500 kbps, for Standard definition content, with average around 800kbps. There is some High Definition content that streams at 3.2 Mbps. In addition, for time critical activities such as streaming, there needs to be minimal variability in allocated bandwidth to guarantee the customer experience.

Content available on the proposed Canvas service would have elements of both time-critical and non-time critical activities as some content would be streamed, whilst some content would be downloaded to the set-top box. Discussions with the BBC Executive indicate that for Standard Definition (SD) content to be of acceptable quality on a TV screen, it would need to stream at a continuous speed of 1.5 Mbps (High Definition (HD) content, would need 6 – 6.5 Mbps).

Currently, there are a number of ways in which a broadband network can provision for time-critical content to be delivered at an acceptable quality of service:

- The first option is to provide **sufficient bandwidth in the network for all time-critical and non time-critical content** to be delivered as demanded. Under this option, ISPs have to provision the network to accommodate maximum peak hour bandwidth demands.
- Second option could be an equal **allocation of available bandwidth across all categories of traffic** with all services suffering a degradation in quality
- Third option is more **selective traffic shaping targeting non-time critical applications** and reserving more bandwidth for time-critical services. In practice most ISPs are implementing increasingly sophisticated traffic shaping, a form of traffic management which uses intelligence in the network to adjust bandwidth available and speeds for different services[16].
- Fourth option is to provide a **managed service**, so that the additional capacity can be allocated for a particular video stream, or a for a period of time. There are a number of such QoS products currently offered by BT Wholesale over IPStream, e.g. IPstream Max, and for WBC e.g. Assured Rate QoS. All of these incur an extra charge.

In reality all ISPs apply some mixture of the above approaches, trying to balance the experience for customers, growing levels of demand, and the associated network costs. These are discussed further in Section 8.

[16] This can be controversial as some consumer groups argue for net neutrality and that ISPs should make no distinction between type of content (or source)

As a result the experience of internet speeds that an individual customer may have can be determined by a number of factors – some linked to their geographic location and the infrastructure used to deliver broadband, and some linked to the commercial decisions of their ISP.

4.5 Regulation of ADSL wholesale market

Ofcom's Telecoms Strategic Review in 2003/2004 led to a number of significant changes in the structure of the broadband wholesale market in the UK. As part of the review and the resulting Competition Commission investigation Ofcom negotiated a number of Undertakings from BT. These included the establishment of Openreach as a separate business unit within BT responsible for providing a set of basic 'passive' wholesale access services to all communications providers (including BT and its competitors) on an equivalent basis.

4.5.1 Openreach and LLU provisioning and pricing

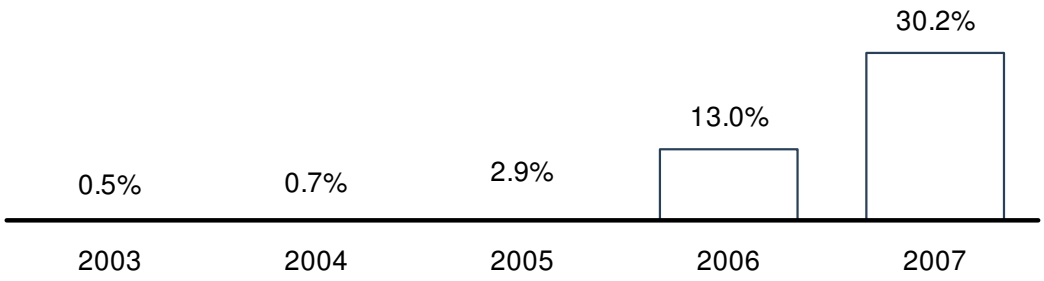
Openreach's portfolio consists of Wholesale Line rental (WLR) for voice services, full and partially unbundled lines (known as Full or Shared Metallic Path Facility MPF or SMPF), a range of Ethernet based Backhaul Extension Services (BES), as well as associated services such as co-location at the exchange. The majority of Openreach's services are subject to cost orientated price controls. There are also strict requirements on equality of access to all ISPs – and Openreach has been required to invest in an IT provisioning platform the Equivalence Management Platform (EMP) that gives exactly the same service to all ISPs, including BT's own companies.

As of May 2009 Ofcom announced revised prices for MPF and SMPF services for the next four years until 2012/13. Current reviews are considering the pricing of WLR and BES services.

4.5.2 Take-up of LLU by ISPs

Following the establishment of Openreach, a number of larger ISPs switched their method of broadband provision to LLU in more densely populated areas today, over one-third of ADSL lines are unbundled.

Exhibit 19: Percentage of ADSL lines unbundled, UK



Source: Analysys

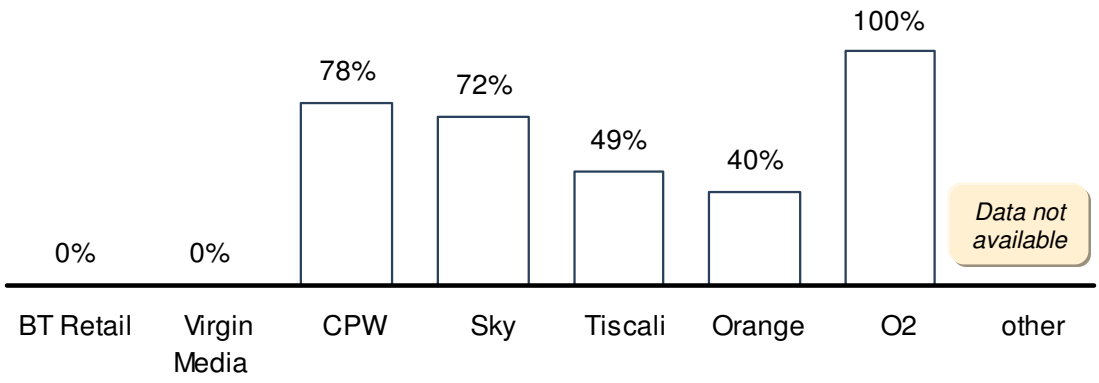
The economics of unbundling an exchange vary by ISP; unbundling only makes financial sense if an ISP can reach a critical mass of subscribers in a given exchange to offset the upfront capital expenditure and ongoing costs associated with LLU.

- Smaller ISPs will find it more difficult to pursue LLU if they cannot achieve sufficient subscribers at an exchange
- In rural areas where exchanges tend to be smaller, with fewer lines, LLU is rarely economically attractive

Currently just under 2,000 exchanges[17] have been unbundled, but the rate of unbundling has recently decreased. Most industry interviewees did not expect to increase the number of exchanges where they had invested in unbundling although several commented that the economics of supporting VoD services such as Canvas may make them look again at unbundling in certain exchanges.

The current proportion of ISP subscribers on LLU connections is outlined in the exhibit below.

Exhibit 20: % of broadband subscribers unbundled



Source: Enders Analysis

4.5.3 BT Wholesale and IPStream pricing

As part of the Undertakings BT Wholesale was limited to the provision of intermediate wholesale products, predominantly, IPStream and Data stream. These are built up from the same range of Openreach products that are available to other ISPs. At the time these services represented the majority of wholesale connections in the UK , therefore to ensure that there was sufficient economic incentive for investment in LLU, BT agreed not to lower its wholesale prices for IPStream services until at least 1.5 million LLU lines had been provided and thereafter only by a maximum of 3% pa until Ofcom had concluded a wider market Review. The number of LLU lines exceeded 1.5 million in January 2007.

Ofcom's latest Wholesale Broadband Market Access Review was completed in 2008. Given the growth in broadband over the period since the original undertakings, the wide take up of LLU in many urban areas and the increased penetration of cable broadband Ofcom made a number of changes to the regulatory arrangements governing IPstream.

Specifically Ofcom identified four distinct geographical wholesale broadband markets in the UK. These were:

- The Hull area; those areas covered by exchanges where Kingston Communications is the only operator. This market covers 0.7% of UK premises.

[17] Samknows

- Market 1; those areas covered by exchanges where BT is the only operator. This market covers 16.4% of UK premises.
- Market 2; those areas covered by exchanges where there are 2 or 3 operators. This market covers 13.7% of UK premises.
- Market 3; those areas covered by exchanges where there are 4 or more operators. This market covers 69.2% of UK premises.

Ofcom also found that while BT had SMP in Markets 1 and Market 2, and Kingston in the Hull area, no operator had SMP in Market 3. As a result BT is under a number of obligations regarding wholesale services in markets 1 and 2, covering issues such as obligations to meet reasonable requests to supply services, non-discrimination and transparency. However, these do not apply in Market 3.

4.6 Expected future developments in broadband provision

Currently the main new investment in broadband in UK is BT's Superfast broadband programme, to which they have committed £1.5bn of investment over the next 4 years. As of July 2009 BT had announced plans to pass 1 million homes by March 2010 and a further 500,000 homes by Summer 2010, with a longer term target of passing 10 million homes, 40% of the UK population, by 2012. As part of this deployment a 'minority' of homes will be offered Fibre to the Premises (FTTP). Currently trials are underway for both FTTC and FFTP services. Other smaller scale local depoyments of FTTH are taking place, but it is unclear whether they will have the financial support for wider rollout.

In addition to the USC discussed above the Digital Britain Report also announced a 'Final Third Project' to encourage the deployment of Next Generation Access (NGA) solutions to the third of the UK where it is unlikely that there will be an economic case for deployment. To support this a Next Generation Fund will be established, funded by a supplemental charge of 50p per month on every copper line in the UK. The NDPG has also been tasked with managing the delivery of this Final Third Project.

5 Methodology and model structure

5.1 Methodology used

The ISP network cost model has been developed to assess the impact of Canvas on ISPs. The principles behind the methodology employed are:

- A focus on peak bandwidth requirements, ie usage at peak times, as ISPs have to dimension their networks to cope with peak time traffic
- The full costs of providing the necessary bandwidth to support the level of forecast VoD streaming are calculated to highlight the 'worst case' investment needed by an ISP
- Costs calculated on a per subscriber (line) basis, to enable an intuitive understanding of the cost elements relative to retail broadband pricing
- Consideration of cost implications for different types of ISP eg small / medium / large LLU, small / medium / large IP Stream, WBC
- Impact of Canvas calculated by determining the expected evolution of key network costs required to support forecast peak bandwidth requirements in a counterfactual world without Canvas, and comparing this to the expected network costs under various Canvas scenarios
- Canvas scenarios are driven by the TV appendix and drive key inputs into the ISP model
- Model does not forecast the impact on any specific ISP's cost base, but has the flexibility to estimate the cost impact for major ISPs by emulating their profiles (size and mix of LLU / IP Stream / WBC customers)

Costs are modelled based on a simplified high level network architecture and assuming that capacity is leased at BT's published prices. As this does not take account of any efficiencies ISPs can generate from use of their own infrastructure, this represents the 'worse case' cost impact for an ISP. Discussions with ISPs have confirmed that this approach and the assumptions used reflect the main elements of their broadband network costs and that the overall cost per subscriber is in line with their analysis.

The model only includes the access, backhaul and core network costs incurred by an ISP as these costs are the most directly affected by potential growth in usage due to Canvas. It does not include any costs of IP transit from the ISP network – as the model assumes the BBC is peering with most ISPs at the edge of their networks. The model has also not considered the allocation of central operational costs, such as overheads, or additional costs incurred due to Canvas such as for enhanced customer support, as these are highly variable depending on each ISP's customer care approach.

5.2 Overview of model structure

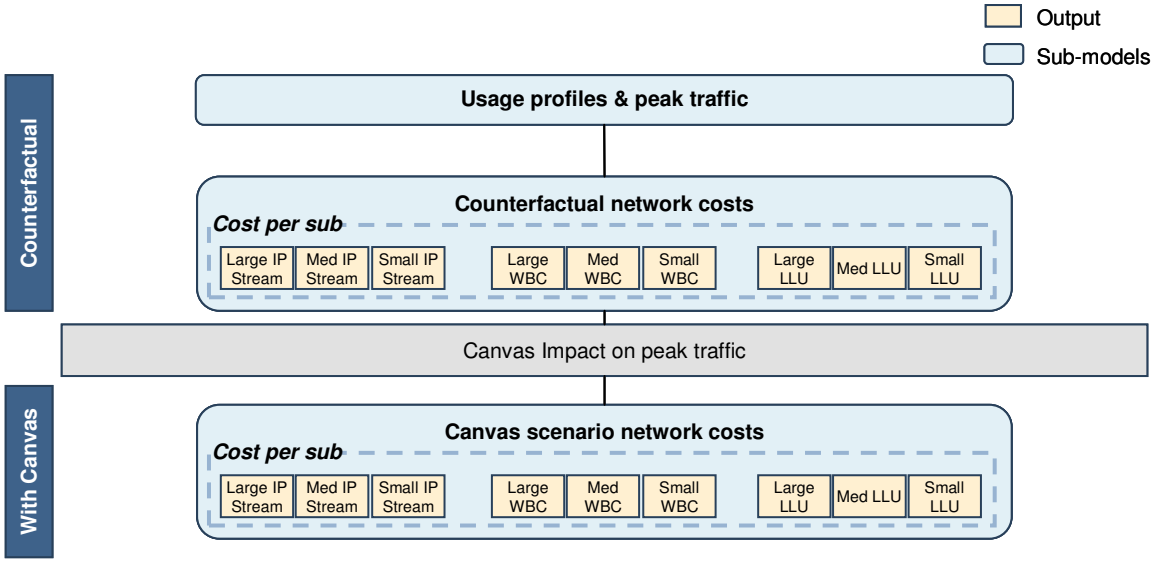
The ISP network cost model is structured as follows:

- ISP network costs are driven by consumer broadband usage patterns and the resulting peak hour demand
- The model calculates the forecast network costs for the different types of ISP, in the counterfactual world
- The model uses the counterfactual as a starting point to calculate the forecast network costs under the various Canvas scenarios
  - Based on Canvas scenario inputs from the TV model around the level of TV VOD watched over broadband

  - Canvas scenario inputs flex the consumer broadband usage patterns and hence the resulting peak hour demand
  - Network costs then calculated using the same cost assumptions as for the counterfactual
- Canvas impact is the difference between the costs in the Canvas scenarios and the counterfactual

The model structure is set out in the figure below,

Exhibit 21: ISP network cost model schematic



For each scenario, the intermediate outputs of the model are:

- Peak broadband bandwidth requirement
- LLU access, backhaul and core costs on a per subscriber basis, for a range of different sized LLU exchanges
- IPStream access, backhaul, and core costs on a per subscriber basis, for a range of different sized IPStream ISPs
- WBC access, backhaul and core costs on a per subscriber basis, for a range of different sized WBC ISPs

The ultimate outputs of the model are:

- Canvas impact on ISP network costs on a per subscriber basis for each type of ISP (High, low and base case)

5.3 Determining evolution of peak bandwidth requirements

5.3.1 Counterfactual peak bandwidth

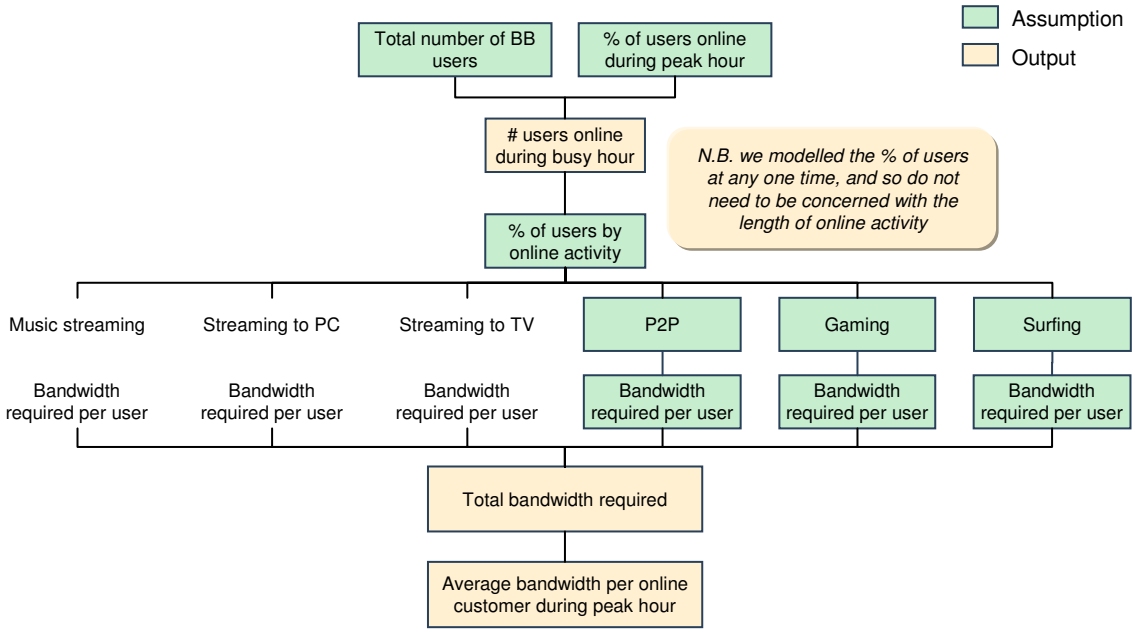
The model sets out current broadband usage and forecasts future broadband usage during peak hour in order to forecast changes in bandwidth demand in a counterfactual world without Canvas.

- Broadband usage is divided into eight categories; music streaming, streaming to PC (high quality, low quality), streaming to TV (high definition, standard definition), gaming and surfing

- Each category of usage requires varying amounts of bandwidth
- Estimations are made around the proportion of broadband users carrying out the different activities during a range of hours
- From the above assumptions, the model calculates the total peak hour bandwidth required and the implied bandwidth requirement per customer during busy hour
- The model assumes that ISPs will build all necessary network capacity to meet the forecast level of demand and calculates the costs to do this. It does not explicitly model the impact of 'throttling' capacity to manage costs or of other traffic management solutions. These are discussed further in section 8.

This approach is outlined in the exhibit below:

Exhibit 22: Broadband usage schematic



5.3.2 *Canvas scenarios peak bandwidth*

The amount of Canvas IPVoD (online streamed Canvas content) usage at any given time is determined by the Value Partners TV model and used as in input to drive the peak bandwidth requirement under the Canvas scenarios.

- TV model provides inputs around the number of users streaming IP VOD during one hour intervals through the day
- This is used to adjust the counterfactual usage profile – increasing the level of TV streaming and adjusting down other activities to take into account that some TV streaming substitutes other activities

An explanation of the assumptions that were made to determine peak bandwidth usage in the counterfactual and Canvas scenarios is detailed in section 6 of this document.

5.4 Determining ISP network costs

5.4.1 Counterfactual ISP network costs

The model calculates ISP network costs by using current and forecast peak bandwidth requirements to dimension the ISP network for the different types of ISP.

- The model aggregates the per customer peak bandwidth requirement at an exchange level
- Peak bandwidth requirements determine the size of the backhaul network required for LLU ISPs, or the type of IP Stream / WBC product required for IP Stream / WBC ISPs
- Network costs are calculated using published rate card data or the appropriate technical capex / maintenance costs, as appropriate.

Network costs are divided into access, backhaul and core costs and these are modelled for each of LLU, IPStream, and WBC, as follows:

- **LLU access**: total cost per exchange per year, which is then divided by the number of users in the exchange to give LLU access cost per subscriber based on an SMPF product. LLU access costs consist of capex per exchange, opex per exchange, capex per line and opex per line.
- **LLU backhaul**: the model calculates the bandwidth required per exchange and selects the most appropriate BES (Backhaul Extension Service) product to supply that bandwidth. The cost lines modelled are the new extension connection fee, pipe rental, circuit upgrade cost and main link cost. The output of this model is the cost per subscriber for different sizes of LLU ISP
- **IPStream access**: access cost per subscriber for a range of ISP profiles is calculated by aggregating the total connection charge and line rental. The most cost efficient IPStream method is selected, taking into consideration that the same charging model (Standard, Capacity or Usage) must be selected for both IPStream access and backhaul. It is assumed that Usage charging is the most appropriate model to select, based on calculations under each charging model
- **IPStream backhaul**: the model calculates the backhaul cost per subscriber for a range of ISP profiles by aggregating the total connection charge and line rental per backhaul pipe on an aggregated traffic level (based on BT Central published prices).
- **WBC access**: access cost per subscriber is calculated by estimating the number of lines migrated from IPStream and the number of new connections.
- **WBC backhaul**: total traffic is calculated on a per node basis, and the model automatically selects the most appropriate Extension Path (EP).
- **Core costs**: core costs for LLU, IPStream and WBC have been calculated by estimating a typical 20 core nodes per ISP, and factoring in bandwidth variable (Core routers, DWDM) and fixed (core switches) equipment.

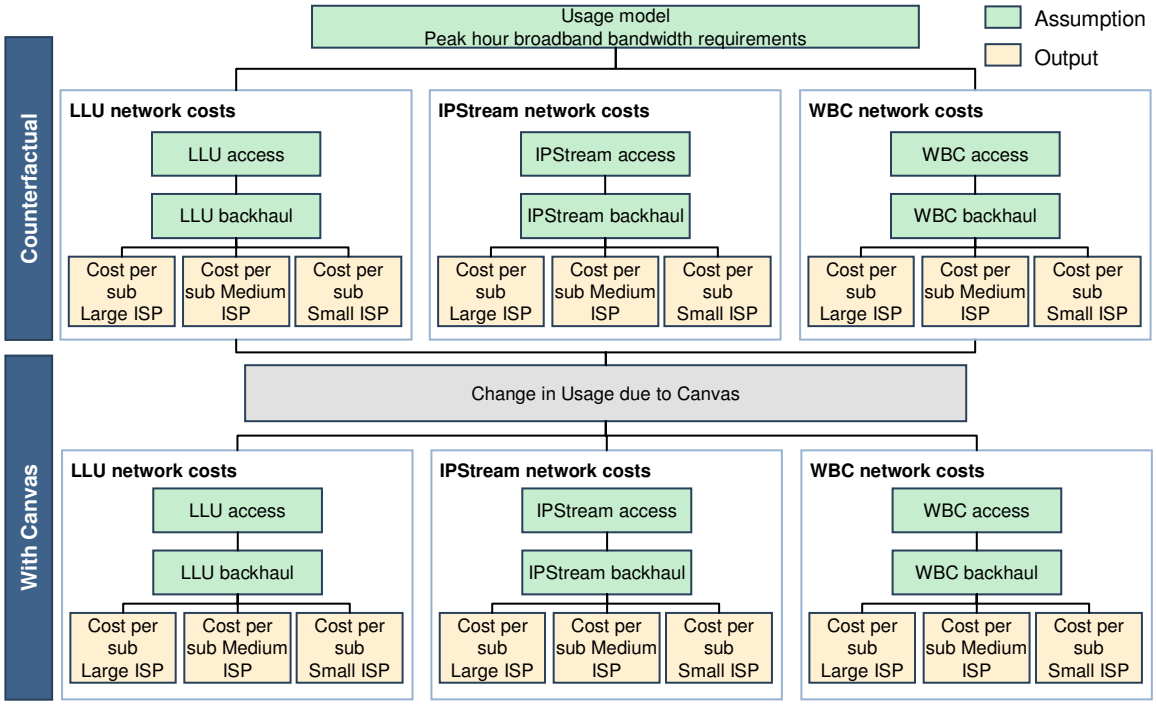
Cost per subscriber is then derived by dividing the network costs by the number of users in that exchange.

5.4.2 Canvas scenario ISP network costs

ISP network costs are calculated using the same approach as for the counterfactual, outlined above, except Canvas scenario peak bandwidth requirements are used. All the other network cost assumptions remain the same.

A visual representation of this approach to modelling ISP network costs for the counterfactual and Canvas scenarios is shown below.

Exhibit 23: ISP network cost model schematic



5.5 Canvas impact on ISP costs

The impact of Canvas on ISP costs is the difference between ISP costs in the counterfactual world and under Canvas scenarios.

- Canvas impact is considered both on a cost per subscriber basis, and the implied cost for different ISP profiles
- A range of scenarios have been considered; however this document focuses on Value Partner's view of the most likely cost impact, the minimum cost impact, and the maximum anticipated cost impact.

The model estimates the cost impact for different ISP profiles rather than attempting to model the cost impact for actual ISPs, for the following reasons:

- Simplifying assumptions are made in a number of areas, for example, the number of customers per exchange, traffic shaping, dimensioning of the network
- In reality these differ for each ISP and this information is not publicly available
- This approach is intended to give the upper bound of the cost impact for the major ISPs, as costs have been conservatively estimated throughout and the network has been dimensioned at the 'highest cost' basis ie by leasing capacity at published rate card rates.

6 Key assumptions and scenario drivers

This section sets out Value Partners' major assumptions around the future evolution of the broadband market and demand for bandwidth under the counterfactual scenario and the main Canvas scenarios.

6.1 Overview of counterfactual and Canvas scenarios

6.1.1 Counterfactual

The Counterfactual assumes that other IPVoD and internet services (besides Canvas) are launched to deliver internet content to televisions with the scale to rival the Canvas proposition.

- Consumers have access to VOD propositions to their TV sets from players such as Freeview/Freesat, DBook6, IP Vision or Sky Darwin
- There would be a corresponding increase in bandwidth demand on ISP networks

6.1.2 Canvas scenarios

The model analyses the impact on ISP across three Canvas scenarios:

- **Canvas Base Case** - Canvas is rolled out in Autumn 2010. Although there are other VOD to the TV propositions already in the market, the strength of the Canvas proposition quickly propels it to be the most popular platform for VOD content to the TV on DTT, co-existing with other VOD to the TV propositions
- **Canvas High Case** - Canvas launches in Autumn 2010; at launch it enters a nascent IP VOD market with other propositions; however Canvas grows to become the standard which other platforms adopt in order to access the most comprehensive content offer. Canvas effectively supercedes other standards.
- **Canvas Low Case** - Canvas is launched in Autumn 2010. However, it is beset with operational issues and does not have the full co-operation of major consumer electronics players, retailers and ISPs. Canvas therefore shares the market with other VOD to the TV propositions achieving a minority market share of DTT VOD STBs.

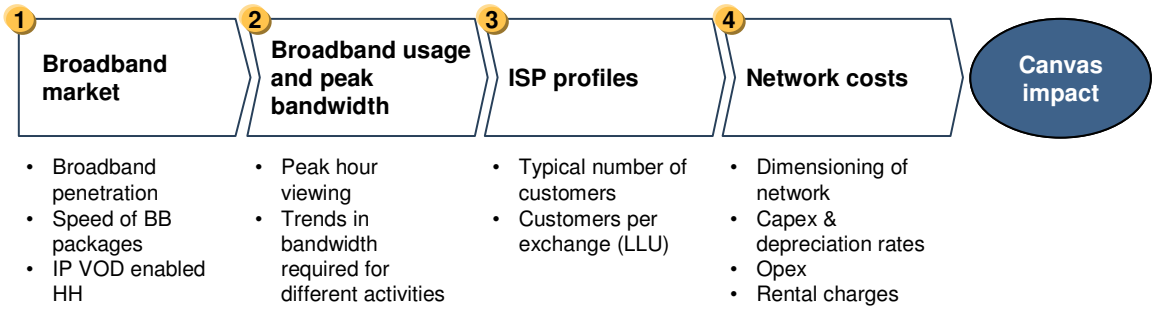
These scenarios are described in greater detail in the Value Partners TV model appendix.

6.2 Details of major assumptions

Assumptions can be categorised into four major categories:

- The evolution of the broadband market
- Changes in consumer broadband usage patterns and resulting peak bandwidth demand
- Profiles of different ISP types (Large, medium and small LLU; large, medium and small IPStream), which affect their economics and the dimensioning of their respective networks
- Network costs

Exhibit 24: Assumption framework



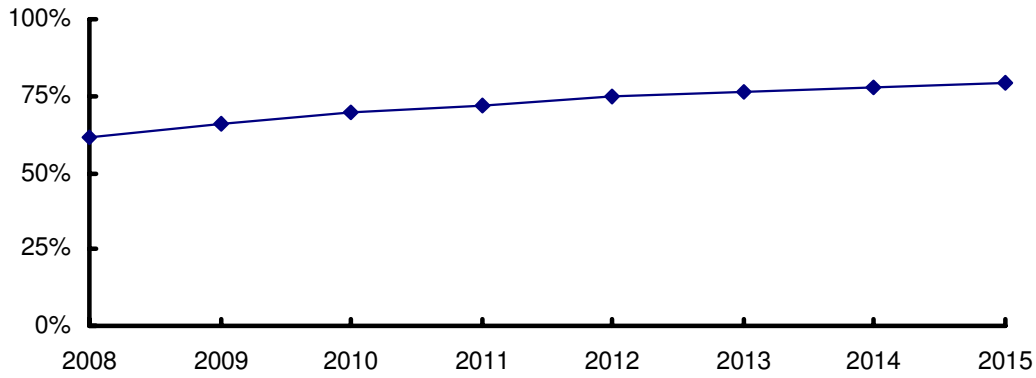
All assumptions remain constant between the counterfactual scenarios and the Canvas scenarios; what drives the different Canvas scenarios are the number of VOD enabled devices in the market and the number of these which stream IPVOD during busy hour. This is determined by the TV model.

6.2.1 Broadband market

i) Broadband penetration

Broadband HH penetration is assumed to grow from 61% in 2008, to 79% in 2015. This based on Value Partners' view of the broadband market, cross referenced with Ofcom as well as a number of different third party forecasts[18].

Exhibit 25: Broadband penetration



[18] Third party forecasts considered include Ofcom, Screen Digest, Forrester and brokers

ii) *Market Shares*

Exhibit 26: Forecast of Sky and Virgin BB HH

	2009	2010	2011	2012	2013	2014	2015
Sky BB HH	2.4	2.7	3.1	3.7	4.2	4.5	4.9
Virgin BB HH	4.1	4.2	4.3	4.3	4.3	4.3	4.3
Other BB HH	10.7	11.4	11.7	11.9	12.1	12.2	12.1
Total BB HH	17.3	18.3	19.1	20.0	20.6	21.0	21.4

Source: Forecast of Sky's BB households based on views of JP Morgan, Deutsche Bank and Macquarie; forecast of Virgin's BB households based on views of Morgan Stanley and Jefferies. Remaining non Sky and Virgin BB households allocated based on proportion of other players' market shares

The Value Partners' Report on the Model Assessing the Impact of Canvas on the TV Market focuses on the importance of triple play offerings as a competitive instrument allowing enabling ISPs to capture market share. Based on the conclusions of the report, we have estimated the growth of Sky and Virgin Media broadband households in line with analyst forecasts. We have used the current market shares of the remaining non-Sky/Virgin ISPs (comprising of BT Retail, Carphone Warehouse, Orange, O2 and other smaller ISPs) to forecast their respective BB households.

Using this approach, we estimate that by 2015, Sky and Virgin will capture 43% of UK BB households on the basis of their triple play propositions. The remaining 57% of the market remains an opportunity for other ISPs to capture, by developing their own bundled propositions using rich-media devices such as Canvas.

iii) *Speed of broadband*

Broadband is sold at a range of different headline speeds. The model forecasts the mix of broadband connections by speed, as follows:

Exhibit 27: Headline broadband speed mix

Base case	2008	2009	2010	2011	2012	2013	2014	2015
Up to 2Mbps	33%	29%	24%	19%	15%	10%	5%	0%
2Mbit/s-8Mbps	58%	57%	53%	49%	45%	41%	37%	33%
Over 8Mbps	9%	14%	23%	32%	41%	49%	58%	67%

The mix of headline speeds is determined by the broadband packages which consumers decide to purchase as well as the products which ISPs decide to offer and their associated pricing. Value Partners assumes that broadband of 8Mpbs and above will become increasingly the norm as ISPs move to ADSL2+, and more and more customers will be either migrated to this speed by their ISPs, or choose higher speeds as lower speeds become too slow to cope with their activities.

These assumptions affect the following:

- How many HH with Canvas STBs have sufficient broadband speeds to stream VOD

- The required backhaul capacity in ISP's networks.

iv) *Households with VOD enabled devices*

The number of households with VOD enabled sets is driven from the TV model and used as an input into the ISP model. The number of VOD enabled devices under each scenario is set out below.

Exhibit 28: VOD enabled HH, 2015

Note: Excludes Sky Darwin StBs

v) *Households that can stream Canvas IPVoD ("IP VOD enabled HH")*

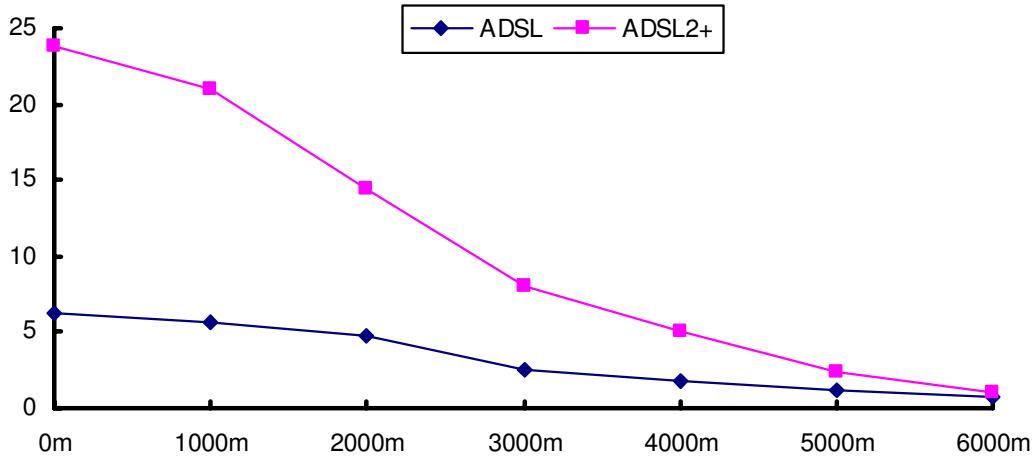
Not all households who buy a Canvas STB will be able to use it to access VOD. This is because:

- The household may not have a broadband connection. They may have chosen to buy a Canvas STB for other reasons, for example, for other features such as HD or the PVR
- The household may have a broadband connection, but the package they buy may not be of sufficient speed to stream video content. This would be a function of the headline speed of broadband that they buy, and the distance they are from the exchange
- Their ISP may have issues with backhaul capacity and restrict usage, particularly at peak time, making streaming video impossible
- There may be issues with customer premises equipment (CPE) or wiring within the home.

The model takes into account the first two points, but does not explicitly take account of backhaul capacity constraints, throttling or in-home issues. The assumption is that ISPs will acquire the necessary capacity to meet the forecast demand and the model compares the costs to do this. In this way it is conservative in potentially over-estimating the proportion of households who can stream VOD and therefore contribute to increasing peak bandwidth requirements.

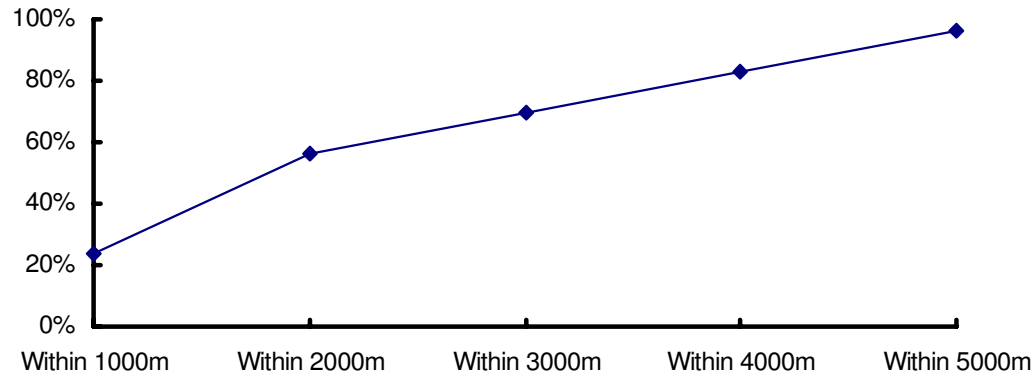
The model uses the headline broadband speed mix as set out in the preceding section to calculate the mix of households and their broadband speeds. From this, the model uses assumptions around the degradation of headline speed with distance from the exchange, and the distribution of connections in terms of distance from the closest exchange, to model the maximum actual speeds received by households.

Exhibit 29: Variation in 'headline speed' received depending on distance from the exchange



Source: Ofcom, Value Partners analysis

Exhibit 30: Distribution of broadband connections relative to distance from nearest exchange



Source: Ofcom, Samknows

It is noted that Digital Britain found that c.11% of homes (2.75m homes) can not readily get a 2Mbps or higher broadband service, due to

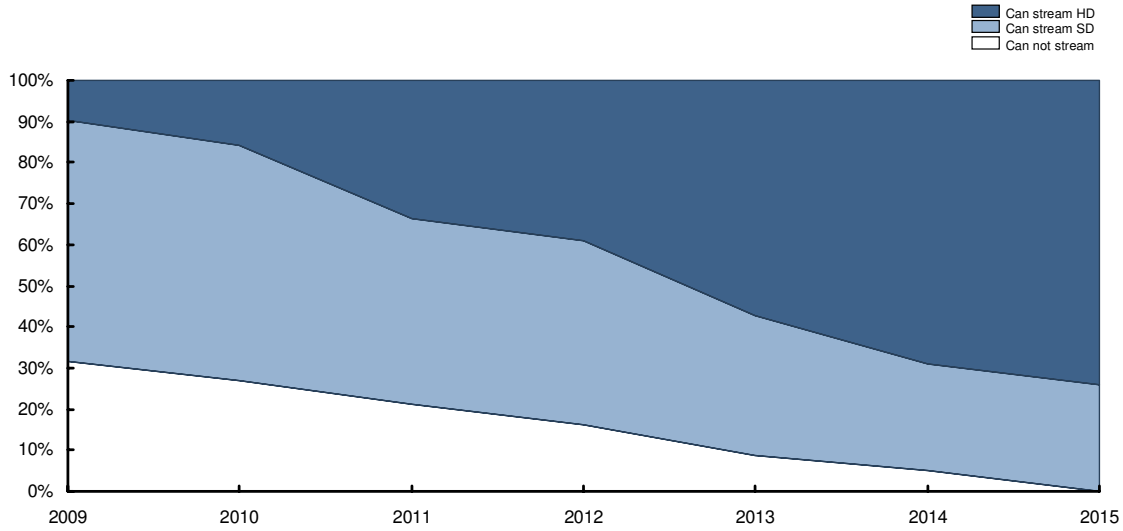
- Problematic home wiring
- Random network effects; and
- Telephone line too long / distance from the exchange.

Our approach is consistent with this finding, but focuses on both the physical limitations on delivery and *actual* broadband speeds being bought and received by households, as discussed earlier a significant proportion of

households are still purchasing 'low speed' (2 Mbps) broadband packages, although the proportion of customers on higher speed packages is assumed to increase significantly over time

These calculations result in a rising proportion of VOD enabled households being able to access VOD streaming, as follows:

Exhibit 31: Distribution of DSL BB HH by ability to stream IPVOD



The rise over time is attributable to:

- Improved compression reducing the bandwidth required to stream video
- Increase in network capabilities, eg with the roll out of DSL2+
- Increase in broadband penetration
- Migration of customers to higher-speed broadband packages

It is estimated that that 16% of households will be able to stream HD in 2010, rising to 74% in 2015, based on existing DSL and DSL2+ architecture.

These figures are based on a single user per home for the internet connection. Clearly if multiple users are trying to use bandwidth heavy activities in busy hour the actual number of households able to stream will be less. This is not explicitly modelled but, is consistent with the approach of taking a worse case scenario.

These estimates are unlikely to change going forward, even if BT's proposed plans to rollout an FTTC service are taken into account. The modelling included indicative estimate of the rollout and take up based on assumption that FTTC roll-out will be in larger urban areas where there are concentrations of high spend customers, who already receive high quality DSL2+ broadband, and based on a 10% penetration of addressable market for FTTC. On this basis almost all new FTTC customers would already be able to stream HD VoD.

6.2.2 Broadband usage and peak bandwidth

i) Peak hour usage

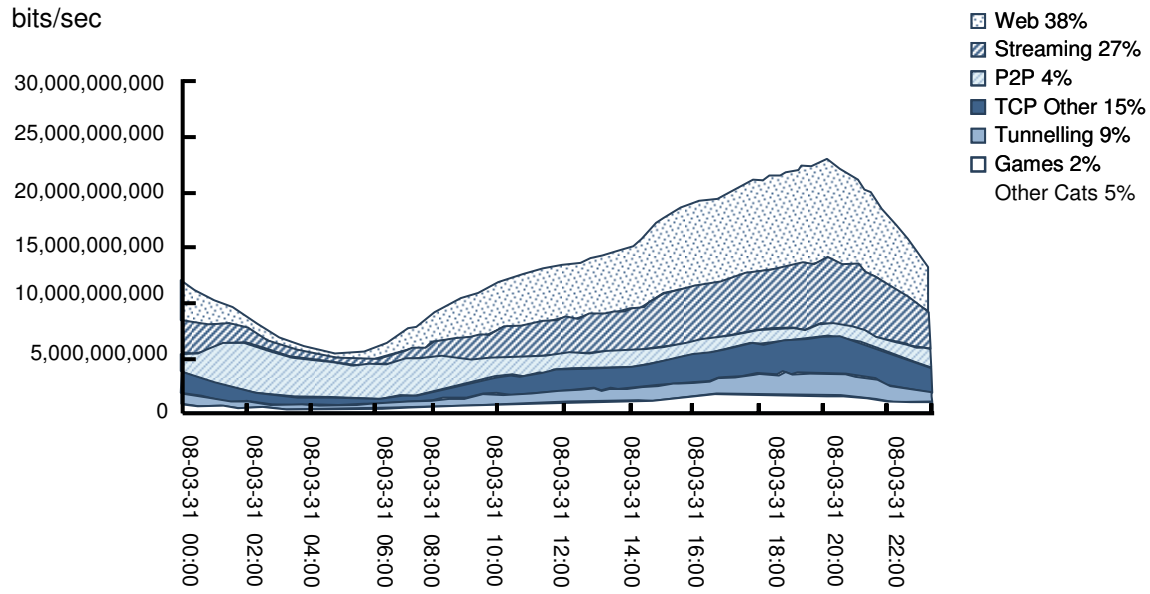
The model assesses internet usage at peak hour:

- Based on public data and discussion with ISPs broadband Internet peak hour is currently around 8pm
- The model uses 2008 and 2009 total peak internet traffic and usage per broadband subscriber as a baseline; these benchmarks have been based on discussions with ISPs and the BBC

Going forward, the model examines the effect of streaming video to the TV on peak hour usage; it is conservative in that it apportions a 'worse case' level of streaming video to the TV during peak hour than is likely to occur

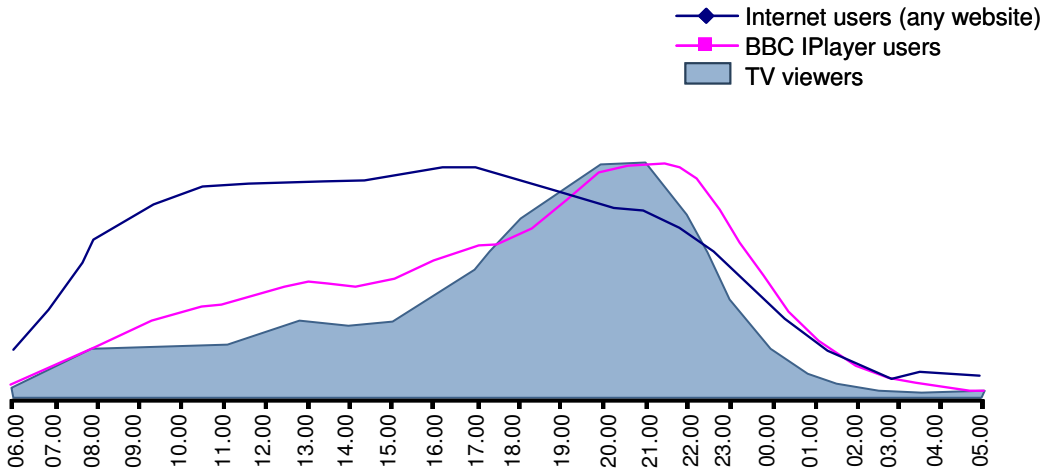
- Although internet peak hour is 8pm, iPlayer peak hour is 9pm – 10pm; TV viewing peaks at 8 – 9pm
- Additionally, iPlayer usage is more evenly distributed through the day than TV viewing
- However, in order not to underestimate the potential effect of VOD on ISPs, the model assumes that VOD viewing would follow the same pattern as TV viewing, ie a experience a more exaggerated peak hour
- From discussions with the industry the current view is that it is likely that peak TV viewing would be linear 'appointment to view' programming, and that VOD viewing delivered over broadband would be 'on the shoulders' of peak, as for iPlayer viewing.

Exhibit 32: Talk Talk internet usage by time of day



Source: Carphone Warehouse analyst day report

Exhibit 33: Internet and TV usage patterns by time of day, current day



Source: BBC.co.uk

ii) TV streaming

Levels of TV streaming are inputs from the TV model, and vary by scenario, depending on

- The number of IPVOD enabled sets in the market
- Assumptions around the amount of viewing that shifts towards VOD

These assumptions are detailed in the TV Appendix

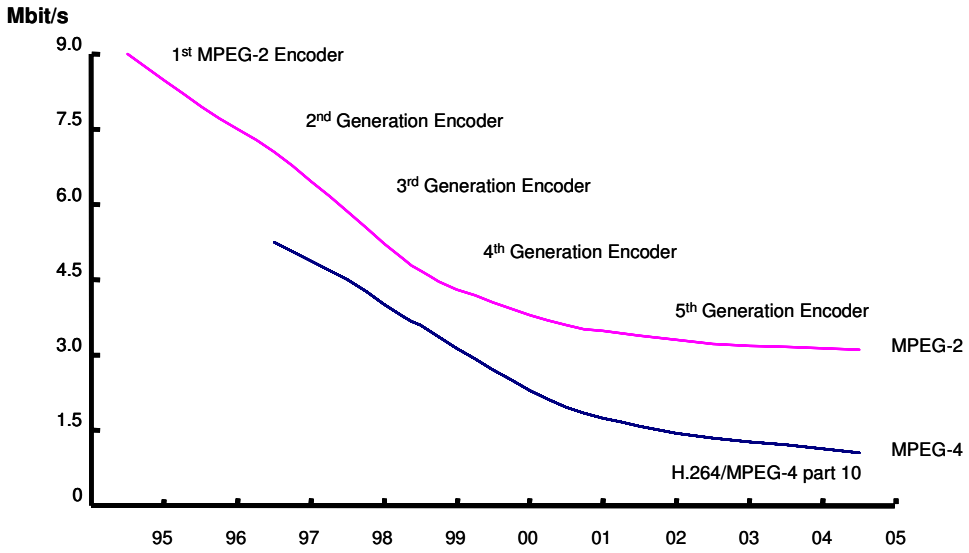
Some of this TV streaming could substitute other broadband activities, for example, music streaming, streaming video to the PC, and gaming. However, in order not to underplay the effect of TV streaming on ISPs, it has been assumed that the level of substitution is negligible, based on the assumption that TV streaming is primarily a substitution of linear viewing.

iii) Bandwidth required for different services

The model makes assumptions around the bandwidth required to deliver the different activities for each user.

- Estimates for 2008 bandwidth requirements are based on publicly available data, Value Partners experience and discussions with ISPs
- It is assumed that bandwidth required for TV streaming services will decrease over time; the model trends this down evenly over the period; video content accessed through Canvas will require the same bandwidth as other standard and high definition streaming to the TV
- This is based on discussions with stakeholders and incorporates the dual dynamic of improving compression technologies and new codecs and increased screen sizes requiring higher resolutions

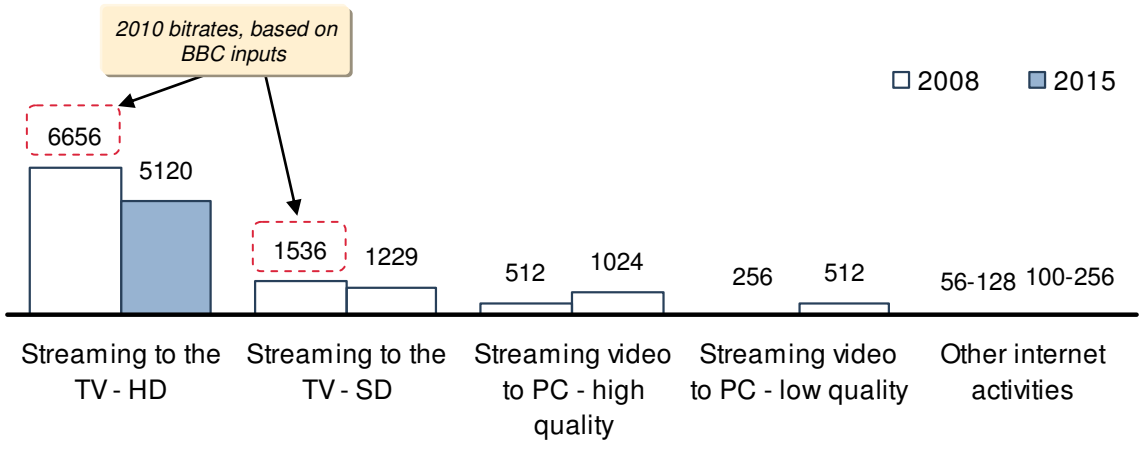
Exhibit 34: Historic improvements in compression technologies



Source: MPEG (Motion Pictures Experts Group)

- Streaming services to the PC, however, are assumed to require increased bandwidth as services stream in increasingly high quality – evidenced by iPlayer and YouTube offering increasingly high (image) quality content for streaming
- Additionally, the model assumes that non-video streaming internet activities (such as surfing, music streaming, gaming) require a growing amount of bandwidth over time due to increased use of 'rich media' and more bandwidth intensive, formats

Exhibit 35: Bandwidth required for different broadband services (kbit/s)



Source: Value Partners assumptions

As network peak hour bandwidth demand is very sensitive to improvements in compression, the model incorporates sensitivity analysis to assess the impact on ISPs network demand and costs in the event that there are no improvements in compression of video content beyond current levels.

6.2.3 ISP profiles

Network costs vary depending on the size of the ISP, and the type of network they use: LLU, IPStream or WBC.

As such the model calculates network costs for the following profiles:

LLU - costs per subscriber depend on the number of subscribers per exchange.

- **Large LLU exchange**, representing ISPs providing broadband using LLU in densely populated urban areas
- **Medium LLU exchange**, representing ISPs providing broadband using LLU in urban areas
- **Small LLU exchange**, representing ISPs providing broadband using LLU in semi-urban areas

IPStream - costs are calculated using the most appropriate BT Central backhaul product for the required bandwidth at a nationally aggregated level[19].

- **Large IPStream**, representing ISPs providing broadband using IPStream nationally, such as BT Retail
- **Medium IPStream**, representing a mid-sized IPStream provider, of a similar scale to Orange, using IPStream to provide broadband to customers living outside its LLU footprint
- **Small IPStream**, representing a small ISP, which most likely only offers a niche IPStream product to its customers. It could also represent a predominantly LLU operator with a very limited number of IPStream customers outside its LLU footprint

WBC – costs are calculated by summing end user charges (access), aggregation point and aggregation bandwidth charges (backhaul) as well as core charges; as WBC is seen as a product which will replace IPStream in the medium to long term, costs have been calculated based on the same ISP profiles as IPStream.

6.2.4 Network costs

The model calculates network costs for LLU, IPStream and WBC ISPs based on the size of the ISP in terms of subscribers per exchange. The costs have been allocated for major fixed and bandwidth-variable components of the ISPs' network, across the access, backhaul and core segments of the network. The models does not assume any IP transit costs on the basis of the assumption that a content provider's network will peer with the ISP's network at major core peering points, as is currently the case for the BBC in the distribution of iPlayer content.

A description of the key cost items for each ISP has been provided below.

i) LLU costs

The model calculates LLU costs across the access, core and backhaul segments of the network. Inputs have been obtained from Openreach's LLU price lists.

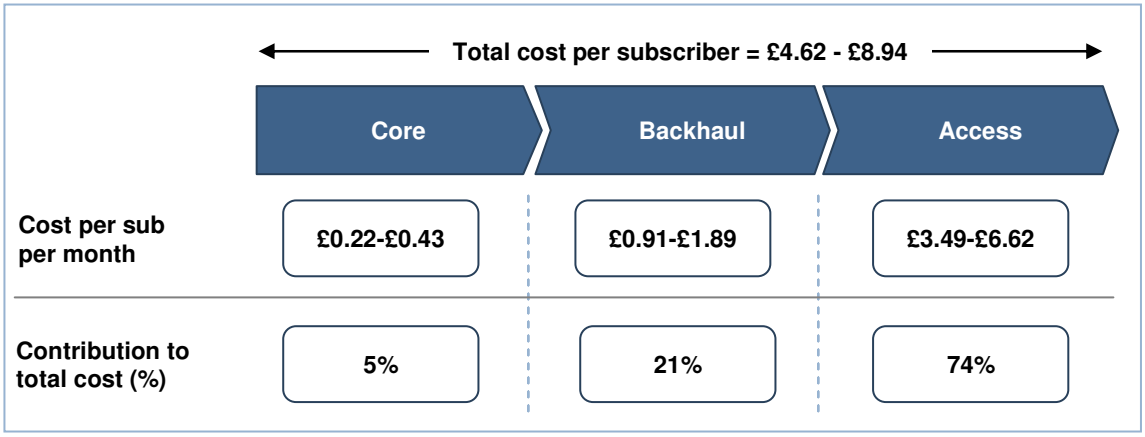
- Access costs are based on partial unbundling (SMPF) only and have been calculated for the key CAPEX and OPEX elements associated with network infrastructure located in exchanges. These include CAPEX

[19] Although BT Retail uses an alternative IP Stream product, which provides a fully managed service. This has not been modelled, as all other IP Stream customers use BT Central; as such the model is based on BT Central pricing.

for accommodation, network infrastructure (DSLAMs), surveying and provisioning; depreciated over a period of 5 years.

- Backhaul costs for LLU ISPs have been calculated using connection and annual-rental costs for BES backhaul circuits required to accommodate the peak bandwidth requirements estimated. Based on interviews with ISPs the model assumes a proportion of BES circuits are arranged in a ring formation with five exchanges per ring. When the level of total traffic increases, the model assumes that LLU ISPs upgrade to higher capacity backhaul products offering better economies of scale.
- Core costs have been estimated assuming 20 core nodes consisting of bandwidth variable (Core routers, DWDM) and fixed (core switches) equipment. These costs also include OPEX stemming from utilities, security, etc.

Exhibit 36: Distribution of costs for an LLU ISP, 2009



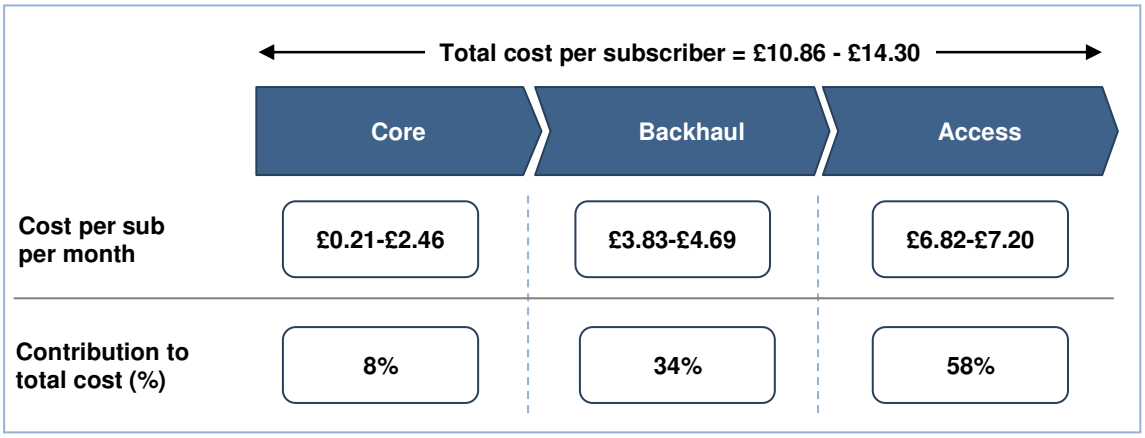
The total costs on a per subscriber basis for LLU ISPs range from £4.62-£8.94. For LLU ISPs, the model estimates that in 2009, 74% of costs are based in the access segment of the network, 21% of costs are based in backhaul whilst 5% of costs are based in the core.

ii) IPStream

The model calculates costs for IPStream ISPs by estimating costs for a basic IPStream service without including any costs for managed bandwidth services. Total costs have been calculated by separately calculating IPStream Home charges (access), BT Central charges (backhaul) and core costs, based on the Usage charging pricing available on BT Wholesale's website.

- IPStream Home (or access) charges have been calculated using pricing information on connection charges as well as annual rental charges (for 2Mbit/s and 8Mbits/s products) from BT Wholesale, which is levied typically on a per-end-user basis.
- Costs for BT Centrals (or backhaul) have been calculated by estimating the number of BT Central pipes required to accommodate peak capacity requirements. This was then used to determine total backhaul costs using pricing information supplied by BT Wholesale. IPStream ISPs have been assumed to utilise the most efficient combination of BT Centrals (BT Centrals typically range from 32Mbit/s to 622Mbit/s) in order to meet total backhaul bandwidth requirements. Compared to LLU products, larger capacity BT Centrals provide limited economies of scale, which consequently leads to an increase in backhaul costs when capacity requirements increase.
- Core costs have been estimated in a manner similar to LLU. The model estimates costs on the basis of 20 core nodes consisting of bandwidth variable (Core routers, DWDM) and fixed (core switches) equipment.

Exhibit 37: Distribution of costs for an IPStream ISP, 2009



In 2009, the total costs on a per subscriber basis for IPStream ISPs range from £10.86-£14.30 as shown in the exhibit above. For IPStream ISPs, the model estimates that in 2009, 58% of costs are based in the access segment of the network, 34% of costs are based in backhaul whilst 8% of costs are based in the core.

It is assumed that IPStream input costs (ie charged by BT Wholesale) remain constant over time as there have been no suggestions that these costs would change.

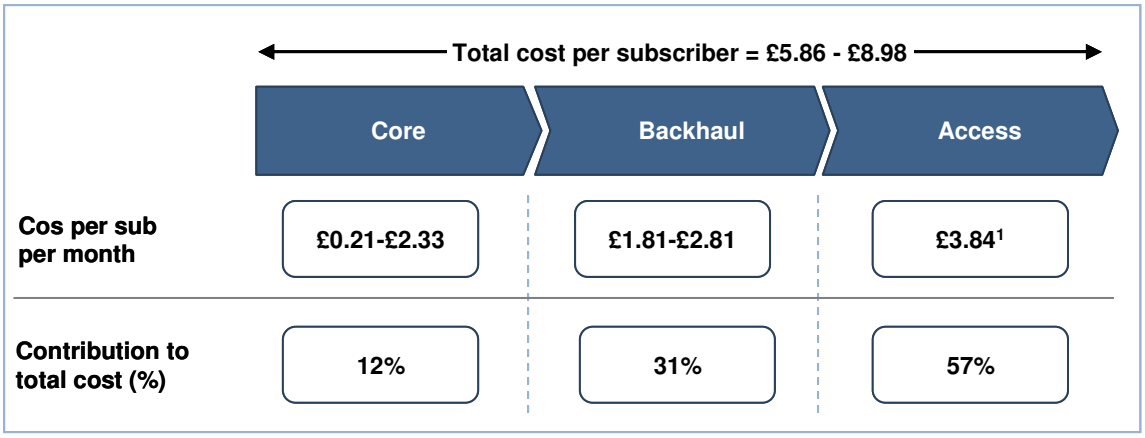
iii) WBC

Wholesale Broadband Connect (or WBC) is an Ethernet-based service being rolled out by BT Wholesale as part of its 21CN (21st Century Network) rollout. Being an Ethernet-based service, WBC allows ISPs greater economies of scale with increases in capacity (compared to IPStream) on the backhaul segment of the network. The model calculates costs for ISPs offering WBC products by summing end user charges (access), aggregation point and aggregation bandwidth charges (backhaul) as well as core charges based mainly on price lists obtained from BT Wholesale.

- End user charges have been calculated on the basis of migration charges, connection charges as well as line rental charges[20] on a per-user basis, as specified by BT Wholesale
- Aggregation point charges comprise of several components including a fixed annual rental cost for 20 core nodes (£330k), aggregation bandwidth charges of c.£80 per Mbit/s as well as extension path charges which vary based on the bandwidth required (the extension path is essentially Ethernet-based and provides some economies of scale as larger capacity products are purchased). Similar to the modelling used for LLU and IPStream exchanges, the model assumes that WBC ISPs upgrade to higher capacity extension paths over time to accommodate growing total bandwidth requirements.
- Core costs have been estimated in a manner similar to LLU. The model estimates costs on the basis of 20 core nodes consisting of bandwidth variable (Core routers, DWDM) and fixed (core switches) equipment.

[20] Note: Assured rate charges (costs associated with providing a managed service which guarantees bit rates to the end user) have not been included in these calculations because a basic vanilla service has been modelled. The inclusion of these charges would add an incremental uplift to access costs.

Exhibit 38: Distribution of costs for a WBC ISP, 2010



Note: Access costs comprise of fixed per-user rental charges and migration charges

The total costs on a per subscriber basis for WBC ISPs range from £5.86-£8.98[21]. For WBC ISPs, the model estimates that in 2010, 57% of costs are based in the access segment of the network, 31% of costs are based in backhaul whilst 12% of costs are based in the core.

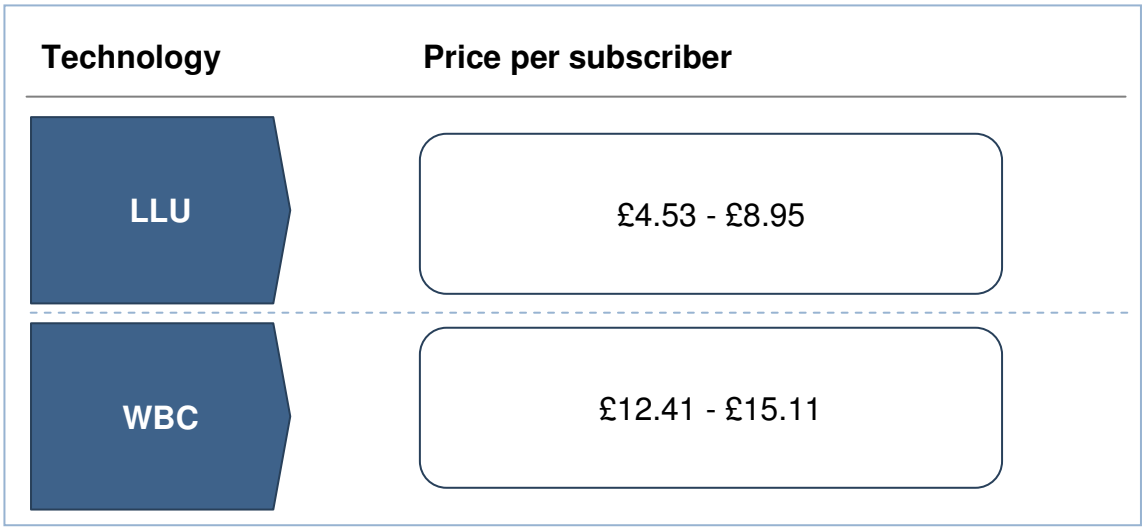
For the purposes of this model it is assumed that WBC charges remain constant over the period. This provides a benchmark of how costs will vary as traffic increases, and there is no indication from BT of expected declines. However, it is likely that costs for WBC will fall further over time.

- BT Wholesale's WBC product is built around an underlying Ethernet infrastructure. BT announced on 24th September that it would halve its current bandwidth prices by 2010, and as such the 2010 prices have taken this price change into account
- Several interviewees made the point that they would expect the inherent economies of scale of Ethernet networks to be reflected in the pricing for elements of WBC services, and would therefore expect both the absolute price levels and pricing structure to evolve over time to provide a cost structure that is more scalable with traffic volumes, and closer to the cost structure available to LLU operators using Ethernet backhaul services

Current prices for 2010 suggest WBC will be priced competitively to LLU, however without further declines the forecast costs per subscriber for WBC will increase significantly above those for LLU in the same period.

[21] This is based on the high case, to give the maximum cost to the ISP

Exhibit 39: Cost per subscriber per month in the high case base, LLU and WBC, 2015



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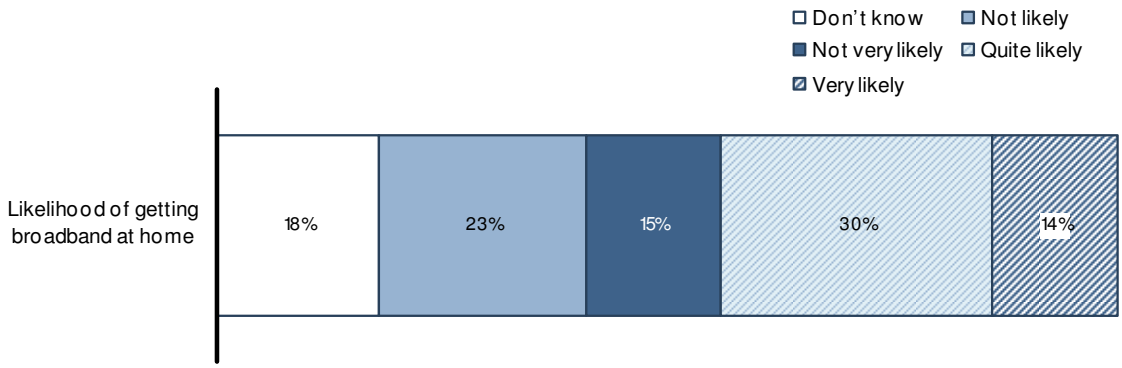
6.2.5 Uplift in broadband penetration and internet usage as a result of Canvas

a) Increased broadband penetration

Canvas will be purchased by some households without broadband. These households may purchase Canvas for other functionality such as HD and PVR. The model assumes that Canvas would result in 25% of these households buying broadband in order to access Canvas VOD and internet services. This compares to market research commissioned by the BBC Trust, which indicates that 14% of respondents interested in Canvas, and who do not have broadband at home, would be very likely to take up broadband, and a further 30% who were quite likely to take up broadband.

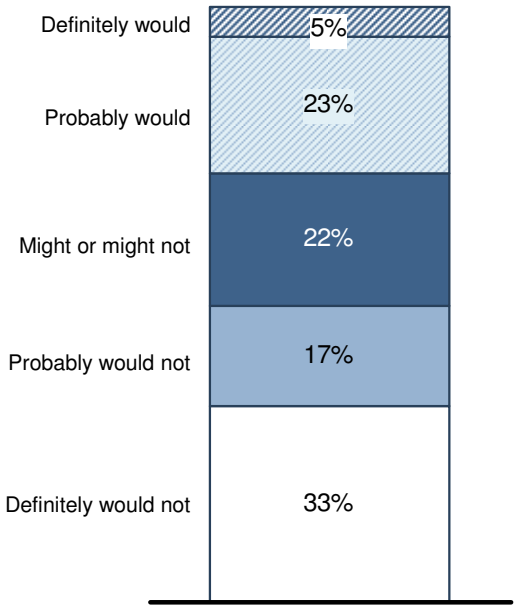
Exhibit 40: Opinion Leader: Likelihood of getting broadband internet at home, non-rejectors of Canvas without broadband



Source: Opinion Leader, May 2009

Additionally, research commissioned by the BBC indicates that 28% of interviewees without broadband could probably or definitely get access to broadband if Canvas became available.

Exhibit 41: Likelihood of getting broadband if Canvas became available, non-internet sample



Question: Assuming that the Canvas digital box and other products like it become available this year, how likely would you say it is that you will decide to subscribe to broadband internet in order to take advantage of them?

Source: IPSOS Mori / Human Capital Conjoint Research report for BBC Executive, February 2009

b) Increased usage of the internet

Canvas would grow internet usage by increasing the reach of internet access to households which would not have internet access, if not for Canvas:

- Households which were broadband households before they acquired a Canvas box are unlikely to use their Canvas STB and TV for internet surfing; they would use their computers for internet surfing
- However, households for which the Canvas STB is the only means of accessing the internet at home (ie they do not have an internet connected computer) could use Canvas as a way of accessing a selected number of websites designed to be accessed via and navigated through a STB.

In the base case, the number of households with internet access due to Canvas reaches 0.5m by 2015; assuming an average of 2.2 individuals per HH, this increases the reach of internet at home to 1.1m individuals.

On average in 2008, internet usage for internet users of all ages in the home was approximately 45 minutes per day[22]. It is likely that individuals that who access the internet via Canvas use the internet significantly less than the average:

- These individuals are late adopters and so inherently have lower propensity to use the internet
- The content / websites available via Canvas STB would be more limited than that available through PCs as it is likely that sites would have to be adapted for use via Canvas, in the same way as sites need to be adapted for mobile
- It is assumed that the number of sites accessible grows over time as the addressable base grows

[22] comScore data, based on June – December 2008 data

- It is noted that the sites likely to be accessible for Canvas include NHS direct and some other community / government sites

For the purposes of assessing how Canvas would affect the overall level of internet usage, the model assumes that usage for these individuals is 5% of average individual usage in 2010, 10% in 2011 and 20% in 2012.

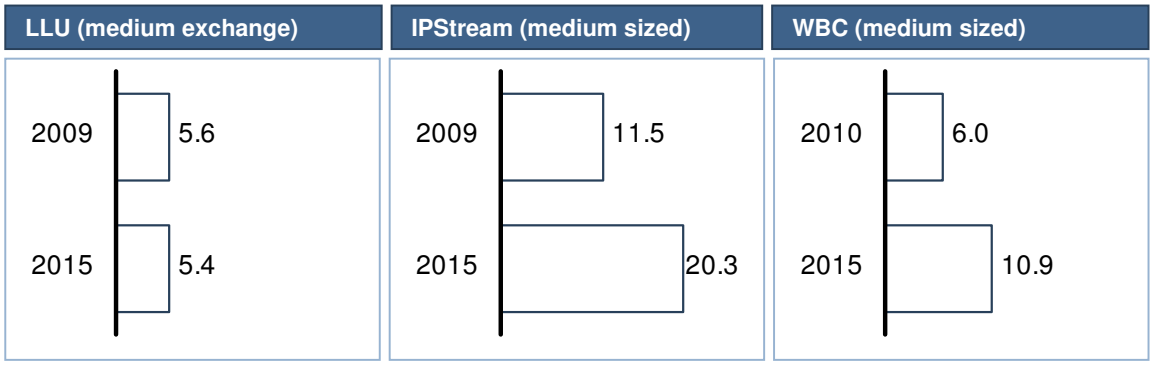
However, in order to ensure that the impact of Canvas on ISPs is not understated, in assessing the impact of Canvas on ISP costs, it is assumed that these additional subscribers have the same usage profile and therefore generate the same level of traffic as any other broadband subscriber.

7 Market impact of Canvas on ISPs

7.1 Summary

ISP costs per subscriber will be affected in the period to 2015 as broadband subscribers generate more traffic due to more 'bandwidth hungry' internet sites and applications, including the increased use of the internet to stream video, both to PCs and TVs. For LLU and WBC, the increase in traffic is offset by the economies of scale from buying larger capacity BES connections with lower unit costs of traffic. Additionally, as broadband penetration grows ISPs can spread fixed costs over a larger subscriber base. The exhibit below shows how the cost per subscriber changes for ISPs (medium sized exchange for LLU, medium sized ISPs for IPStream and WBC) offering broadband between 2009 (2010 for WBC) and 2015.

Exhibit 42: Cost per subscriber, Counterfactual, 2009 and 2015 (£ per subscriber per month)

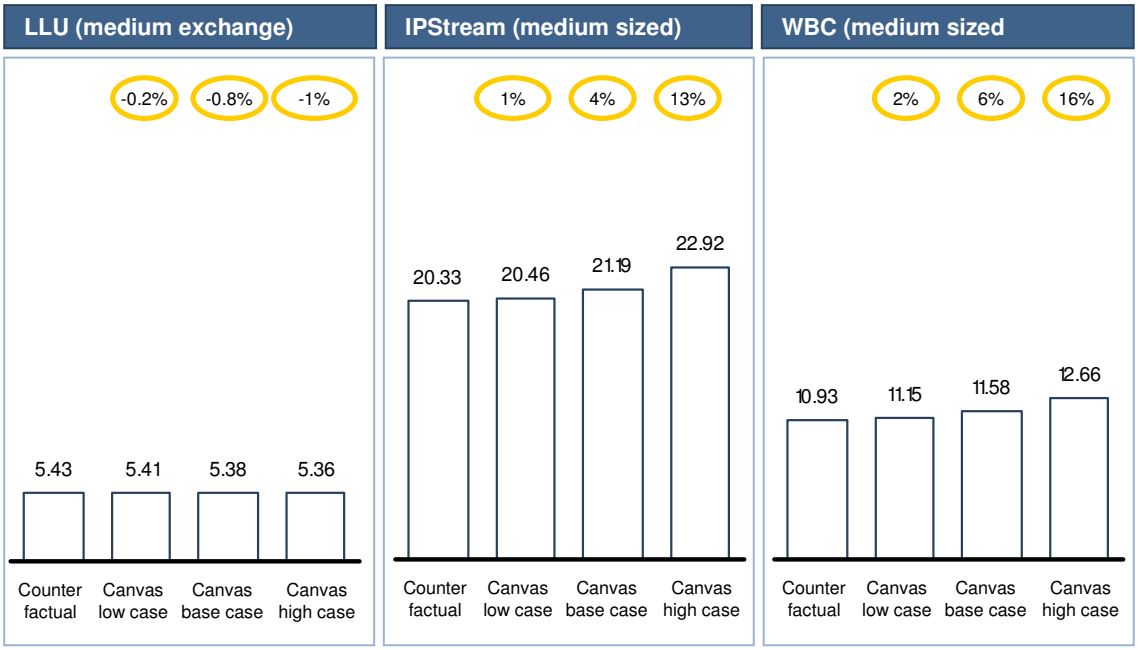


Source: Value Partners analysis

The impact of Canvas on ISP costs is due to Canvas growing the number of IPVOD enabled sets in the market, and therefore the peak hour bandwidth required. The introduction of Canvas will have differing impact on ISPs depending on their wholesale business model. By 2015, for a medium sized exchange, the increase in cost per subscriber would be negligible for a LLU ISP[23]; for an ISP using a bitstream product (IPStream or WBC) the increase in cost would range from 1% to 16% (depending on the wholesale model and scenario).

[23] In fact, analysis indicates that cost per subscriber could fall very slightly due to Canvas causing increased numbers of broadband subscribers resulting in economies of scale

Exhibit 43: Impact of Canvas on ISP cost per subscriber, 2015 (£ per subscriber per month)



Source: Value Partners analysis

If the NPV of these incremental costs are compared over the 6 years until end of 2015, the differences are smaller, ranging from almost 0% to 11.2%.

Exhibit 44: High case 6 year discounted additional cost per subscriber

	LLU		IP Stream		WBC	
ISP size	£ impact	% impact	£ impact	% impact	£ impact	% impact
Large	-0.6	-0.3%	67.4	8.3%	45.2 3	11.2%
Medium	-1.1	-0.4%	66.9	8.1%	45.1	10.7%
Small	3.1	0.7%	97.5	9.1%	44.2	7.9%

The rest of this section details the impact of Canvas relative to the Counterfactual for the three cases, and provides further detail on cost impact for the different profiles of ISP.

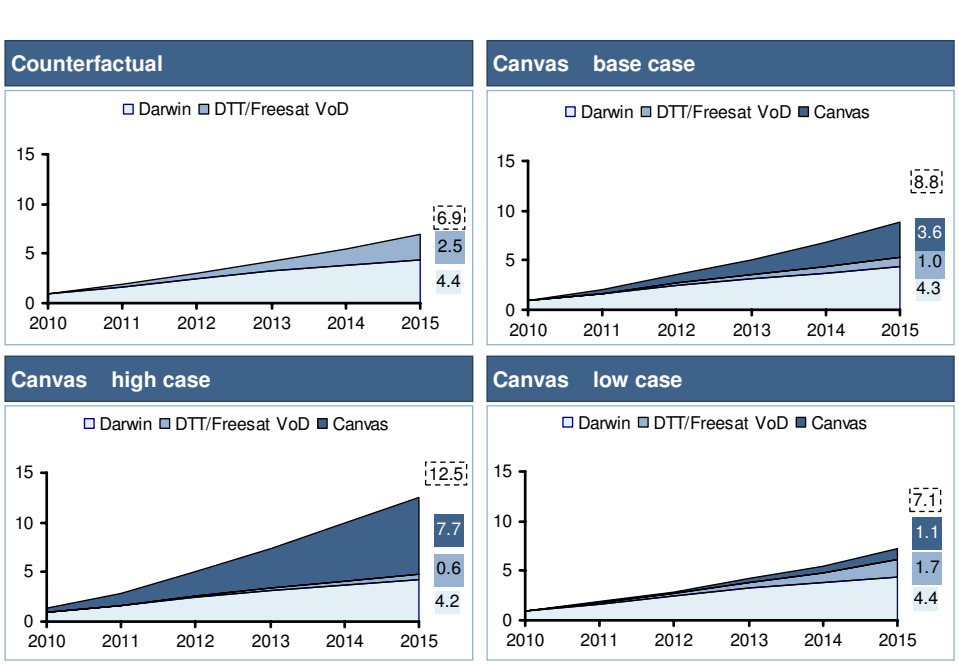
7.2 IPVOD enabled sets

The number of IPVOD enabled sets grows over time in both the Counterfactual and Canvas scenarios. This is a result of three key factors:

- An increasing number of VOD enabled sets in the market
- An increase in the number of broadband households, and the migration towards higher speed broadband
- A reduction in the speed of connection required to access IPVOD, due to improvements in compression.

The number of IPVOD enabled sets under the Counterfactual and Canvas scenarios is shown in the exhibit below. This includes IPVOD enabled Darwin boxes, Canvas boxes, and other VOD enabled boxes.

Exhibit 45: IPVOD enabled sets (millions) , 2010 – 2015



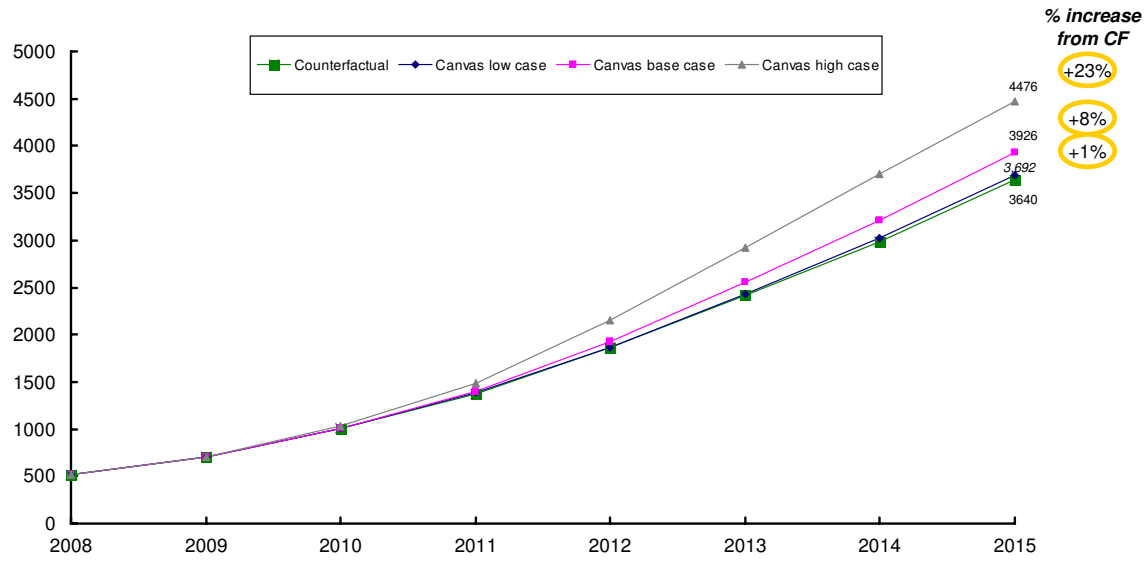
It is important to note that not all IPVOD enabled sets are streaming video content to the TV in peak hour. For the set to be streaming video, it would have to

- Be turned on
- The viewer would have to be using VOD, rather than watching linear broadcast content or PVR content
- The VOD would have to be streamed over the internet rather than have been previously pushed to the hard disk

7.3 Peak hour traffic

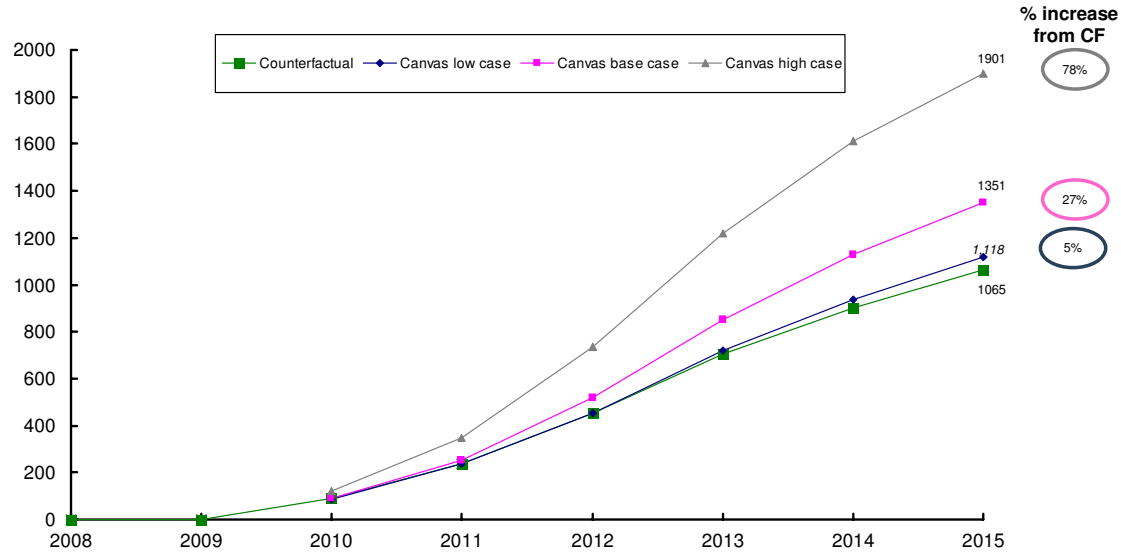
The introduction of Canvas would accelerate the increase in peak hour traffic as more households have the right technology (STB) to stream video content to their TVs. In the counterfactual, peak hour traffic is expected to group to a total of 3,640 Gbits/s; by 2015, in the base case the introduction of Canvas would increase this by 8% to 3,926 Gbits/s; in the high case the increase would be 23% to 4,476 Gbits/s. In the low case the increase is minimal, an increase of 1%.

Exhibit 46: Total peak hour internet traffic, UK, Gbit/s



In the counterfactual, in 2015, streaming video traffic to the TV comprises 29% of total traffic (1066 Gbits/s out of 3,640 Gbits/s). Canvas has a direct and marked impact on this traffic. In the base case, Canvas increases streaming video traffic to the TV by 27%; in the high case this increases by 78%. The low case impact is smaller, an increase of 5%.

Exhibit 47: Peak streaming to the TV traffic, Gbit/s

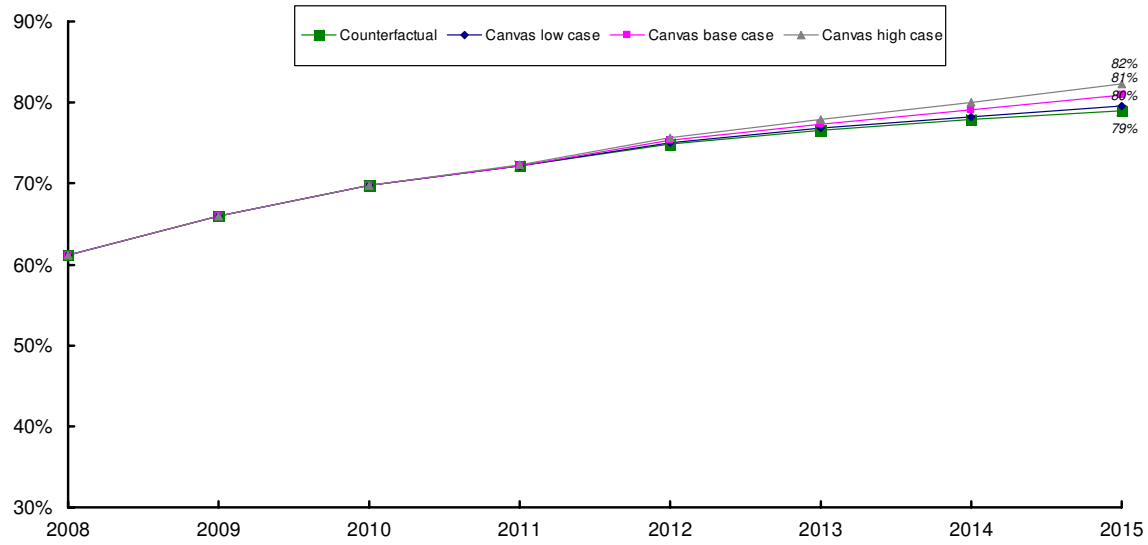


7.4 Broadband penetration

One of the impacts of Canvas is that it helps to grow broadband penetration, as some households buy a Canvas set but do not have a broadband connection at home; Canvas encourages them to take a broadband

connection to be able to benefit from the VOD functionality. In the base case, Canvas grows broadband penetration by two percentage points, or a total of 490,000 households, from 79% to 81%; in the high case, Canvas grows broadband penetration by three percentage points, or a total of 870,000 households, from a penetration of 79% to 82%.

Exhibit 48: Canvas impact on broadband penetration, %



7.5 Internet usage

As Canvas grows broadband reach, it would grow overall internet usage, as individuals who previously did not have internet access at home are able to access selected websites such as NHS direct. In the base case, by 2015, this could grow overall internet usage by 0.5%, or a total of 1.4m hours per week; in the high case this could grow to an increase of 0.8%, or a total of 2.4m hours per week.

However, for the purposes of assessing the impact on peak bandwidth and therefore the cost base of ISPs, it has been assumed that these households would contribute the same level of traffic as other broadband households. This ensures that the cost impact on ISPs is not understated.

7.6 Peak bandwidth per DSL subscriber

7.6.1 Peak bandwidth per DSL subscriber – Canvas impact

The introduction of Canvas would act to accelerate growth in peak bandwidth per DSL household. This is calculated by dividing the total peak hour traffic by the number of DSL broadband households. In the counterfactual, peak hour bandwidth per user is forecast to rise from 43 Kbit/s in 2009 to 179 Kbit/s in 2015. In the base case, the introduction of Canvas would result in a rise to 188 Kbit/s (5% more than the counterfactual); in the high case the rise would be to 211 Kbit/s (18% more than the counterfactual) and in the low case the rise would be negligible.

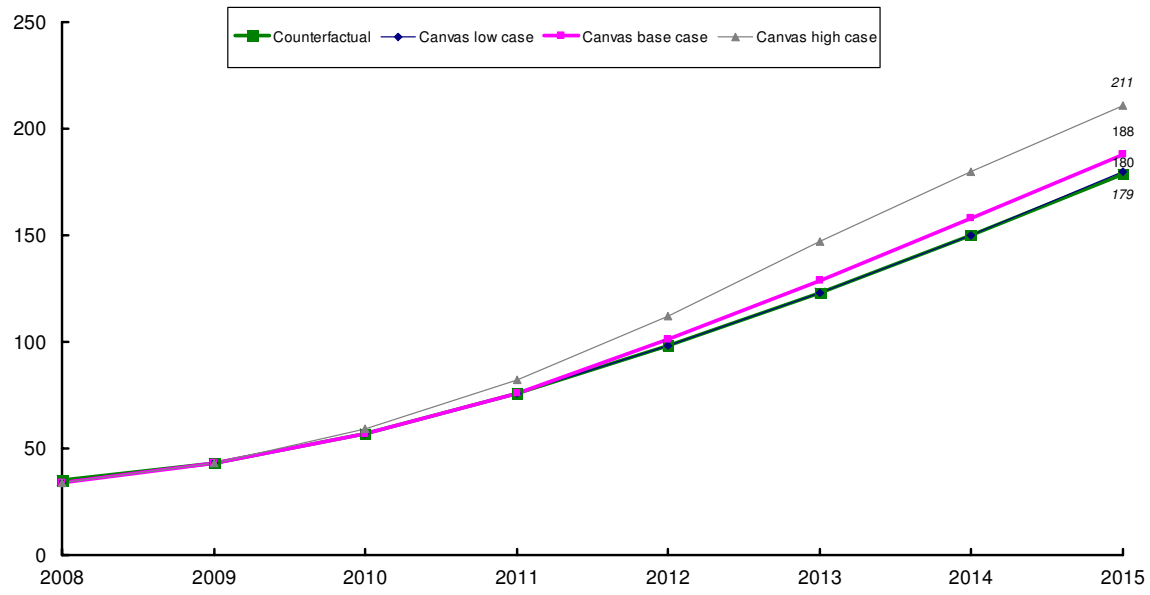
These forecasts in peak hour bandwidth are lower than those forecast by Analysys Mason in their report, 'Delivering high-quality video services online' for Ofcom. In 2015, their low case forecasts traffic per

subscriber of approximately 143 kbits/s in 2015, and their mid case forecasts approximately 315 kbits/s in 2015. Their high case forecasts approximately 540 kbits/s.

However, Analysys Mason make a number of assumptions which significantly increase bandwidth requirements:

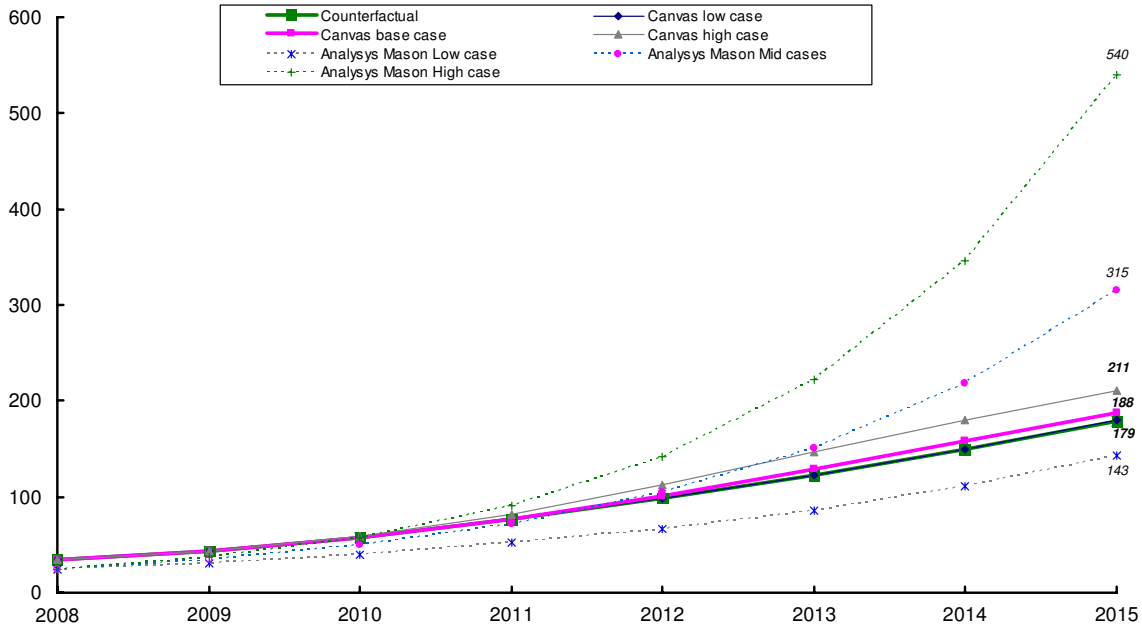
- SD is assumed to stream at 2Mbit/s which is higher than the 1.5 – 1.6Mbit/s indicated by the BBC; additionally they do not take account of compression, which would reduce the demands on bandwidth in later years;
- HD is assumed to use 10Mbit/s in 2008, falling to 8Mbit/s in 2018; this is much higher than the 7Mbit/s indicated by the BBC, and furthermore compression should further reduce this over the period. Discussions with several ISPs suggested they believed HD at higher bit rates would be very unlikely other than for selected content
- No use of push VOD is assumed
- Apart from VOD, it is assumed the some linear broadcast channels are streamed over IP.[24]

Exhibit 49: Peak hour bandwidth, 2009 – 2015, Kbits/s



[24] The possibility of linear broadcast channels streaming over IP us not modelled. Solutions to support this service currently use a multicast technology delivered as a managed network service over backhaul and core networks that do not directly contribute to costs for 'over the top' internet traffic

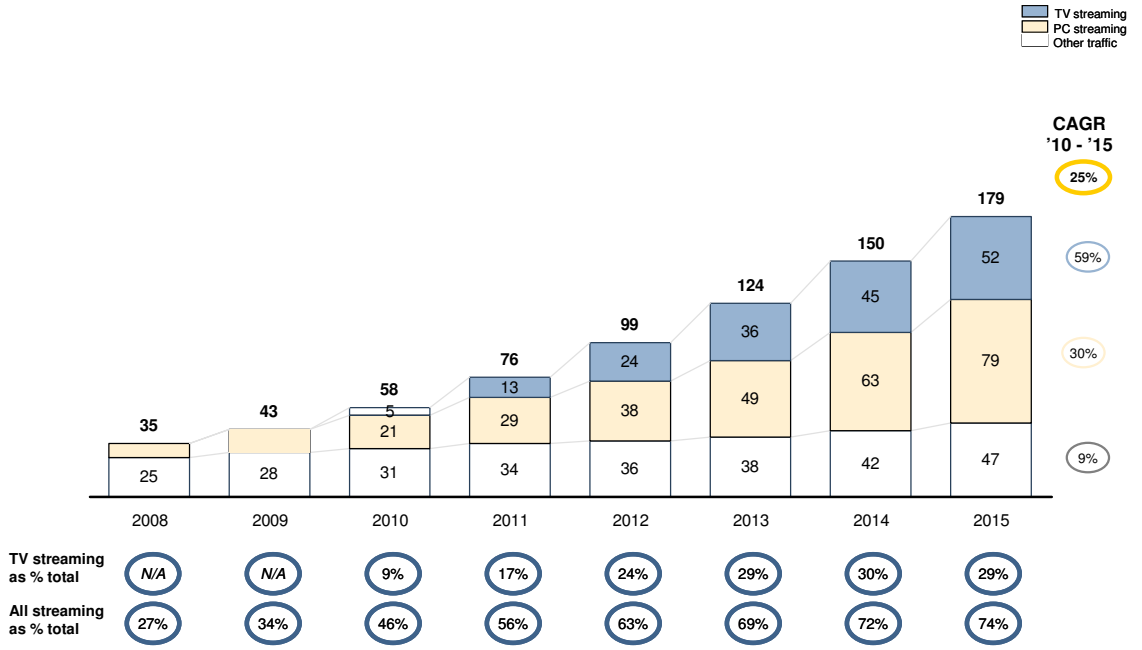
Exhibit 50: Peak hour bandwidth, 2009 – 2015, benchmarked against Analysys Mason, Kbits/s



7.6.2 *Peak bandwidth per subscriber by activity*

Most of the growth in bandwidth per DSL subscriber is due to video streaming. In the counterfactual, non-streaming activities grow traffic by a CAGR ('10 – '15) of 9%; streaming video to the PC grows at a CAGR of 30% and streaming video to the TV grows at 59%; video streaming grows from accounting for 27% of traffic in 2008, to 74% of traffic in 2015.

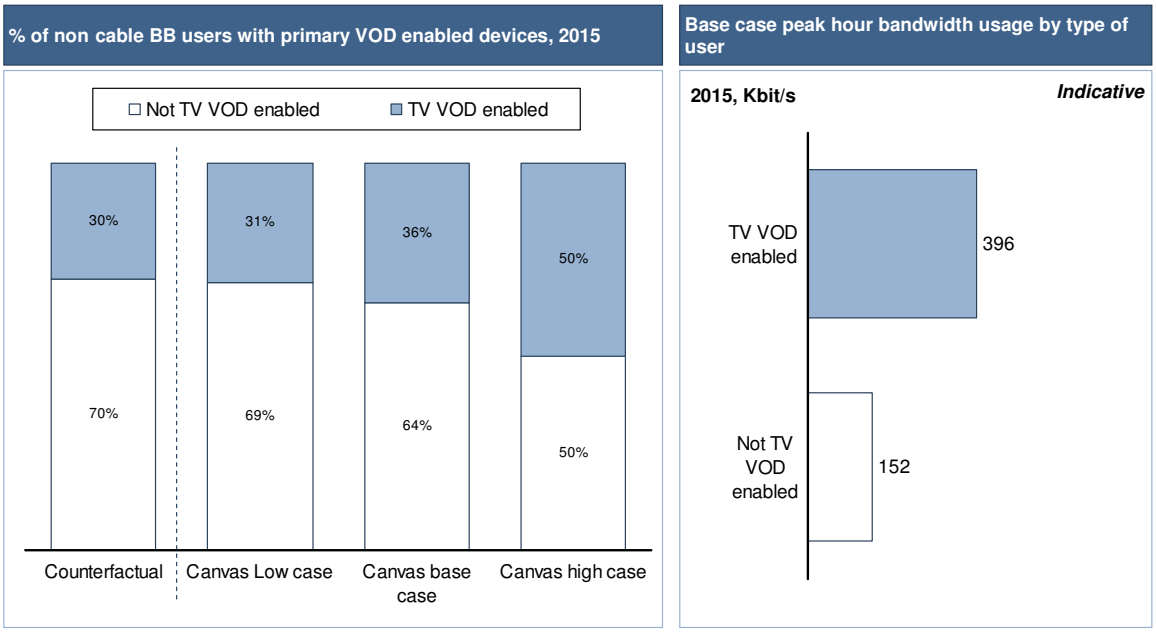
Exhibit 51: Bandwidth per DSL subscriber by activity, counterfactual, Kbits/s



The growth in bandwidth per subscriber is due to Canvas increasing the amount of TV streaming, as more households are able to stream to their TV.

This increase in bandwidth is a consequence of an increase in the proportion of broadband subscribers using their broadband connections to stream VOD to their TVs. This type of broadband subscriber typically uses over two and a half times the peak hour bandwidth than a broadband user without TV VOD devices (an average of approximately 396Kbit/s for a broadband user able to stream VOD, compared to 151 Kbit/s for other users). It is not anticipated that Canvas users would use any more or less bandwidth than other DTT VOD enabled users such as DBook6, as it is assumed that both standards would incorporate functionality to minimise bandwidth consumption, such as using push VOD, and taking advantage of compression technologies.

Exhibit 52: Proportion of non-cable BB users with VOD enabled primary TV sets



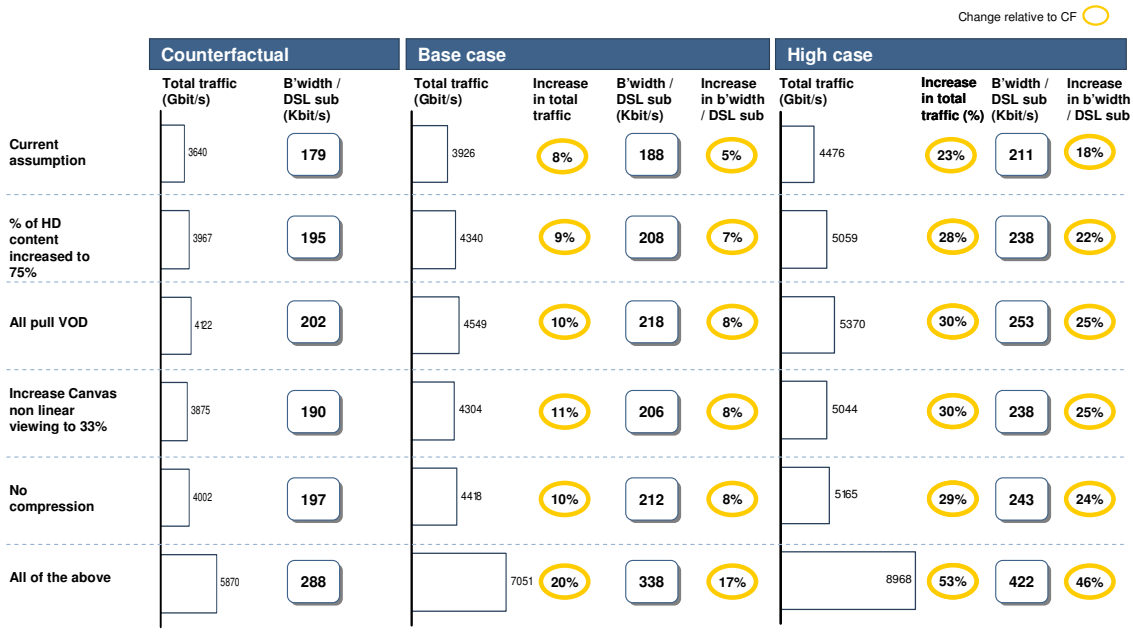
7.6.3 *Sensitivity analysis*

Sensitivity analysis has been carried out to assess the maximum potential increase in bandwidth in a 'worse case scenario'. To do this, the following assumptions have been flexed in the base and high cases:

- Increasing the proportion of content which is HD by 2015 from 50% to 75%
- Assuming that all VOD is delivered via IP streaming; there is no push VOD
- Increasing the amount of non linear content from 25% to 33% by 2015
- Removing the effects of compression

The results are shown in the exhibit below. From this, it can be seen that the combined effect of all these sensitivities could increase peak bandwidth per DSL subscriber in the high case to 422 kbits/s; this would be a 48% increase from the corresponding counterfactual. In the base case, the combined effect of all the sensitivities would increase bandwidth per DSL subscriber to 338 kbits/s, representing a 17% increase compared to the corresponding counterfactual.

Exhibit 53: Sensitivity analysis around total traffic and bandwidth per DSL subscriber, 2015



7.7 ISP network costs

The impact on ISP network costs is assessed on a per subscriber basis for ISPs delivering BB using LLU, IPStream, and WBC, and is expressed in terms of the net present value of the increase in costs between 2010 and 2015, discounted back to 31 December 2009.

7.7.1 LLU

The incremental costs per subscriber of Canvas on LLU ISPs are negligible in most scenarios. There are, on occasion, some minor decreases in costs per subscriber for LLU ISPs. These decreases are driven by a growth in the number of broadband users in the Canvas scenarios (due to subscribers taking up broadband connections as a result of Canvas), which in turn reduces overall unit costs per subscriber. The NPV of these incremental costs shows a limited impact per subscriber ranging from -£0.50 (representing a reduction in costs) to £4.40, a maximum increase of c.1%.

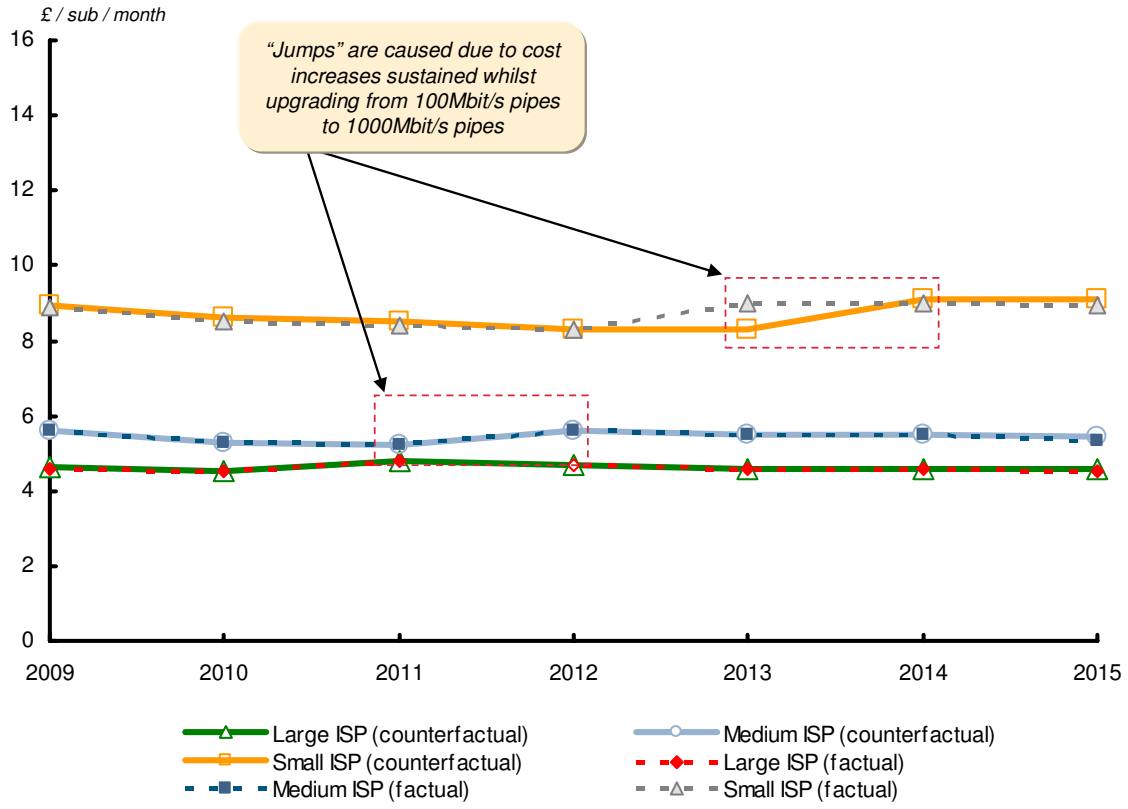
Exhibit 54: Six year per subscriber NPV of increase in LLU costs due to Canvas

	Counterfactual	Canvas Low case		Canvas Base case		Canvas High case	
ISP size	£	£ impact	% impact	£ impact	% impact	£ impact	% impact
Large LLU	242.2	-0.1	-0.1%	-0.4	-0.2%	-0.6	-0.3%
Medium LLU	282.8	-0.2	-0.1%	-0.7	-0.2%	-1.1	-0.4%
Small LLU	449.5	-0.5	-0.1%	4.4	1.0%	3.1	0.7%

LLU costs per subscriber are expected to remain largely flat in the counterfactual, except for some 'jumps' due to ISPs making step-change upgrades to their backhaul BES products (eg from 100 Mbit/s to 1 Gbit/s) to accommodate higher bandwidths.

In terms of the impact of Canvas, even in the high case, there are minimal differences in cost per subscriber per month, shown in the figure below. The main driver of incremental cost as a result of increases in traffic is the requirement to provision more backhaul capacity. However, for medium and large LLU exchanges, the increases due to Canvas are generally within the capacity already provisioned by ISPs in the counterfactual; for small LLU exchanges, Canvas simply brings forward the upgrades to their BES products by one year.

Exhibit 55: LLU ISPs: Cost per sub per month, Counterfactual compared to Canvas high case



These findings are broadly in line with those of Analysys Mason, which forecast an increase in cost per line per month of about £0.50 – even with their significantly higher peak bandwidth per line of up to 950kbit/s,

7.7.2 IPStream

Canvas does have a material impact on IPStream ISPs; the NPV of the incremental cost per subscriber over six years is £1.8 - £97.5, an increase of 0.2% - 9.1%.

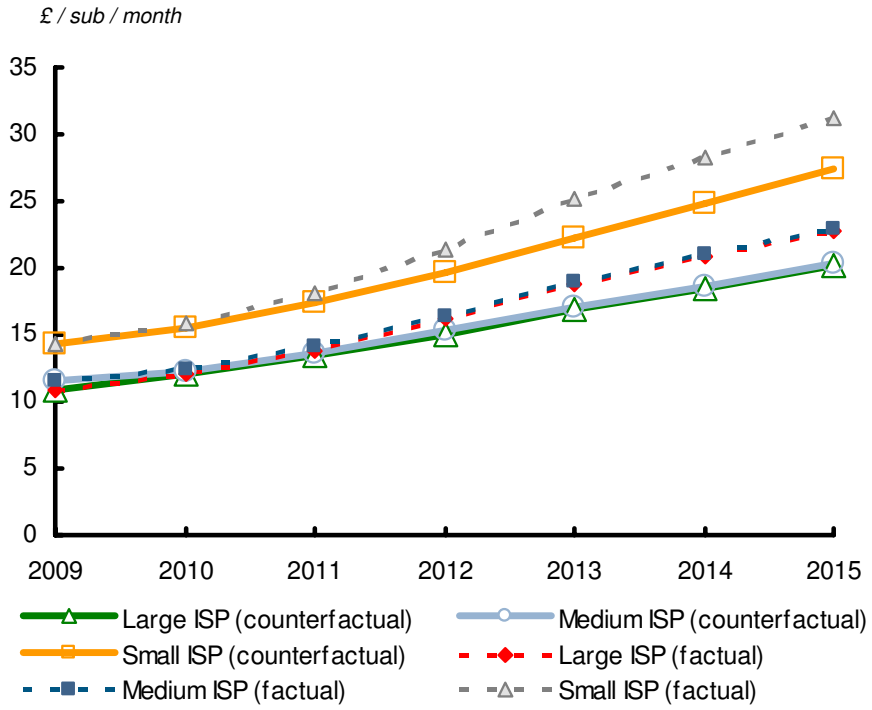
Exhibit 56: Six year per subscriber NPV of increase in IPStream costs due to Canvas

	Counterfactual	Canvas Low case		Canvas Base case		Canvas High case	
	£	£ impact	% impact	£ impact	% impact	£ impact	% impact

Large IPStream	810.7	2.1	0.3%	18.7	2.3%	67.4	8.3%
Medium IPStream	823.7	1.8	0.2%	18.4	2.2%	66.9	8.1%
Small IPStream	1,074.6	3.0	0.3%	25.7	2.4%	97.5	9.1%

This reflects the fact that network costs scale with usage as more BT Centrals are required to satisfy aggregate demand – unlike LLU providers, IPStream providers do not benefit from economies of scale in the backhaul. Therefore, cost per sub per month increases over time compared to the counterfactual as bandwidth demand increases. This difference in cost per sub per month is illustrated below.

Exhibit 57: IPStream ISPs: Cost per sub per month, Counterfactual compared to Canvas high case



In the high case, a small ISP could incur an additional monthly cost per subscriber by 2015 of £3.79 (a 13.8% increase). For a medium and large ISP, this additional cost per subscriber would be between £2.58-£2.60 (12.7%-12.9% increase).

If these costs were to be passed on to the subscriber, whether only to Canvas users or spread across the customer base, it would make broadband from IPStream ISPs significantly more expensive than LLU. However, it is clear based on discussions with ISPs that it is generally accepted that it will be economically and competitively difficult to use IPstream products to support VoD streaming services, therefore additional products may be needed.

7.7.3 WBC

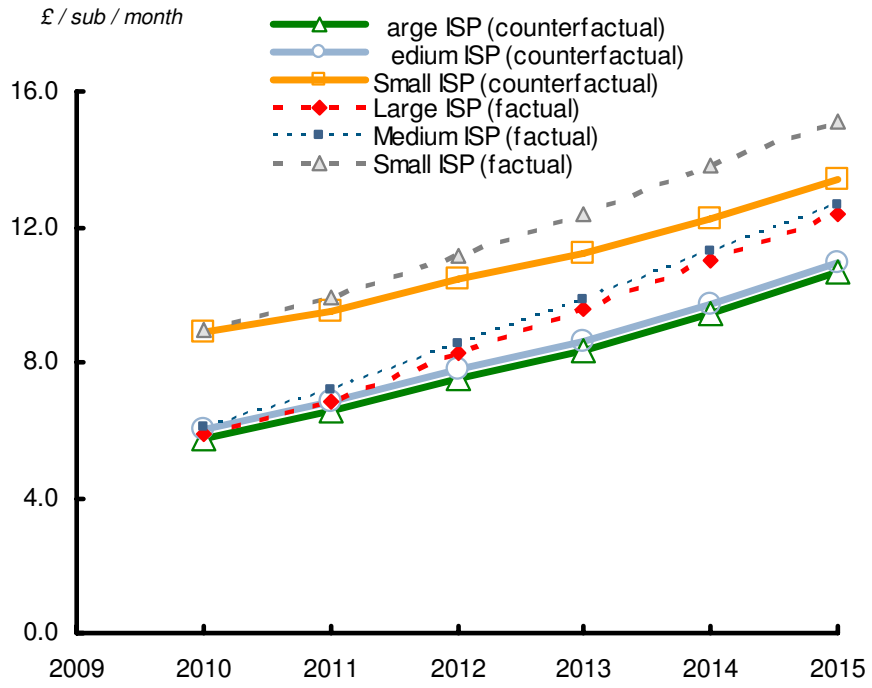
Based on the assumption that WBC charges remain constant, Canvas is expected to have a moderate impact on ISPs providing broadband using WBC. The six year NPV impact ranges from £5.2 – £45.3, an increase ranging from under 1% up to c.11%.

Exhibit 58: Six year per subscriber NPV of increase in WBC costs due to Canvas

	Counterfactual	Canvas Low case		Canvas Base case		Canvas High case	
	£	£	% diff	£	% diff	£	% diff
Large WBC	405.9	5.5	1.4%	15.2	3.8%	45.3	11.2%
Medium WBC	420.6	5.6	1.3%	15.2	3.6%	45.1	10.7%
Small WBC	559.2	5.2	0.9%	14.4	2.6%	44.2	7.9%

WBC charges are likely to continue to scale with aggregate backhaul usage; therefore the increase in bandwidth resulting from the introduction of Canvas would increase costs per subscriber for a WBC ISP. By 2015, the increase in cost per subscriber per month as a result of Canvas would range from £1.68 for a small ISP to £1.75 for a large ISP (an increase of between 12% and 16%).

Exhibit 59: WBC ISPs: Cost per sub per month, Counterfactual compared to Canvas high case



7.8 Impact on ISPs

The impact of Canvas on individual ISPs depends on a number of factors. The key decision is how they want to support Canvas. In principle this is either as an Over The Top Internet service or as a managed customer experience. In addition the rollout of new wholesale products such as WBC, WBMC, FTTC, offers alternative

cost models as does the opportunity for further investment in unbundling. But some general principles can be noted:

- As traffic grows, supporting Canvas, or any video streaming services, using IPStream becomes economically unattractive
- ISPs may have the option of moving to WBC / WBMC, if it has been rolled out to that particular area
- LLU based operators have the economies of scale in their backhaul network to support significant additional volumes of traffic economically
- Alternatively, the business case for LLU may become more attractive given the widening difference in cost between IPStream and LLU, together with growing broadband take-up. Thus the business case for unbundling exchanges which have previously been regarded as uneconomic could be reconsidered.
- It could encourage migration to FTTC. While it is not essential to support Canvas, or other VoD platform streaming in SD or HD, FTTC may provide greater bandwidth to the entire household allowing other internet users to use services while VoD users are streaming
- Canvas would not be the reason for ISPs changing their wholesale models, but it could accelerate the timing of such decisions.

As such, any discussion on the direct network cost impacts on major ISPs is just a reflection of one option for their business model,:

- BT Retail: BT Retail currently provides broadband using IPStream only. As such, if it continues to use IPStream, growth in peak traffic will lead to a very significant rise in its cost base relative to today, even in the counterfactual. This will be unsustainable, especially in those regions where there are competitive alternatives. Therefore, it is likely that BT Retail will migrate away from IPstream to WBC, where it is available, for much of its internet provision.
- As an alternative, BT Wholesale is developing a number of solutions to support content delivery and offer a managed service to the customer, such as WCC, but these are still under development.
- Talk Talk: Currently, including its acquisition of Tiscali, approximately 70% of Talk Talk's subscribers are based on LLU and the remainder on IPStream. For those customers on LLU, Talk Talk will face limited network cost pressures as traffic volumes grow. For IPstream customers the costs will increase significantly, and there are therefore clear drivers to migrate to more scalable, cost effective wholesale models, either Talk Talk's existing LLU network or potentially WBC. Overall, given the balance of customers, the impact of Canvas on Talk Talk is likely to be a small increase in cost per subscriber relative to the counterfactual.
- Sky: As for Talk Talk, approximately 70% of Sky's subscribers are provisioned using LLU and the remainder provisioned using IPStream. Therefore if they choose to support Canvas they are in a similar position to Talk Talk. However, Sky has stated clear plans to launch its own Internet based video demand services, using its own platforms, Darwin and Sky Player, irrespective of Canvas. As a result the direct impact of Canvas on Sky's network would be very limited compared to the counterfactual
- Orange: It is estimated that 40% of Orange's fixed broadband subscriber base are on LLU, with the remainder on IPStream. Additionally, Orange's scale is such that it would have fewer customers per exchange (ie 'small LLU' exchanges) and thus enjoy fewer economies of scale for LLU. The choices are similar to the other operators, but lack of scale may change the commercial drivers
- O2: O2 have focussed their broadband on those areas where they have unbundled exchanges. As such, they are likely to face the least direct incremental costs due to Canvas.
- Virgin: The network cost impact of Canvas on Virgin has been discussed earlier, and as set out in that analysis, will be extremely limited.

Smaller ISPs made up c.4% of the market as at the end of Q4 2008. The impact on these ISPs has been assessed at an indicative level:

- There are a number of small ISPs targeting business and residential broadband users, who differentiate on the service provided and niche products (for example, 'gaming broadband' or 'Homeoffice broadband'), rather than price. In most cases to offer these services these ISPs will either have invested in unbundling capacity or buy LLU capacity from third parties, such as Cable & Wireless. Canvas is therefore unlikely to have a significant impact on their cost per subscriber.
- The impact on small ISPs which do rely on IPStream products may be mitigated by migration to BT wholesale's WBC or WBMC product which would enable them to obtain some of the cost benefits available to other ISPs, without investing in significant network infrastructure. The exact impact of Canvas on cost per subscriber will depend on the evolution of these services and pricing over time. However, it is reasonable to believe that the impact would be limited.
- During the consultation several ISPs raised the issue of additional customer service costs for technical assistance and hardware support. Canvas will undertake the first line customer care for Canvas enabled devices. For other technical issues it is not clear that these will be different to those already faced by ISPs in relation to other devices. In effect, ISPs will have to build such support activities into their business plans. Small ISP's lack of scale may lead to them taking a greater cost burden relative to larger ISPs.

7.9 Impact on different wholesale broadband markets

As discussed in Section 4, Ofcom has identified four distinct geographical wholesale broadband markets in the UK. Of these, Market 1, where BT is the only operator (16.4% of UK premises in 2008), and Market 2, where there are 2 or 3 operators (13.7% of premises in 2008) are the areas most likely to be where LLU is not currently economic to deploy and therefore where provision of broadband using IPStream is the only option. Market 3, where there are 4 or more operators (69.2% of premises in 2008), would have healthy competition between LLU, IPStream and potentially cable operators.

The availability and impact of Canvas on these different wholesale broadband markets depends on:

- The coverage of new wholesale products such as WBC / WBMC and how fast they are rolled out
- The changing economics of unbundling exchanges, and ISP decisions around further investment in LLU
- The coverage and price of any wholesale managed content services eg BT's WCC

However as ISPs are using the same range of wholesale products to support their services, we do not see that the launch of Canvas changes the competitive dynamics in any of the regional markets.

8 Potential remedies to manage impact of growth in VoD on network costs and customer experience

As outlined in the previous sections in both the counterfactual and Canvas scenarios all ISPs will experience significant growth in network traffic due primarily to the increase in video traffic. The model has shown that in theory an over the top model has limited cost impacts for LLU provider, but significant cost implications for ISPs based on IPstream.

To date most internet services are offered on a 'best efforts' basis, with most catch up TV propositions such as BBC iPlayer competing with other internet traffic known as 'over the top' delivery. In practice this can lead to variability in the customer experience, especially in peak hour.

Canvas, and other TV VoD services are expecting to complement, or substitute, consumers' existing viewing behaviour and from discussions with stakeholders providing a TV quality viewing experience is seen as a key part of their proposition. This implies a continuous video stream, without interruptions, and clear high quality picture with minimum infractions (imperfections in the picture).

The previous sections showed that the impact of Canvas in terms of traffic growth over and above the counterfactual scenario is not significant. However, as Canvas is designed as a TV services, issues of quality and customer experience are likely to be major concerns for customer, ISPs and content owners.

There are a number of possible strategies that could be deployed by ISPs to mitigate the cost increases and potential quality of service (QoS) issues. These fall into three areas:

- Encouraging more efficient use of the available network capacity: e.g. via traffic shaping, or deployment of a content delivery network (CDN) involving caching within an ISPs network
- Collaborating with content providers to minimise the traffic generated by VoD: eg by encouraging deployment of improved compression Codecs ; intelligent use of push VoD services; managing the customer experience , via CDN and other QoS solutions, and sharing the costs of the service
- Developing specific VoD commercial propositions for customers: e.g. offering 'Internet TV' services with a guarantee of experience at a premium price, or managing their expectations and only streaming if bandwidth allows

Several of these initiatives are already deployed or under discussion and from conversations with ISPs it is likely that some or all of these techniques may be deployed.

8.1 Efficient use of network capacity

By actively managing traffic loading, ISPs can decrease their network's peak bandwidth requirement, therefore reducing the amount of additional capacity, primarily in backhaul, provision that is required. There are two main possibilities for ISPs to manage the peak hour traffic demand on their networks, namely, traffic shaping and use of Content Delivery Networks (CDNs).

8.1.1 Traffic shaping

Traffic shaping involves the management of network traffic in order to optimise or guarantee performance and increase available bandwidth. It provides a means to control the volume of traffic being sent into a network in a specified period or the maximum rate at which the traffic is sent, also referred to as bandwidth throttling and

rate limiting. Traffic shaping is typically targeted at non-time critical content, such as P2P file sharing traffic to make more capacity available for time critical content, such as video.

By targeting P2P traffic, operators have been able to significantly reduce peak hour share of traffic. , Carphone Warehouse, who introduced Traffic shaping tools in 2008, reported reductions in the share of traffic due to P2P from 25% to 4% a reduction of over 80%. Most ISPs have introduced the necessary tools to support traffic shaping and employ this approach to some extent.

8.1.2 CDNs

A Content Delivery Network (CDN) is a system of intelligent caching and network storage, which stores content closer to the end user so that the data does not have to be sent across key elements of the network each time it is viewed. This can both improve the customer viewing experience and responsiveness, and reduce the peak hour capacity needed at various levels in the network.

There are already a number of CDN providers in the UK market, such as Akamai, Limelight and others. They provide services to a number of major content providers such as the BBC but at the moment their content caching is at the 'edge' of the ISPs network. As a result these CDNs can save IP transit costs for content providers but do not have an impact on network costs for ISPs

BT Wholesale is planning to launch a CDN solution, Wholesale Content Connect (WCC), in Q4 2009, where they would install caches at 20 broadband remote access servers (BRAS) across the network. By deploying CDNs downstream from the ISPs own networks, BT Wholesale believes that the WCC product would save ISPs 50% of traffic related costs due to the decrease in the amount of traffic travelling across the network. BT Wholesale sees WCC as an important enabler of Canvas, believing that the majority of Canvas users on non-LLU networks would access content through this product. However, the product is still being developed and the results of trials will not be available until the end of this year.

It is theoretically possible that CDNs could be placed even deeper into the network, in local exchanges rather than BRAS. However, the current network architecture of most broadband networks would likely make it difficult to locate CDN servers at the local exchange due to the position of the BRAS.

The commercial drivers for an ISP to use a CDN will also differ between ISPs. If the major attraction is reduction in peak backhaul capacity the CDN must be able to offer a price, typically charged per GB of video distributed, that compares favourably to the network costs saved by an ISP. Given the relative backhaul cost structures of IPstream and LLU operators the price at which CDNs become cost effective could be significantly different for different ISPs.

8.2 Collaboration with Content Providers

8.2.1 Encouraging use of Compression

Improving the compression of video files can significantly reduce the bandwidth required for video services. Whilst it is traditionally content providers that determine the encoding, quality and hence bandwidth requirements of their content, ISPs could work with these providers to adopt improved compression standards to decrease the bandwidth required. This has benefits for content providers by increasing the quality of the viewing experience and the reach of their services.

Compression technology continues to evolve so that content can be compressed into a low bit-rate stream without significant impact on quality. Any increase within compression standards will vary depending on equipment and technology currently used. While MPEG4 is still in its infancy there have already been rapid

developments in the compression equipment that supports it and it is likely there will be further improvements over time.

However, it should be noted that improvements in compression, don't necessarily translate into reductions in overall network traffic. This can also drive demand as more users will have the bandwidth to view certain types of content.

8.2.2 Use of bit rate switching

It is possible for content providers to code in multiple bit rates and trade quality of picture with continuity of the stream. As an example, currently the BBC streams its iPlayer service at 3 possible bit rates, 1.5 Mbps, 800kbps, 500kbps. The player detects the available bandwidth and streams at the highest possible bit rate. If during the stream the available bandwidth drops below the necessary level the stream switches to a lower bit rate stream. The viewer may see some reduction in quality of the picture, but is likely to maintain the continuity of the programme.

8.2.3 Supporting Push VoD services

One option to reduce peak hour traffic is for the most popular content to be stored locally on a customers' hard drive. This could be based on popular titles across all categories, or using some intelligence based on the customer's recent viewing habits. It is possible for ISPs to collaborate with content providers in this, possibly by sharing their own insights into customer behaviour, or to encourage content providers to adopt this approach independently. Given that part of the Canvas proposition is for all boxes to have local storage for PVR functionality the use of Push VoD via Canvas will have a major impact on the peak bandwidth requirements. This has been allowed for in the modelling when calculation of volumes of Video that are actually streamed in peak hour..

8.2.4 Progressive download

Progressive downloading can be used when a broadband connection is too slow to stream at the required rate. The video file starts downloading in the background and only starts to play when enough of the file is downloaded to provide an uninterrupted viewing experience.

Progressive download technologies could help to provide a reasonable audience viewing experience on connections which are slightly too slow, or where speeds achieved are vary significantly due to other users sharing backhaul capacity. It is already deployed by some existing VoD services in the UK.

8.2.5 Download services

A download service could be offered to viewers who are unable to stream content. Download would occur during off-peak internet times, and therefore it would not stress network capacity. Based on experiences from iPlayer and 4OD, this is likely to only be attractive to customers whose connections are very slow and are unable to stream content.

8.2.6 Managed Quality of Service

As discussed previously techniques such as improved compression can be deployed to ensure the quality of TV experience. In addition improvements in buffering technology and solutions such as 'bit-rate switching' are already being deployed in order to smooth out any small fluctuations in available bandwidth whilst retaining a good viewing experience. However, if available bandwidth is not sufficient, or subject to enough fluctuations that it interrupts the viewing experience, an 'over the top' approach to delivery may not be sufficient

A managed quality of service offer can guarantee the end user experience through a number of solutions. BT Wholesale currently offers a numbers of quality of service products over both IPstream and WBC, and is also developing its WCC product discussed above. Other providers may also develop CDNs offering caching services at some level in the network. By combining a number of these products, and other network management tools an ISP can develop a QoS guarantee.

There are several possible commercial models for a managed service. They could be provided for specific programme or period of time, eg a Pay per view Sports event, or for all a customers' consumption of VoD if they subscribe to specific package; or even just for specific programmes where the content provider wanted to ensure viewing experience, eg to promote an event. The costs of such quality of service products could be carried by the ISP, the end customer or the content provider or some combination.

8.3 Developing Consumer VoD Propositions

8.3.1 Managing customer expectations

Depending on how VoD services such as Canvas are to be positioned to the customer, there are a number of network related features that can be developed so that the customer has a clear expectation of the experience they will receive. These could include a basic initial 'line rating' that informed the customer whether their broadband service could support to Canvas at SD or HD, and therefore whether they should purchase a Canvas enabled STB. In addition once purchased basic line speed checks could tell customers whether at certain times of day streaming is available, or whether alternative delivery models such as progressive download would offer a better viewing experience.

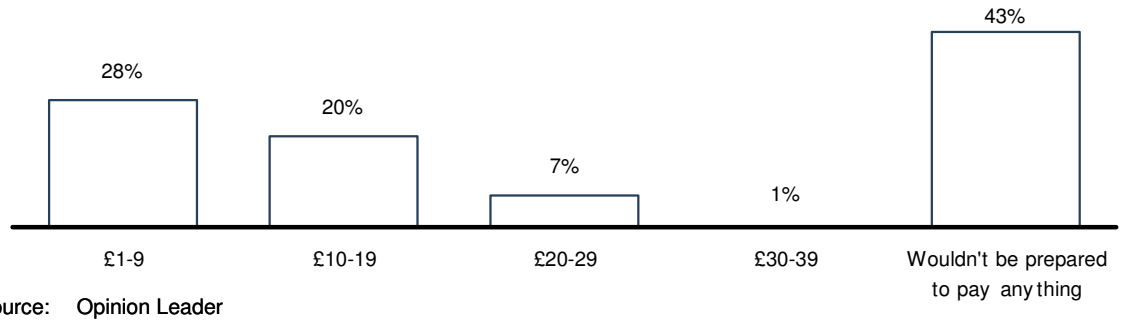
A number of ISPs expressed concern about the increased role of their own customer service teams in supporting Canvas. They argued that if customers needed advice in setting up Canvas devices, or found the viewing experience not as they expected a significant number would contact their ISP, even if no Canvas specific service had been offered. They recognised that managing customer expectations should help reduce this impact, but were concerned about the potential brand impact. ISPs did accept that if they were to offer a specific Canvas based service, as many now intend to do, customer support costs would be part of their overall commercial business case. It is also now clear that Canvas will undertake the first line customer care for Canvas enabled devices. Therefore the technical calls expected by ISPs should be no different to those already faced in relation to other devices. As a result incremental customer support costs have not been explicitly modelled.

8.3.2 Creating Canvas Specific Packages

Several ISPs discussed the possibility of developing specific Canvas enabled broadband package for a premium price. These could either positioned as 'a higher bandwidth service' to offer Canvas as an over the top product., or with a guarantee of the viewing experience based on a number of the managed service propositions described above.

In discussions with ISPs during the consultation, an increased price of £5 per month was mentioned as a possible price point. Based on consumer research, an estimated 56% of consumers would be prepared to pay an additional monthly fee for Canvas.

Exhibit 60: Additional broadband spend consumers would be prepared to pay for Canvas[25]



Source: Opinion Leader

All these techniques are currently deployed or under development to meet the demands of VoD services. Users of the Canvas platform will be able to exploit them as needed to meet the commercial requirements.

[25] In response to the question: 'what additionally would you be prepared to pay per month to upgrade your internet connection?'

9 Conclusion

Internet traffic, and particularly video traffic, will continue to grow significantly in the coming years. There are a number of platforms coming to market that will support the delivery of video on demand services to the TV, and Canvas is just one of these. Given market research and evidence to date it is likely that VoD to the TV will be adopted widely. Therefore if Canvas is launched it will not fundamentally change the dynamics of this market but it will accelerate the adoption of these services.

The forecast growth in traffic highlights major differences in the cost structures of alternative wholesale models for ADSL broadband. With LLU, and to an extent WBC, offering significant advantages in terms of economies of scale with growing traffic compared to IPstream, there is likely be further migration to LLU, and to WBC where possible. It is unclear if ISPs based on IPstream will be able to dimension their networks to support full VoD to the TV and pass these costs to customers. Therefore those areas of the UK where only IPstream services are offered may not be able to receive the full range of Canvas functionality. However, for all technologies, the impact of Canvas on network costs is minimal.

It is unclear whether Canvas will be predominantly offered as an 'over the top' Internet enabled VoD service, with the necessary limits of quality that that might entail. Or whether a premium, QoS based proposition will prove more popular. Since Canvas has been positioned as a TV service, ISPs, and content owners, may want to build their commercial proposition around the quality of the experience. If they do there are a number of tools open to ISPs, to manage bandwidth and ensure a guaranteed quality of service to the customer. How the costs of these services will ultimately be shared between end customers, ISPs and content owners remains unclear.

In conclusion there are no major network cost implications arising from the launch of Canvas in the UK.

Contact information

Value Partners Management Consulting Limited
Greencoat House
Francis Street
London SW1P 1DH
United Kingdom
Telephone: +44 (0)20 7630 1400
Facsimile: +44 (0)20 7630 7011

dan.kirk@valuepartners.com
kim.chua@valuepartners.com
gaurav.bhatnagar@valuepartners.com

Value Partners Group
http://www.valuepartners.com

