Broadband Infrastructure: The Service and Application Providers' View

VALUE PARTNERS

MANAGEMENT CONSULTING

BSG

Broadband Stakeholder Group

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Contents

■ Acknowledgements

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■ Foreword by the BSG

This report looks at the current and future performance of UK broadband networks from the perspective of those who offer services and applications over the internet in the UK today.

Both the BSG and Value Partners believe that this service and application provider perspective has been overlooked in many of the studies and reports published on broadband networks in recent years. We therefore decided to undertake this brief study in order to shed more light on their experience and views about the capabilities of today's networks and the implications of future investment in next generation broadband.

To do this we conducted 19 interviews with representatives from major content providers, e-commerce sites and those providing internet-based applications. We are very grateful for their time and contribution, without which this report would not have been possible.

The report sets out their views on UK broadband networks; some indicative conclusions about common concerns; and some case studies of what services these companies are offering or intend to in the medium to longer term; and how these may impact on or benefit from investment in next generation broadband networks.

Although this report is based on a small sample of interviewees and is not therefore intended to provide the definitive analysis on the subject, we believe it has thrown up some interesting and timely conclusions:

- Application and service providers are increasingly concerned about their ability to provide end to end quality of service to their customers. However there are many factors that inhibit this end to end performance. Very few interviewees regarded last mile bandwidth as the most significant constraint to innovation today, with many being concerned about other limitations, such as the prevalence of outdated web browsers on their customers' PCs.

- However, as consumer demand for and expectations of data rich services continue to grow bandwidth is expected to become a constraint in the medium term and there is some nascent concern that this could lead to a battle for bandwidth emerging in the next 18-24 months as service and applications providers seek out opportunities to deliver better end to end performance.

- Current investments in next generation broadband therefore appear well timed, with all of the respondents expecting that next generation broadband will spur innovation and that they will quickly find new ways to use the additional bandwidth to deliver new, improved and enhanced services.

In the short term this study suggests that bandwidth is not the only constraint on quality of service. Indeed a whole range of factors across the network have a bearing on the capability to deliver the level of service we expect consumers to demand.
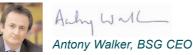
In the medium term the desire of some service and applications providers to provide managed end to end quality of service is likely to raise concerns about net neutrality. This report suggests that Ofcom's Chief Executive Ed Richards was right to warn recently that this issue needs to be looked at more closely in the UK.

In the longer term this report suggests that there will be strong demand for next generation broadband and that when it is delivered service and applications providers will quickly start to innovate to deliver a next generation of services and applications.

Kip Meek, BSG Chairman

Antony Walker, BSG CEO

■ Executive Summary

In recent years there has been a wide debate in the UK on the need for, and timing of, Next Generation Networks and the models for funding and delivering them. Yet within this debate there has been little contribution from the companies who provide their content, applications and services ("service providers") to customers over the web. Even though, ultimately, it is what they offer to customers that will determine the need for and value of these networks.

This White Paper is therefore intended to contribute to the wider debate by capturing the requirements service providers have from the broadband infrastructure in the UK. Our intention was to understand how the current capabilities of this infrastructure affect what service providers can deliver today; how they think this will change in the near term; and to understand what services they believe customers will use when Next Generation Networks are deployed.

Unsurprisingly, for all the service providers we interviewed their number one concern was the customer experience. Frustrating delays and poorly designed sites that take too long to load lose customer attention. While traditionally the internet has delivered services on a 'best efforts' basis, customers are becoming increasingly demanding and can easily click away to a competing service.

More surprisingly, we found that few of the interviewees said that the most important limit of their customers' experience was last mile broadband speed. Concerns were raised about a wide range of pinch points including browser capabilities, 'in home wiring', peering capacity, connections to hosting facilities as well as contention in the broadband network. In fact, the biggest surprise was how few of our interviewees actually had a clear understanding, end to end, of what was affecting the final experience their customers received.

The reality of the multiple pinch points in today's broadband infrastructure is that most service providers have to adapt their offer to work within uncertain end to end delivery conditions. Solutions range from offering simple 'lite' versions of sites and staggering the launch of richer applications, through to the more complex 'adaptive bit-rate' switching solutions deployed by some content providers.

While most of the service providers expressed themselves as 'broadly satisfied' with the networks today, there was widely held concern about how delivery infrastructure would perform in the next few years. Two key trends are emerging. First, the interviewees believed inexorable growth in traffic would lead to a 'competition for bandwidth' at various points in the delivery infrastructure. Secondly, consumers are starting to demand - and service providers want to offer - a guaranteed customer experience.

Several of the smaller service providers, and some of the larger content providers, were worried about how scarce bandwidth would be allocated, and whether new charging models would limit their ability to compete. But equally, many interviewees stressed how for services such as Internet TV, and business critical applications delivered via the 'Cloud', the traditional internet 'best efforts' model would not be enough. Several providers were already considering how best to provide a guaranteed service quality.

When we asked the interviewees to look ahead to a world where Next Generation Networks were widely deployed, we heard two consistent messages. First, everyone was convinced that these networks would be exploited and fully utilised. There was a broad consensus that consumer demand will grow and service providers will develop their offers to exploit available speeds. But, secondly, no-one was currently developing plans to exploit these faster capabilities. It is only when these networks are widely deployed that service providers anticipate they will make the investments to develop the next generation of applications and services to fully utilise them.

Although our interviewees are not yet investing in new services, they did share common views on how Next Generation Networks might be used. These included richer high definition quality video content; enhanced collaboration tools and user generated content exploiting uplink capabilities; and a much wider use of video interaction for meetings,

medical diagnosis and personal communication. While none of these ideas are radically new, all our interviewees felt that if delivered as a reliable end to end quality proposition, they would have a major impact on consumers' lives.

In Value Partners' view these trends have fundamental implications for the model of the internet to date. While we see continued refinements in infrastructure performance and further investment in network infrastructure as inevitable, and welcome, we do not believe that on their own they will be enough to meet consumers' demands. Web based services are now becoming a mainstream and essential part of everyday business and personal life. These now require guaranteed end to end performance across the delivery infrastructure. Consumers will expect this and assume they have paid for this when they buy a service - service providers must respond by offering this, and infrastructure providers and their partners must start to support this.

■ Introduction

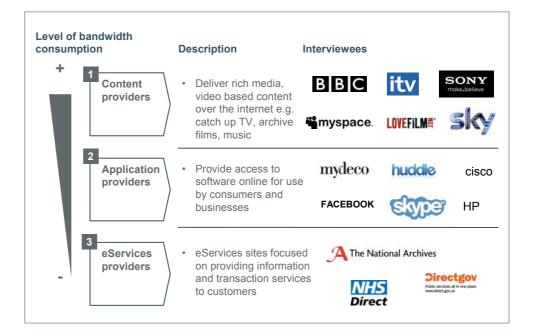## Scope and purpose of the study

To date, the debate on broadband provision in the UK has tended to focus on the network speeds available, either advertised or delivered. Value Partners and the Broadband Stakeholder Group were motivated to undertake this study as the voices of the content and application providers who provide services over this delivery infrastructure have, to a large extent, been missing from this debate. We have focused on understanding how the capabilities of the current infrastructure affect what service providers can deliver today; how they think this will change in the near term; and to understand what services they believe customers will use when Next Generation Networks are finally deployed. To do this, we have interviewed a small, but representative sample of consumer and small business focused content, application and e-service providers ("service providers").

Our objectives for this study were:

- To provide insight into the service providers' perspective on features of the delivery infrastructure that are important today, and understand whether they believe current broadband networks in the UK are meeting these requirements

- To showcase, if planned, the future possible applications and services that are likely to come to market and understand how the planned Next Generation Networks will influence these

This report has been compiled for key stakeholders in the broadband industry: policy makers, the ISP community, hardware and software developers, and content and applications providers. This White Paper sets out the views of our interviewees, and draws some initial conclusions on the matters discussed. It is intended to stimulate debate rather than provide a comprehensive analysis.

Interviews

Structure of the White Paper

This report draws together the findings from the completed interview programme. We asked our interviewees three broad questions. The structure of the White Paper draws together the views that we heard, and our initial conclusions on implications for the industry.

- **Today:** How do existing broadband networks serve the needs of your current range of services, and how are they performing against your requirements?

- **Tomorrow:** Over the next 12-24 months, what services do you plan to bring to market and what improvements on existing broadband networks would be needed support these plans?

- **Next generation future:** given future network capability (e.g. 50-60% of premises passed with downlink speeds capable of 20Mbps and uplink speeds of 2-5Mbps), what application and service developments could be possible?

■ Today

Summary

For all service providers, user experience is central. Until now, most consumers have understood that internet services are delivered on a 'best efforts' basis. But that is changing - for some customers and services, particularly rich content such as video 'best efforts' delivery is not good enough. Although the current delivery infrastructure is seen as broadly meeting service provider needs, there are multiple pinch points across the delivery infrastructure that can affect the user experience. As a result most service providers invest time and effort in managing the delivery of their product to account for inconsistency in 'end to end' delivery. In Value Partners' view, there is a timely opportunity for greater industry collaboration to identify the bottlenecks across the delivery infrastructure, and take steps to address them.
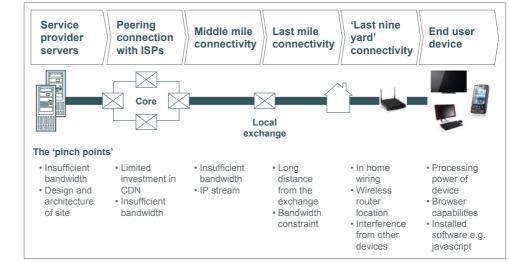
The user experience is central

Delivering a high quality user experience was a clear priority for all services providers. For all interviewees, the internet is a crucial, and for some the only, channel for interaction with their customers. The user experience online is therefore not just a way to encourage a specific transaction but a key driver of brand performance, encouraging customers to visit more often, and spend longer online. As a result, significant time and effort has been invested to optimise the quality of the consumer experience.

Common elements of a good user experience, cited by interviewees, included a swift site launch, an uninterrupted browsing session (i.e. no page freezes or crashes), intuitive navigation around the site and consistent playout of any video content. Several interviewees commented that customers are increasingly intolerant of a poor experience. As 'switching' costs between sites are minimal, this can be a source of competitive disadvantage. However, service providers prioritised different elements of the user experience. For content providers, consistent playout of video content was identified as a key priority; e-service providers proved to be more focused on in-site navigation, reflecting the type of customer interaction.

Many of the service providers highlighted the trade-off between customer reach and the richness of the content and features they offer. For these providers, typically offering customer services or information, a simple clear presentation of information accessible over multiple devices and the widest network footprint was more important than offering richer content. For public sector service providers, reach was particularly important reflecting their greater emphasis on universality of access.

There are multiple pinch points in the delivery infrastructure

Interviewees invested significant resources in those areas of the end to end delivery infrastructure where they had direct control. However, there are multiple pinch points that were identified as potentially disruptive to the customer experience. Interviewees identified six stages where problems can commonly arise: site design and architecture; connectivity to their hosting facility; peering connection onto an ISP's network; middle mile connectivity; last mile connectivity; 'last nine yard' connectivity (i.e. into the consumer device); and, the end user device.

Six stages of the delivery infrastructure

Service provider servers	Peering connection with ISPs	Middle mile connectivity	Last mile connectivity	'Last nine yard' connectivity	End user device

The 'pinch points'

• Insufficient bandwidth • Design and architecture of site	• Limited investment in CDN • Insufficient bandwidth	• Insufficient bandwidth • IP stream	• Long distance from the exchange • Bandwidth constraint	• In home wiring • Wireless router location • Interference from other devices	• Processing power of device • Browser capabilities • Installed software e.g. javascript

Sufficient bandwidth in the middle mile and last mile is critical to ensure that the end user experience does not suffer degradation. However, to guarantee customer experience, all six elements of the delivery infrastructure must work effectively - focusing on bandwidth provision alone is not enough.

The interviewees clearly recognised that where bandwidth is constrained or other elements of the delivery infrastructure are not optimised, the user experience can suffer. But they also commented that to address these issues, the pinch point, or points, inhibiting performance must be identified. Only a very few of the interviewees currently had systems in place and resources dedicated to monitoring and understanding what was happening to a customer's experience end to end. Most of them focused only on the elements under their direct control such as how customers moved through their site or the speed of playout from their hosting facility.

Several interviewees commented that even with greater visibility over the causes of disruption, it is difficult to address all the issues, as no single party in the delivery chain has responsibility for managing the end to end performance. In particular, the smaller service providers argued that they did not have the resources or the ability to influence other elements of the delivery infrastructure. Only a few of the larger interviewees had taken direct measures to identify the pinch points and address them.

BSkyB conducted a survey of their customer base and found that a significant proportion of their customers were experiencing maximum data rates well below those anticipated. A number of home visits enabled Sky to identify some common problems caused by the in-home set-up of broadband access:

- *the use of extension cables or wireless routing through walls that degraded the signal*
- *interference from common in home equipment, e.g. microwaves, cordless phones which can further reduce capacity*

Sky now offers customers simple instructions on broadband set up to ensure they get the maximum performance from their networks.

Several interviewees expressed concern that as end customers are typically unaware of the complexity of the delivery infrastructure, they are likely to channel frustration with a poor experience towards the brands they can clearly identify, such as either the service providers themselves or the customers' own ISP.

The current delivery infrastructure is broadly meeting service provider needs

Despite the number of pinch points in end to end delivery, most interviewees described themselves as 'broadly satisfied' with the current performance of the delivery infrastructure in the UK. For most service providers, most of the time, the bandwidth requirements for delivering their services are being met.

In fact, all interviewees had roadmaps in place for additional features and services they intended to offer, generally involving richer content such as video, animation and higher quality graphics. However, all new services are planned and designed within the constraints of the current infrastructure. Several providers noted that while they were continuing to develop and innovate, there were some services they would not be launching given the anticipated poor experience over today's infrastructure.

And, despite expressing broad satisfaction with current infrastructure, most of our interviewees were deploying measures to mitigate against the impact of pinch points on user experience, particularly to cope with variations in demand and end to end capacity. These include:

• *managing the order in which the elements on a site load onto a customer's device:* basic information to start a session comes into view rapidly, while richer content and applications progressively load in the background. This minimises the risks of customers losing interest and clicking away from a site

• *running 'lite' versions of key content to adjust to delivery constraints:* for example, if there are spikes in visits to a site due to a particular promotion, or customer care issue, then bottlenecks can arise in the connectivity to a site's hosting location. A 'lite' version of the site ensures that most customers can at least get access to a basic level of information

• *adaptive bit rate solutions for content playout:* these actively monitor end to end available data rates and switch to the appropriate quality video stream to ensure the customer receives a continuous viewing experience

Although techniques such as these are widely deployed, several service providers commented that building these approaches into their web sites caused a burden in terms of time and effort.

Interestingly, even though all the service providers we interviewed claimed they were able to meet their customers' needs within the constraints of the current infrastructure, many noted that this is because today's customers accept that the internet works on a 'best efforts basis'. And there are clearly significant differences between service providers in the extent to which they believe their customers will continue to accept such a variable quality of service.

a) E-service providers

For the 'e-service' providers, the web offer they want to present to their customers is rarely constrained as a result of insufficient bandwidth. For these organisations, the internet is a channel to provide information, sales transactions and customer care. The majority of this is presented via text and graphical images. As a result, these providers were more focused on the ease of navigation within their sites so that the user journey is intuitive and customers can easily find the information and services they are looking for. For public sector sites, significant emphasis was placed on maximising reach by managing the site so that it could adapt to different speeds, literacy levels, and any disabilities of end users.

Directgov
Public services all in one place
www.direct.gov.uk

- *Directgov makes it easier to access essential government information and services when you need them via the internet, TV and mobile*
- *It provides a digital service, shaped and driven by the public and supports the 'Smarter Government' objective which is to make 100% of Government transactions available online by 2014*
- *Up to 12.5 million adults in the UK are digitally excluded; 6 million of which are both socially and digitally excluded* and may not be able to take advantage of online government services and benefits available to them, therefore Directgov has recognised that steps need to be taken to provide access to services and information via other means*

* This figure can vary from source to source

b) Application providers

For application providers, the current delivery infrastructure proved more of a constraint. Concerns were expressed across the delivery chain ranging from lack of capacity in the wider broadband network, poor in-home wiring and the processing and graphics capabilities of home PCs. All these affect the quality of customer experience that they are able to offer, and the range of customers they can reach. More specifically, some of the community focused providers were concerned about the limitations of 'uplink' speeds. They argued that a typical uplink limit of a few hundred kbps was insufficient given the increasing volume of content that customers wished to share on line.

Unsurprisingly, most of the work from these providers to date has been focused on areas within their direct control, for example optimising their services for delivery on particular types of PC and browser. While many expressed occasional frustration about the performance of the networks, none of those interviewees were actively looking at ways to address any network capacity issues. In part, this was a recognition of their resource limitations which mean that they do not have the scale to deal with multiple ISPs. More widely, it was not held to be a source of competitive disadvantage. Most believed that customers were likely to accept that 'best efforts' meant that more complex functionality may not be effective during busy times, and although this was not ideal, customers would come back at a later date. It was a common view that if their services were constrained then it was likely that other application providers would be offering a similarly constrained experience.

However, several application providers did say that they had delayed launching richer features, such as higher quality video or animation, that could not be used by a wide base of their users. Although they did not place the same focus on universality as the e-service providers, there was a clear trade-off between balancing reach with richness of the content.

mydeco.com

- *MyDeco is a rich media interior design website that enables users to see furniture and interior décor within custom built 3D virtual rooms*

- *MyDeco prioritises the users' experience within the website - for example, shifting development focus towards Javascript, rather than Flash which is incompatible with Apple's mobile internet devices*

- *With low visibility over network performance, MyDeco focuses on developing innovative content for the highest common denominator (a user with access to a fast internet connection, a PC with a fast processor, high quality monitor and compatible image software)*

c) Content providers

Content providers are the most affected by pinch points in the end to end delivery infrastructure, which particularly impact their ability to support long form video content at a higher quality.

Several interviewees noted that the viewing experience for a rich content site is not just dependent on the available bandwidth. These sites require more advanced graphic and processing capabilities on the end user device, and often exploit the features of the latest generation of browsers and video players. As a result there is a significant challenge for these content providers to develop versions of their services that work with a wide customer base. Significant effort is spent to consider how a rich content site will present itself to a consumer and what features and content will be supported given the variability of the end user device capabilities.

- *MySpace has re-launched its music services to reinforce its place as the forum of choice for bands and fans to share content*
- *The speed of site launch is paramount to enable users to engage rapidly and prevent immediate churn therefore MySpace carefully manages the order in which features are loaded*
- *This has to account for the customers' PC and operating system - for MySpace, focus is on understanding how the site launches across the increasing variety of browsers, rather than on the speed of the delivery network*

A common message from the content providers was that consumers are becoming more demanding as they consume more content online. This is especially true for long form content traditionally watched on television. Consumers are less willing to tolerate video playout that is interrupted by repeated buffering. Several content providers observed that click away rates as a result of repeated buffering were increasing.

Unsurprisingly therefore the content providers are the most pro-active in spending the time and effort to identify where the bottlenecks in the network are and to develop solutions either with third parties or independently to bypass them. All our content provider interviewees were engaged in some form of real time monitoring of performance of their services, however there was a substantial variation in the depth and granularity of the monitoring processes used and the level of interaction with ISPs. Again this was largely a function of the relative resources of the content providers.

Managing the bandwidth requirements of the playout of content is a key part of this process. Content providers are taking steps to reduce the bandwidth required by using improved compression technologies so that they can support high picture quality at lower bandwidth. This has a positive impact on the consistency and reliability of the content delivery. In addition, several providers take control of how their content is played out to ensure the customer's viewing experience is uninterrupted. This can be achieved by deploying 'adaptive bit rate' solutions or by offering progressive downloads, with a delay before playout to ensure that the stream will not be interrupted.

BBC iPlayer

The BBC iPlayer team has taken this challenge seriously, and has deployed a number of techniques:

- *Regular improvements in encoding to maximise quality whilst minimising required bandwidth*

- *Deploying "adaptive bit-rate" solutions: this encodes content streams to a number of different bit-rates, and continuously monitors the available bandwidth end to end to a consumer's PC. If the available bandwidth drops below the set threshold, the stream switches to content coded at a lower bit-rate. This means that viewers on a good network connection get a high quality experience, whilst viewers on a poor connection get (as far as possible) an uninterrupted viewing experience at the best video quality that their network can provide*

Challenges to managing performance

All our interviewees recognised the importance of identifying and understanding where the bottlenecks are in the delivery infrastructure. However, two main challenges were highlighted: first, the difficulty of identifying these pinch points; secondly, the difficulty of acting to address them when service providers may not have control over the problem area. Smaller content and application providers were particularly concerned by this. They were unwilling to liaise directly with ISPs as they lacked the time and resource to invest in individual relationships. They were also concerned that methods of mitigating against delivery pinch points, such as bit rate switching, were costly to deploy.

Value Partners' Perspective

To us, these interviews highlighted a positive story of the state of the internet industry in the UK today. There are a wide range of innovative applications and services being offered to customers. Increasingly these are used as part of our every day lives. Current networks and infrastructure are broadly meeting service provider requirements and delivering an acceptable customer experience. And while customer expectations are increasing there is also a greater focus from the industry on delivering a good customer experience

However, this is also where we do see a clear gap in the current market. It is difficult for service providers to have full visibility end to end of problems and 'pinch points' in delivery infrastructure. Even once identified, many of these will be difficult or costly for a service provider, especially smaller providers, to address directly. Yet many of the problems, such as in-home wiring or choice of browser can be relatively simple to address and have a major impact on the customer's experience.

Therefore, in Value Partners' view, there is a timely opportunity for greater industry collaboration. This could range from providing common frameworks and tools to identify end to end problems in delivery through to wider programmes of customer education on how to get the most out of their broadband experience. But ultimately it is clearly in the wider interests of the whole industry to support a better end to end experience for customers.
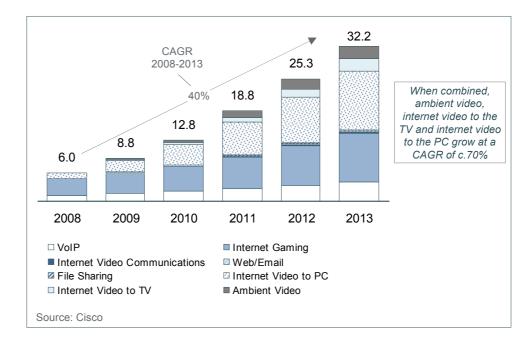
■ Tomorrow

Summary

In the next 18 to 24 months, service providers anticipate that bandwidth demand will rise as usage increases, and content and applications become richer. Consumers will become reliant on internet services for day-to-day functionality such as TV consumption and performance critical business and consumer applications. However, interviewees expressed concern that this will drive a bandwidth crunch. Some are taking action to educate the consumer to upgrade PC and browser capabilities, but recognise that this will not be sufficient to overcome the limitations on available bandwidth. Ensuring end to end guaranteed service quality will remain critical for service delivery in a web dependent world. Greater industry collaboration to help educate the consumer will play a key role in this. But in a fragmented delivery chain, we believe there will be a strong commercial rationale for more guaranteed quality of service offers to provide both consumers and service providers with the security of a high quality end user experience.

Bandwidth demands are going to increase…

It is clear from all interviews that service providers expect continued growth in both overall traffic and in the bandwidth requirements for services. This will be driven by consumers turning to the internet for everyday services, and richer content and applications.

Cisco's Global Consumer Internet Traffic Forecast (000s of Pb/s per month)

CAGR 2008-2013
40%

6.0 8.8 12.8 18.8 25.3 32.2
2008 2009 2010 2011 2012 2013

When combined, ambient video, internet video to the TV and internet video to the PC grow at a CAGR of c.70%

☐ VoIP
■ Internet Video Communications
▨ File Sharing
☐ Internet Video to TV
▨ Internet Gaming
▨ Web/Email
▣ Internet Video to PC
▨ Ambient Video

Source: Cisco

…and consumer expectations will rise

Most interviewees felt that the expectations for the service experience demanded by the user would also increase. In part, this will be driven by the growth in content and richer services which customers will demand to be comparable to the offline experience. And in part, due to the importance of the internet for day-to-day services. As more of these migrate online and users become reliant on the internet as the key channel for consuming services their expectations of quality, consistency and reliability will match those of the current 'physical' channels.

Several interviewees also noted that the type of internet user will change. As services become available across a wider range of platforms - some not even obviously connected to the internet such as TV - later adopters with less willingness to accept the 'best efforts'

performance of a new technology will become mainstream users. If service providers are to meet the needs of these customers alongside ever demanding early adopters, they will need to offer a guaranteed quality of experience.

Interviewees identified the particular importance of guaranteed user experience in two areas:

• Internet TV

• Performance critical applications: business and consumer

a) Internet TV

The growth of video internet services delivered direct to television sets is widely expected to drive demand. The attraction of access to a wide range of catch up content as well as libraries of classic movies and TV programmes will make this a mass appeal service.

The challenge is to deliver this at the same quality as current 'lean back' broadcast TV experience. The size of current TVs and growth in HD content will require the content to be delivered with sufficient resolution to match DVD and broadcast quality.

Project Canvas

• *Project Canvas is a proposed partnership between the BBC, ITV, C4, Five, BT and TalkTalk to build an open internet-connected TV platform. The partners believe that internet-connected TV is the future of home entertainment offering video on demand, public sector services and targeted advertising. Scheduled for launch in 2010 Canvas will support content streams at 1.5 Mbps*

• *Sony is innovating in this space, launching the new web-enabled Sony Bravia TV in 2010 with built-in Wifi for accessing online Sony content and widgets served by Bravia Internet Video*
• *The Sony Bravia TV will provide a 'lean-back' customer experience with access to high quality streaming of over-the-top content including DemandFive's catch-up TV service, LOVEFiLM movie rental and social networking sites*
• *Sony identifies its current role as a content facilitator - it will provide information on minimum broadband speeds but does not anticipate a role engaging in content delivery*

b) Performance critical applications: business and consumer

Tools for collaboration and remote hosted services can drive significant cost and productivity efficiencies. As more users adopt these working and socialising practices, reliable connectivity is essential for service continuity. The application providers developing these services felt that both companies and consumers will be willing to pay for these services, but implicit in that would be an assumption that they were paying for a service with some level of guaranteed performance.

i) Business

One of the most widely discussed trends in the internet industry in recent years has been the potential for 'cloud-based' services, particularly for businesses. These can range from remote data storage and backup of key information through to the running of a wide range of software applications as a remote service. This remote hosting model can provide significant benefits in terms of security, cost efficiencies, flexibility and scalability to businesses both large and small. It can also enable new models of collaborative working between individuals and organisations across different locations, built around online collaboration tools, real time video conferencing and file sharing.

Several application providers that we interviewed are developing propositions to exploit this space. However, one of the challenges is to convince users that 'access' to the Cloud can be consistently reliable. If this can be achieved, they felt that migration to Cloud type models would be rapid and increasingly that customers may not even be aware of the role that web based applications are playing.

However, there were real concerns that the current delivery infrastructure does not yet support this level of performance and reliability other than for dedicated higher capacity business connections. For these services to reach a level of mass take up for home workers and small businesses, customers would need greater assurance of guaranteed consistent performance and higher uplink speeds than are generally available. These are critical to facilitate collaboration, although user hardware and browser capabilities will also be important.

- *Huddle provides access to a hosted suite of online collaboration tools (software as a service) through a network of secure online work spaces - its functionality includes project and document management, remote file sharing and storage, online document creation and editing, group discussion forums and phone and web conferencing*
- *Huddle is working to enhance its 'cloud-based' services by expanding its suite of tools to add real time, high quality video conferencing, instant messaging and integration with existing software like Microsoft's Sharepoint*
- *Huddle is committed to increasing its accessibility across devices focusing on mobile handsets building on its recently launched iPhone App*
- *Huddle anticipate that these developments, combined with increasing end user trust in the reliability of 'cloud-based' services will drive significant growth in usage*

ii) Consumer

Opportunities are not limited to small and medium size businesses. Interviews suggested that these application developments will be adopted by individuals enabling them to participate in real time video conferencing with friends and relatives across the globe. As consumers increasingly rely on these methods of communication, guaranteed quality of service becomes as important as it is for businesses.

- *Skype is a leading provider of Internet communications software that enables users to communicate through free video and voice calls, instant messages or file sharing with other Skype users, and optionally and where possible, low cost calls to landlines and mobiles*
- *Skype has seen strong growth in usage from both consumers and enterprises (with Skype for Business) - in particular, video calls are becoming the communication medium of choice. Currently, video accounts for 35% of all calls and Skype forecast that this will continue to rise significantly*
- *Skype has started to embed the software across a wide range of devices from PCs to HD TVs and mobile devices driving greater usage and end user reliance for its existing products while building a strong user base for high quality video calls, bringing videoconferencing to the living room*

Implications for the delivery infrastructure

a) The battle for bandwidth

There was a widespread concern among our interviewees that, although today the networks had sufficient capacity, in the near term there would be a bandwidth 'crunch'. They were worried that the sheer growth in the number of users, and the amount of usage, would stretch the delivery infrastructure. Although they were less clear where the pinch points would be, most felt that network capacity would be a problem. Specifically many interviewees were worried that the growth in multiple users in the same home would put pressure on the last mile networks.

Smaller application and content providers were particularly concerned that they would be crowded out by the larger players who may be able to play on their scale, or on more established ISP relationships, to secure preferential access to bandwidth. For example, larger players are better placed to invest in driving content deeper into the network through content delivery networks. This represented a real concern that, at time of rising customer expectations, they would face a growing constraint on bandwidth with significant impact on their ability to offer a competitive proposition.

Several interviewees were concerned that the bandwidth crunch could lead to a new model of charging for guaranteed bandwidth. Larger content providers were concerned about the precedent that paying to secure guaranteed delivery would set, but broadly felt that they had sufficient scale to minimise the economic impact of this model. Smaller service providers expressed concern that they would have insufficient scale and financial resources to compete if this model became widespread.

b) Increasing the role of the consumer

Many of the interviewees commented on the role of the consumer in managing the user experience. Pinch points within the home, specifically in-home wiring and PC or browser capabilities, can have a significant impact on the quality of the user experience. Several service providers highlighted that they would be prepared to invest time and effort in consumer education to address these pinch points. Examples suggested by interviewees included stipulating conditions for maximising the user experience such as minimum recommended speed, in-home connection advice, and requirements for PC or browser capability. None of the service providers thought it likely they would move to a model of 'recommending' a specific ISP's network, mainly for reasons of commercial reach. But several commented that there was a key role for the ISP in educating the consumer through more comprehensive set-up support to improve the quality of the end user experience.

One area of particular focus across many interviews was the role of the browser. It was widely acknowledged that ensuring customers had upgraded to a current generation browser could have a significant impact on the speed of service launch and the consistency of delivery. There are also clear benefits for service providers in customers upgrading their browser. The current mix of legacy and new browsers requires service providers to optimise all new service developments to be backwards compatible. This holds back the development cycle and limits the experience of their service among a large proportion of the addressable market.

Current browser developments are focused on improving speed. Most interviewees thought increasing competition between browsers, and heavy investment in marketing, will drive migration to the next generation of browsers. Several service providers thought that widespread deployment of new generation browsers would address many concerns over end to end performance. However, interviewees were on the whole careful to emphasise that upgrading the browser alone would not resolve the bandwidth constraint.

'Browser wars': a comparison of internet browsers

Browser selection is critical

NEW — Windows Internet Explorer 8 — Firefox 3.5 — Google Chrome

Vs.

OLD — (Internet Explorer icon) — (Firefox icon)

• An up-to-date browser is essential for the optimum browsing experience – they provide:
  - Faster loading for web pages
  - Greater security
  - Efficient tabbed browsing

Global browser market share
(% of internet connections)

Legacy browsers: includes IE6, IE7, Firefox below v.3

• Despite this, 39% of consumers still operate a legacy browser

• Service providers recognise the need to stimulate migration
  - Google announced in February 2010, it would withdraw support for legacy browsers

Current browsers: includes IE8, Firefox 3.5, Google Chrome, Safari

39%

61%

Source: Net Applications, Feb 2010

A number of interviewees also believed that there was an opportunity for consumers to take greater control over how services were delivered and how the bandwidth to their home was managed. They argued that if there was a crunch in bandwidth then consumers are best placed to decide which applications and services were prioritised to their home. As an example, one interviewee suggested that in the near term ISPs, or service providers, might be able to offer a facility by which customers could allocate their available bandwidth between services - or set minimum bandwidth for use on a particular application for a particular period. This could help overcome many of the concerns currently held regarding net neutrality.

Value Partners' Perspective

Interviews highlighted to us that the next 18-24 months will be critical for service providers. It is clear that the use of online content and applications will continue to grow rapidly, and play an increasing role in customers everyday lives. A reliable end user experience will therefore become even more important, and potentially a driver of competitive differentiation between service providers.

It is also clear that improvements to the delivery infrastructure will happen as service providers invest mechanisms to improve service delivery. Consumers will also contribute as they refresh PCs and upgrade browsers. But this will not be enough to address the anticipated bandwidth crunch.

In Value Partners' view, end to end management will be essential in order to identify and work around the ongoing multiple pinch points in the delivery infrastructure. We believe that there is a clear opportunity for a commercial proposition to provide a quality assured guaranteed end to end delivery. There are multiple players who could consider operating in this space.

It is clear to us that customer expectations will drive demand for such guaranteed service quality. We envisage that this demand will become more prevalent within the next 18 to 24 months as the bandwidth crunch plays a greater role in the user experience. We also believe that consumers and service providers will be willing to pay in order to guarantee quality of delivery. As a result, commercial models that support the reservation and prioritisation of traffic at key bottlenecks in the network are likely to become more widely available. While we recognise that this is a key part of the ongoing debate on net neutrality, we believe that the reality of demand from both customers and service providers will be the determining factor in how these models develop.

■ Next Generation Future

Summary

When we began this study, we hoped we might find a clearer view of the services and applications planned by service providers to exploit Next Generation Networks. Instead we found that the companies we interviewed were focused solely on the near term, and how to better exploit today's infrastructure. All interviewees were confident that demand would continue to grow with faster networks, but none of them were investing in content or applications to specifically exploit these network capabilities. Service providers' investment priorities will only shift towards innovating to exploit this new network capability once the networks have been deployed and reached critical mass. Although fibre networks will ease constraint in the access network, it is our view that end to end management and guaranteed customer experience will remain a key element of service provision in the next generation world.

Demand will be there …but will follow network build

All our interviewees expected demand for bandwidth to continue to grow in the future. They argued this has been a consistent trend since the beginning of the internet and no-one saw any sign of demand slowing either now or in the foreseeable future.

In addition, there was broad consensus that the rollout of Next Generation Networks would stimulate demand to grow even further. The deployment of faster speeds will remove any last mile bandwidth bottleneck for both downlink and uplink speed, and most service providers saw this as an opportunity to unleash further innovation.

However, currently, none of the interviewees were investing in developing services, applications or content to exploit the Next Generation Networks. This was not due to scepticism about the value of Next Generation Networks. Rather, most interviewees argued that optimising the current and near term user experience was their priority and as a result, they were focusing investment and development effort on exploiting the delivery infrastructure that would be in place for this time period.

There was a general view that investment in content and applications to exploit Next Generation Networks would be stimulated once the networks had reached critical mass. Most interviewees also recognised that Next Generation Networks would not be universal and that they would continue to provide services in a mixed environment. There was broad consensus that managing the customers' experience in this mixed technology world would be one of the challenges in the future.

Interestingly, a number of interviewees expressed doubts about whether Next Generation Access networks would fundamentally change the end to end experience. If greater bandwidth in the access network drives the development of richer services and in turn greater usage, there is a high likelihood of capacity bottlenecks moving to other parts of the delivery infrastructure. While there is always the possibility for continued upgrades in infrastructure, several interviewees suggested there would inevitably be an ongoing role for propositions offering end to end service quality.

Potential services to exploit a Next Generation future

Despite the lack of current investment in services, interviewees were able to visualise several possible developments as a result of access to fibre networks. Primarily, most suggested bigger and bolder versions of existing content and services, but many also made reference to the fact that the next innovation was one that had not yet been conceived.

Potential developments suggested included:

- *Richer downloads:* high quality video content in HD/3D surround sound. While it is true that improving compression techniques will make delivery more achievable, these technologies are bandwidth hungry. If households are attempting to stream or download more than one stream at a time then bandwidth consumption will be extremely high

- *Richer uploads:* opportunities for enhanced user generated content will increase. Interviewees cited examples such as increased citizen journalism, and greater use of high quality video and music on social networking sites

- *Two way communications:* real time high definition video communications will enable increasingly personal interactions. For the public sector, this could drive substantial cost savings if health checks, passport interviews etc could be conducted online

- *The 'unknown':* this captures the widespread view that the real innovation that will drive bandwidth consumption and prove to be the next revolutionary service has yet to be developed

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- *NHS Direct provides 24 hour a day, seven days a week access to a telephone health and advice line and website. The telephone line is staffed by qualified nurses, health advisors and pharmacists. NHS Direct also provides commissioned services which include out of hours GP support, telephone support for patients with long term conditions, pre and post operative support for patients, 24 hour response to health scares and remote clinics and assistance to a number of ambulance services to deal with their category C (non-emergency) telephone calls.*

- *With richer downloads available on Next Generation Networks, NHS Direct could offer access to complex 3D models to provide detailed information to patients and substantially improve telephone nurses ability to diagnose over the phone, reducing doctors visits and ambulance call outs*

- *Real time, HD video conferencing could allow nurses and doctors to provide remote consultations with the same personalisation as a face to face visit. HD picture quality would enable nurses to see the patients and assess symptoms in person, rather than relying on patients' descriptions on the phone*

- *As patient data is inputted onto the digital database, fibre networks will enable medical professionals to tap into this database remotely whether on house visit, on an ambulance call out or in an NHS Direct contact centre*

- *All these developments will improve the speed and accuracy of patient diagnosis and care, while driving considerable cost efficiencies within the health service*

- *LOVEFiLM is Europe's leading film and TV subscription service, delivering thousands of films instantly to the PC and TV and DVD's by post to the home*
- *LOVEFiLM launched online streamed access to a library of over 4,000 new releases and archive movies in 2009*
- *Looking forward, LOVEFiLM see a world where consumers have embraced immersive content, experiencing movies and games in HD, 3D and surround sound*
- *LOVEFiLM will be able to deliver these content and service innovations online to multiple devices, facilitated by symmetric bandwidth and sophisticated devices*

Value Partners' Perspective

In our view, it is both positive and reassuring that service providers expect fibre networks to be deployed and are confident that this will stimulate the development of new services and richer experiences.

We also believe that it is realistic that services to exploit Next Generation Networks are not the focus of product development at the moment. Service providers are concentrated on enhancing and developing what they can deliver over the existing networks and there is clearly more that they can do within the current infrastructure. However, this does mean that the decisions to build and invest in Next Generation Networks will be required ahead of evidence of service innovations to exploit the additional bandwidth.

Despite this the interviews highlighted a wide range of ongoing innovative customer-focused solutions both entering the market and in development. This suggests to us that innovation in the UK service provider industry is thriving, and there is no evidence that the lack of next generation network deployment is holding back further developments. On this basis, we anticipate that innovation will continue both for current networks, and once Next Generation Networks become a reality, for fibre as well.

Next Generation Networks may provide a respite from bottlenecks in one area of the network, but with continued growth in usage and richer services it is likely 'pinch points' in delivery will continue to appear across the delivery infrastructure. The overarching lesson from this study has been that bandwidth is not sufficient to guarantee customer experience. We therefore believe that end to end service guarantees will remain as critical in a next generation world as they do in the near term.

■ Conclusion

This report was intended to provide a snapshot of what service providers require from delivery infrastructure, both now and in the future, to support their customer propositions.

We expected to hear criticism of the current broadband network infrastructure, but instead heard as many comments on the 'pinch points' at other areas in the delivery infrastructure, as we did about the current access network. These ranged from bottlenecks in the consumer's home to the service provider's own infrastructure. The emphasis on providing a good quality customer experience, 'end to end' highlighted the need for greater collaboration across the industry. It also demonstrated to us the value of guaranteed propositions that ensure that customers can access the services they value consistently and reliably. This will become ever more important as the internet becomes the enabler of many basic services, both public and private, essential to every day business and personal life.

We believe the message for Next Generation Networks is broadly positive, although it is clear that decisions on investment will have to be taken in advance of clear product and service requirements. But we also believe that the future internet world is a more complex world of managed services and prioritised service delivery, running alongside the continued open access internet world of today.

We deliberately have not focused on the timing or geographic coverage of the next generation network build. We also did not ask about the competitive impact on the UK if next generation network investment is delayed.

However, it seems clear to us that the current trends in usage and the anticipated rise in customer dependence on performance critical, rich media applications drive a strong case for investment in Next Generation Access. We anticipate strong demand from both customers and service providers for additional bandwidth. But equally there is no evidence from this study of market failure in the UK as a result of a lack of Next Generation Access deployment to date; rather the market appears to be highly dynamic and innovative. Web services continue to become ever more mainstream to the lives of UK consumers, driven by the investment in content and services for today's networks. We believe that this innovation is likely to continue, and will drive further exciting developments in a next generation world.

■ Additional information

Value Partners Management Consulting

Value Partners Management Consulting is a leading global management consulting firm, focusing on the TMT sectors, dealing with portfolio and business strategy; change management and operational improvement programs. Since 1993, we have been helping major companies to handle turnarounds successfully and to create lasting value.

Broadband Stakeholder Group

The Broadband Stakeholder Group is the UK Government's leading advisory group on broadband. It provides a neutral forum for organisations across the converging broadband value chain to discuss and resolve key policy, regulatory and commercial issues, with the ultimate aim of helping to create a strong and competitive UK knowledge economy.