Philips

broadband 2.0

Home access requirements are climbing steeply, yet today's bandwidth is limited. So how do we get to Broadband 2.0 from here? By **Steve Methley**

THE INTERNET is now firmly part of our everyday life. We perform many common tasks online, such as banking, grocery and gift shopping and purchasing travel or cinema tickets. Plus we get a growing portion of our entertainment from online sources: entertainment and social networking are two of the largest growth areas. We have seen the beginning of basic quality video from the likes of YouTube and the development of social networking sites such as MySpace or FaceBook, which are enormously popular among younger generations of consumers. If we are to continue

HDTV turns up the viewing experience

doing more online, our need for bandwidth will increase. And that bandwidth demand may become more symmetrical; in future we might expect to generate appreciable content ourselves, for upload onto the Internet, as well as continuing to download content. But that is not all; our need for Internet availability and quality will also increase.

THE WAY FORWARD

It might be very convenient if future Internet access were wireless. Given that it is likely that fixed and mobile Internet access will remain quite different areas, as indeed they are now, we have restricted our initial interest to fixed wireless Internet access, i.e. the local loop or 'last mile', which serves businesses and homes. We wish to consider whether there is a way forward to offering economic, ubiquitous broadband wireless access. We know that previous solutions for a wireless broadband last mile have had marginal business cases. Our time scale covers the next 10-20 years, in other words the long-term future.

The first specific question to answer is: What is the future last mile wireless broadband requirement? This really is a key question over the long time scale we have in mind. We have come to believe that the last mile requirement will increasingly be one in which there is a convergence of the services and platforms providing communications and entertainment to the home. It is becoming abundantly clear that High Definition (HD) displays and services are set to play an increasing role in this future. While we cannot predict the exact nature of future HD services, we can take today's HD television and video as a proxy – it is likely that future services intended for HD displays will have comparable requirements to HDTV. It is worth bearing in mind that although we cannot list these future services today, this does not mean they are not coming. Neither the success of SMS text messaging nor social networking sites were predicted much more than a year before they were mainstream. The availability of HD displays in consumer homes will fuel an innovation in services.

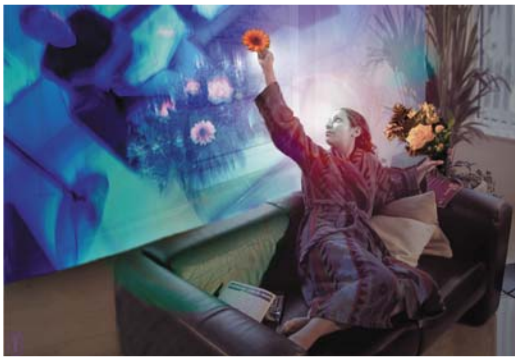
But estimating the future requirements of simple HDTV is not as straightforward as might be thought. We found that while video codecs have typically improved two-fold each five years, this fails to take into account two things: firstly, consumers' quality demands are known to increase as the codec technology matures; secondly the amount of coding gain for a given codec depends on the quality and resolution of the source; at the highest quality and resolution, less coding gain is available. Taking all such factors into account, 10-15Mbps of bandwidth is likely to be required, per channel, for HD services in 10-20 years' time. In a home where there are three active users, this would amount to 30-45Mbps.

'In 10-20 years, homes will require 10-15Mbps of bandwidth per HD channel'

PEAK RATE CONGESTION

At first sight it may appear that the present-day ADSL service is close to what is required by HD services. This could not be further from the truth. In fact, examining a typical ADSL service advertised at 'up to' 8Mbps results in two immediate problems. Firstly, the bandwidth of 8Mbps may only be available at up to two miles from the exchange. But only 20 per cent of customers live this close. At five miles from the exchange, the rate will have fallen, perhaps to only 2Mbps or even 512 kbps. Secondly, the present day ADSL service is a contended service, which means that when more users try to access the service, each will get less bandwidth. BT Wholesale provides two contention levels: they are 20:1 and 50:1. Even a home user close to the exchange, who may access 8Mbps peak rate, may access only 160kbps when the system is working hard to support the maximum number of users. A recent survey by Ofcom revealed that most home users ▶

Home users bandwidth requirements will grow dramatically in the long-term



Homes of the future will eat up bandwidth, with each individual requiring his or her own HD channel

do not realise that their Internet connection is shared at all, much less that the worst case oversubscription might be 50:1.

MULTIPLE USERS

Hence we found that present day contended ADSL is unsuited to deliver HDTV or indeed even standard definition TV. Imagine tuning in to watch the news at standard TV quality and size over ADSL – but as your neighbours all begin to do the same, your picture becomes fuzzy, stutters, then goes blank. So do your neighbours' pictures. This problem is clearly recognised by BT, which has just begun to offer 'Advanced Services' over ADSL for their BT Vision customers. This provides a bigger share of the ADSL bandwidth pool for those users who are willing to pay the premium. Clearly, this approach is not scaleable to all users. BT's Advanced Services addresses the issue that the contention for resource occurs in the backhaul, rather than the ADSL line itself. Today's bandwidth is limited. Present video over Internet solutions such as YouTube are kept well below standard TV quality and picture size. Try to imagine YouTube picture quality shown on an HDTV display, if you can.

So why does the Internet work as well as it does at present? Because we make quite small demands upon it, on average. We can use fast ADSL to our advantage when we download a huge file over a few minutes, as long as our neighbours are not doing the same thing at the same time. And this is the point; mostly our neighbours are not doing this at the same time. But the situation is so different for video. We might watch a TV programme for an hour, and for that whole hour we will require a high bandwidth. On the whole, our neighbours will also want a high bandwidth for their TV at the same time as we are watching our TV. It is the long-term streaming nature of video which demands more of the Internet capacity than legacy applications, such as email, web browsing, file downloads etc.

At this point we accepted that the requirement for HD services of at least 10Mb/s streaming is vastly different to what contended ADSL presently provides – so much so, that we termed this future bandwidth requirement 'Broadband 2.0', to clearly differentiate it from today's 'Broadband 1.0'. The key issue becomes one of 'How to get there from here?' and is summarised in Fig 1.

FIG 1 BROADBAND 2.0

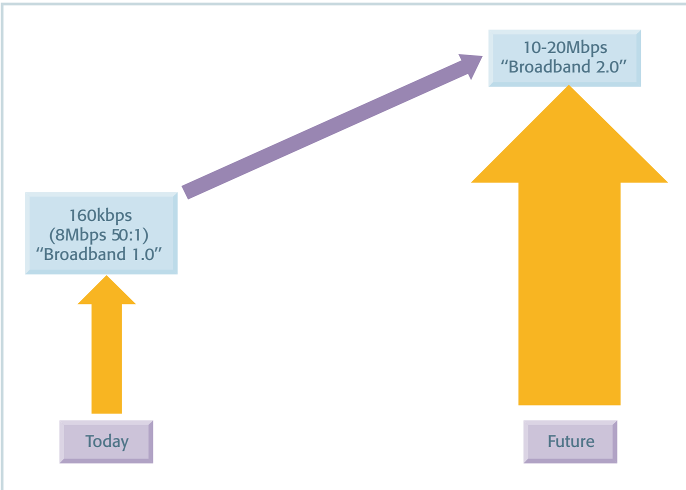
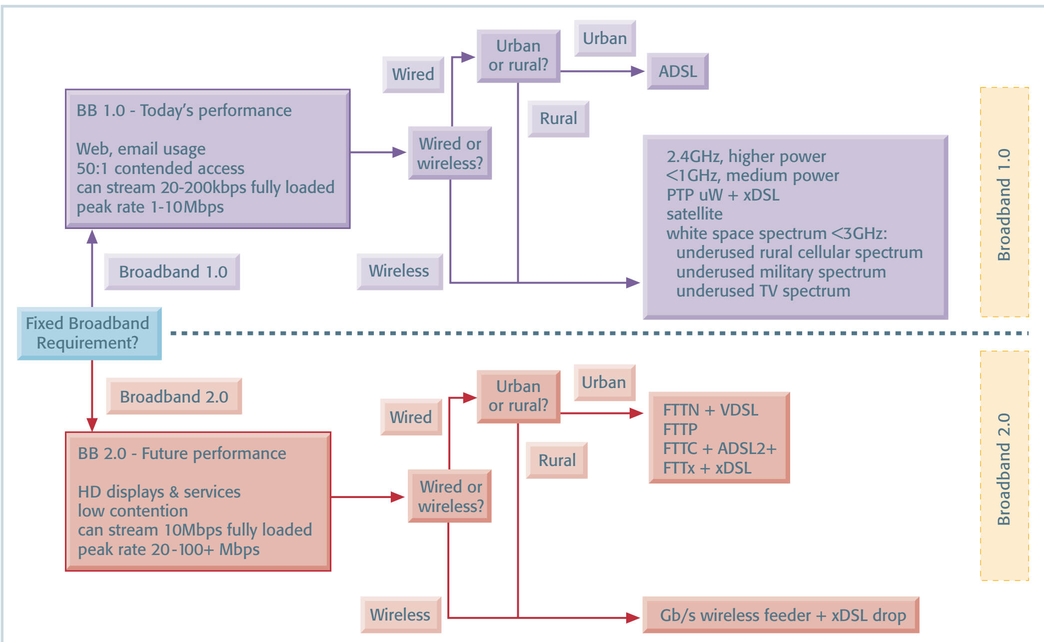


FIG 2 BROADBAND DECISION TREE



MEETING REQUIREMENTS

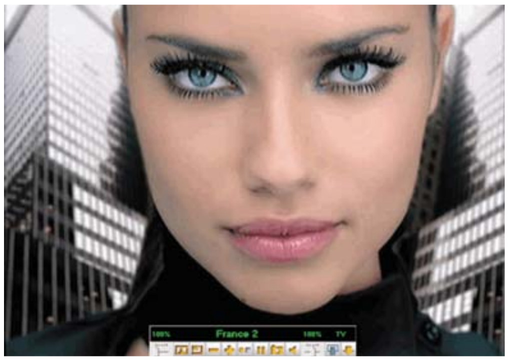
We returned to our original interest – can wireless address the needs of Broadband 2.0? It would have to do so at a competitive cost, which means preferring self-install, indoor systems and minimising base station numbers, perhaps by working at the lower frequencies of the UHF band.

But before evaluating specific wireless technology approaches, we sought benchmarks for broadband access technologies from other countries. It was quickly apparent that countries leading on bandwidth to the home are all using some form of fibre system. While Japan/Korea are doing this with government sponsorship, Verizon and AT&T in the US have recently begun fibre roll-outs on a purely commercial basis. This is a watershed development for fibre in the local loop. Interest in fibre is high in the EU too, but some operators have halted their roll-out plans due to the absence of an FCC-style forbearance on fibre unbundling within the EU.

Benchmarking against upcoming wireless standards showed these were biased towards small screen mobile content delivery, i.e. they are not attempting to address the challenge of the Broadband 2.0 requirements for delivery of HD services to the home.

Our evaluation of wireless technology approaches began by looking generally at the capacity-coverage trade-off involved in all point to multipoint wireless systems. We also looked in detail at WiMax

‘Most home users do not realise their Internet connection is shared’



French video-on-PC service ADSL TV offers television on home computers, over an ADSL connection

and 802.22 capacity planning. This provided a profound, if not entirely unanticipated result – the practical, economic capability of wireless, while adequate to provide today’s Broadband 1.0, is very clearly inadequate for the very much more demanding Broadband 2.0. The capacity shortfall is nearly two orders of magnitude. For example, to provide even only an SDTV-capable uncontended streaming capacity to all subscribers would need 50× more base station resource than is needed to provide Broadband 1.0.
This would either require 50× more spectrum allocation or 50× more base stations would need to be deployed. To provide HD services, this factor becomes 500×.

The basis of the 50× and 500× factors is contained in the fact that most radio systems, like ADSL systems, are not designed to service the maximum number of users at maximum bit rate, simultaneously. To do so requires an increase of resources. Such an increase may come from either more spectrum for the same number of base stations, more base stations within the same spectrum, or any point in between. We assumed a rule-of-thumb that HDTV requires 10x more bandwidth than SDTV, and noted that 802.22 intrinsically has 50:1 contention built into its design. In fact the radio system capacity estimates are really based on physics rather than any specific system. We assumed an efficiency of 3bits/sec/Hz. This figure of merit is quite good for an affordable radio, and while some radio standards may do better, they will not do 50x better, so our overall conclusion is valid independent of radio system.

Tomorrow’s bandwidth requirements are a long way from today’s realities

SEEKING SOLUTIONS

Applying this finding first to UHF point to point systems and then to generic mesh working approaches, in both cases we can show that wireless cannot be expected to provide Broadband 2.0 in a cost-effective manner. Having thus concluded that neither today’s contended ADSL nor wireless can provide Broadband 2.0, attention focuses on what could – and whether wireless has any contributing part to play within that solution. It seems an unavoidable result that a Broadband 2.0 solution must be based on fibre, which must in future reach further into the access network, and potentially all the way to the customer premises. Fibre can solve the contention issues by increasing back haul capacity, and can solve the last mile issue by acting as a point to point solution alone, or as a feeder to DSL distribution technologies – thus effectively reducing the length of DSL lines required.

These findings are summarised by the broadband decision tree in Fig 2.

Nonetheless, within Broadband 2.0, wireless does have at least two key areas of application, as component parts in the whole solution. Firstly as a last mile feeder element; using Gbps wireless as a fibre replacement can cost-in less. This is most likely to be true where the cost of installing fibre is high. Typically this is in large cites, where digging up the infrastructure is logistically difficult and thus expensive. In New York City, for example, laying fibre might cost a million dollars per mile. In contrast, equivalent trenching costs outside the city might be $100k per mile. Secondly, within the home, 802.11n is aimed squarely at future multimedia home networking. 802.11n’s home networking task force thinks 150Mbps raw (about 100Mbps to the user) should be enough. The aim is that 802.11n will be capable of distributing high definition, real time services around the home.

Wireless may not provide the whole solution for the local loop, but it will help get us to Broadband 2.0 from where we are today. ■

ADSL TV offers 5,700 channels to PCs

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