

Connecting the country

An engineering approach to creating 'broadband Britain'

Broadband services have the potential to transform the way we live, learn, work and communicate. But how can broadband be delivered and made widely accessible? Sir Peter Bonfield here applies the disciplines of engineering to the technical, commercial and public policy challenges involved in creating 'broadband Britain'. This article is based on The Royal Academy of Engineering's Hinton Lecture, delivered by Sir Peter on 2 October 2001.

Introduction

Communications networks today are undergoing a step change, as more and more individuals and businesses adopt broadband services. This change

will profoundly affect the way we live and work. It demands high levels of engineering skills, and poses continuing questions for policy makers and regulators.

But these challenges are well worth meeting. Patricia Hewitt MP has said that high-speed internet connections will be as important to our economy as roads and railways. A BT customer put it a different way, describing broadband as being like hot water – 'not strictly essential, but highly inconvenient to live without'.

Clearly, broadband communications can make a significant difference to people's everyday lives. So how can we make sure that the benefit is felt as widely as possible? This is a complex question, and I want to look at it in accordance with classic engineering principles. By this I mean I will analyse

the process in terms of its intended output and the available inputs.

First of all this means defining the output – the objective. I define this as: enabling as many people as economically possible to enjoy the benefits of broadband.

Then we need to examine the inputs. I categorise these under three headings: supply, demand, and policy. By ‘policy’ I am referring to the policy environment created by governments and regulators.

Then, having analysed each element of the inputs and output, we can identify the main challenges and ask what can be done to meet them.

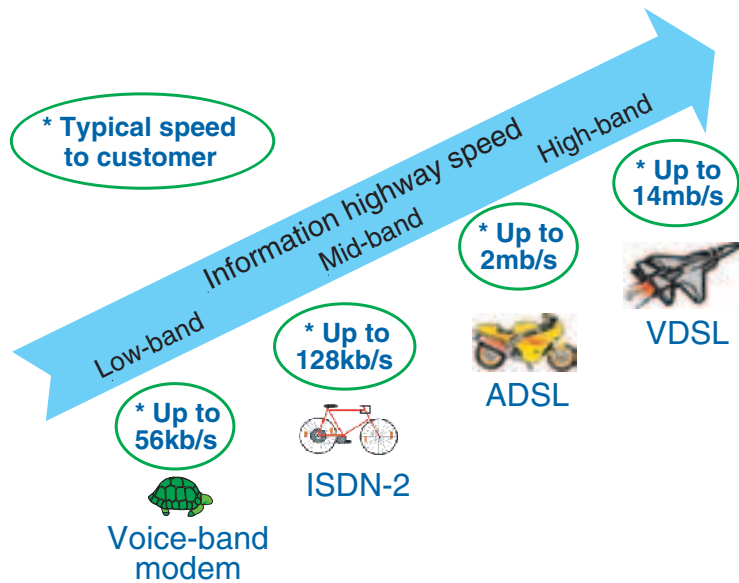
What is broadband?

Broadband is not precisely defined but is a term that has come to mean services with certain features – speed, a permanent network connection, and interactivity. It tends to describe local connection speeds greater than 128 kilobits per second. This is the limit of the conventional telephone network’s local connection when it is enhanced by the technology known as ISDN. Typically, a local connection via computer and modem runs at lower speed – up to 56 kilobits per second.

Broadband is also ‘always-on’, that is, permanently connected to the network. In addition it is often (although not always) interactive. Signals can be sent upstream *from* the user as well as downstream *to* the user. Such broadband connections can be channelled to the computer or the television, and in time they will reach all kinds of appliances, from the central heating to the fridge.

The applications can be passive, such as watching videos, or extremely active, such as downloading business-critical applications or playing a game against an opponent in another continent.

None of the key elements – speed, permanent connection, or interactivity – is new in itself, which means the term ‘broadband Britain’ can be



Digital copper line evolution

misleading. For many years, backbone networks have carried data at speeds measured in gigabits per second. High-speed, permanent connections are the norm among large corporations. As for interactivity, the telephone has been an interactive device for more than a century. In other words, broadband is not something that can be boxed up separately from the rest of the system.

There is a continuum of network speeds all the way from mobile networks operating at 9.6 kilobits per second (kb/s) to backbone networks running at hundreds of gigabits per second (gb/s). Communications networks carrying digital bits are similar to electricity or road networks. Different sections have different levels of capacity and people use the networks in different ways, consuming varying amounts of bandwidth.

Benefits of broadband

The reason that broadband is now in the spotlight is that fast, always-on, interactive services are now available to millions of individuals and small

businesses. At broadband speeds, video images are smooth rather than jumpy, the downloading of large files takes seconds rather than minutes, and graphics-rich internet pages appear instantly.

Some people may ask what all the fuss is about: isn't this just a faster network? That question was answered in a report by McKinseys (*Broadband Changes Everything*, McKinsey & Company, 2000) which stated:

To those who still think we are making excessive claims for what is basically a faster way to do things we can already do, we would say that a car is just a faster version of a horse and carriage and a computer merely a faster mechanical calculator. If broadband applications have a fraction of the impact of either of these, they will indeed change everything.

So speed equals transformation, and the addition of a permanent connection coupled with interactivity creates a new and powerful combination. This has a clear impact. For example, research in the United States has shown that once people have broadband they tend to move

... once people have broadband they tend to move their computer from the study or bedroom to the kitchen or living room ...

their computer from the study or bedroom to the kitchen or living room. One customer said: 'If I've got to turn my computer on to get a recipe and I'm on a 56 kilobit modem then the recipe book wins. Now, broadband wins.'

So broadband represents a turning point in the customer's experience. Digital information becomes more central to people's everyday lives:

- You can watch the film of your choice at the time of your choice.
- You can download software or music in seconds.
- You can set up a corporate intranet TV system to provide video briefings for employees.
- You can remotely monitor heart patients with critical conditions via mobile implants.
- You can access multimedia education packages from anywhere in the world.

The benefits are clear – no wonder broadband has been compared to the car or computer. However, while the benefits of the computer were clear, it took two decades to reach half of the population. The benefits of the car were also clear, but it took nearly a century to reach half of the population.

Early experience has shown that broadband will not be adopted overnight either. Over half of UK households could have broadband services today, but fewer than 1% have actually signed up – around 160,000 in total. So what is preventing faster, wider adoption of these services?

To answer that question, we need to look at what is being put in to the process in the UK at the moment – in terms of supply, demand and policy.

Supply

There are several methods of delivering interactive broadband services to customers' premises. Optical fibre is one. Satellite and radio can also be used but, for the home or small business, there are currently two main access routes – co-axial cables or telephone lines converted by the technology known as DSL.

Over half of UK homes are now passed by the cable companies NTL and Telewest. Cable operators chose their franchise areas and – not surprisingly – they chose the most commercially attractive ones. They can offer a bundled service of television access, telephony and, in some areas, broadband.

The other main current technology route is DSL – Digital Subscriber Loop. DSL converts an existing copper telephony line to offer speeds in a typical range of 500 kilobits per second to 2 megabits per second (mb/s) – 10

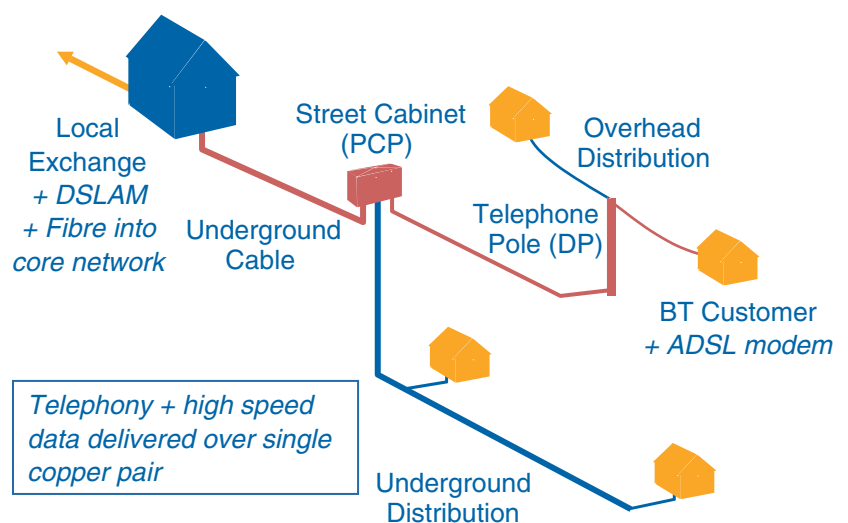
or 40 times faster than the standard phone network's local connection.

The version of DSL currently widely used in many countries (including the UK) is asymmetric DSL, or ADSL. This provides high-speed downstream service to the customer but with a slower return channel. It is very suitable for internet access where users want to download large amounts of information but generate less themselves.

DSL requires special equipment at the exchange (called a DSLAM) and another box at the customer's premises. It is limited by distance but can now operate up to around 5.5 km from the exchange, with the help of our new rate adaptive technology.

Another variant of DSL which BT is exploring is VDSL – very high speed DSL. This involves running fibre from the exchange to the roadside cabinet and then installing DSLAM equipment to convert the last few hundred yards of the line. It enables the connection to run at a typical speed of 14 mb/s downstream and 3 mb/s upstream. In practice this means that the single copper loop can simultaneously handle several channels of television, as well as fast internet and telephony.

BT has been at the centre of the development of DSL in the UK. We



Upgrading the network for ADSL

carried out the early trials and have enabled 1000 exchanges with ADSL. These 1000 exchanges cover some 60% of the UK's local access lines. This is far ahead of current demand, and we have the capacity to install four times as many connections as we are actually doing.

However, some parts of the country are not technically viable for DSL because too great a proportion of customers live too far from the exchange to receive it. Other areas are not commercially viable. In these, the size of the exchange area means that forecast demand is so low that we cannot justify the rate of return to our shareholders. I do not believe that these areas will be permanently excluded from the broadband world, but operators have to follow commercial principles. This means that the burden of investment cannot be borne by a single company, unless there is a dramatic change in technology.

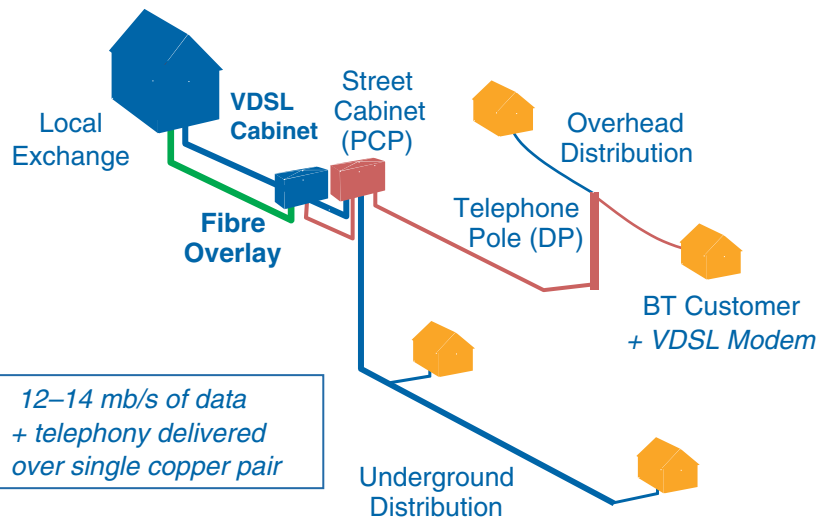
Competition

There has been a great deal of debate over the process known as 'local loop unbundling'. Under this system, BT's lines from local exchanges to customers are made available for use by other operators, to offer whatever services they wish under EU terms interpreted by the regulator, Ofcom.

It would be wrong to think either that broadband depended entirely on local loop unbundling or that BT was determined to stop it happening. Out of 80,000 ADSL broadband connections, only 150 or so are running on unbundled loops. However, that is not because BT has been intransigent, but because operators have dropped out of the market.

A year ago there were 40 operators seeking to use lines in 2000 exchanges. Now there are around 10 seeking to operate in around 300 exchanges. There are about 30 sites where other operators are actually running services over local loops.

Last year competitors were clamouring to enter the market and BT



Upgrading the network for VDSL

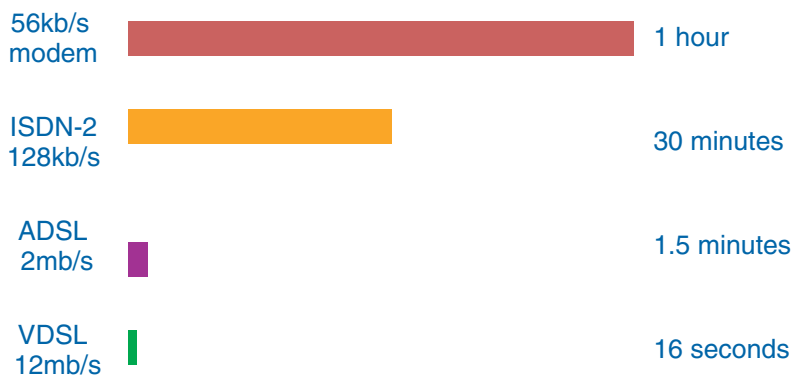
drew up plans to accommodate their equipment at 500 exchanges. This was a complex task when operators had different needs in terms of power, space, security and other issues. There was even controversy over how space would be allocated to prevent congestion.

But then the demand evaporated. The clamour subsided. Designers and surveyors had to be made redundant. BT transferred new recruits on to other work. There has been no congestion at any exchange.

Today, far from obstructing unbundling, BT is keen to make a successful business out of it. We have launched a new service whereby BT will install and manage DSLAMs for other operators, reducing their investment requirements and hence the risk.

Meanwhile, competition is alive and well in the retail market. BT Wholesale sells a broadband product to around 180 retail service providers who channel their content to end-users over BT's network. This means that the

Time to download a 25 Mbyte 12 minute video clip



How fast is ADSL/VDSL?

majority of broadband customers are with non-BT providers.

I should also mention mobile services, as higher bandwidth is now available on the move. For example, BT Cellnet – soon to become O₂ – is offering GPRS services that enable users to stay connected to a corporate network all day. Soon, there will be high-bandwidth ‘3G’ services as well.

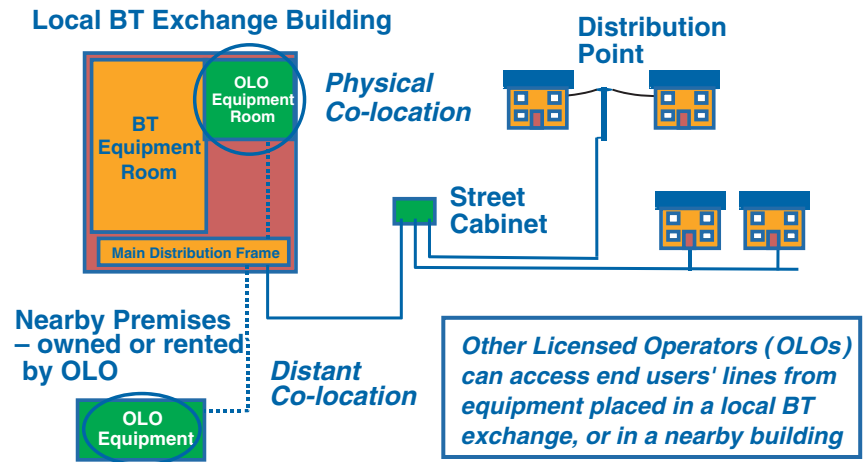
So this analysis demonstrates that if broadband is slow to take off, it is not because of blockages on the supply side. The focus of our attention therefore has to switch to demand.

Demand

Given that large organisations already use broadband, the focus today is on consumers and small and medium enterprises. For these customers, broadband has only recently become a realistic option. The question is whether they can see a tangible benefit from using a faster local connection.

The small and medium business market contains many different types of customer, ranging from those who simply want email facilities to the companies that have moved their entire customer relationship and supply chain operations online. In between are those using e-commerce facilities with professionally hosted web sites. Depending on the applications required, different access technologies are needed. At one end are those using the Public Switched Telephone Network for simple access. At the other are those using optical fibre and local area networks at very high speed.

Increasing numbers of small and medium companies are now taking the step up from narrowband to broadband. A music production company told us: ‘ADSL has changed the way we work. We used to have to send CDs by post – now we send music as digital files in seconds.’ A design company is using broadband to exchange files with clients, and a car retailer is using ADSL to upload



Local loop unbundling

advertisements to web sites – in effect switching from hard copy to web-based advertising.

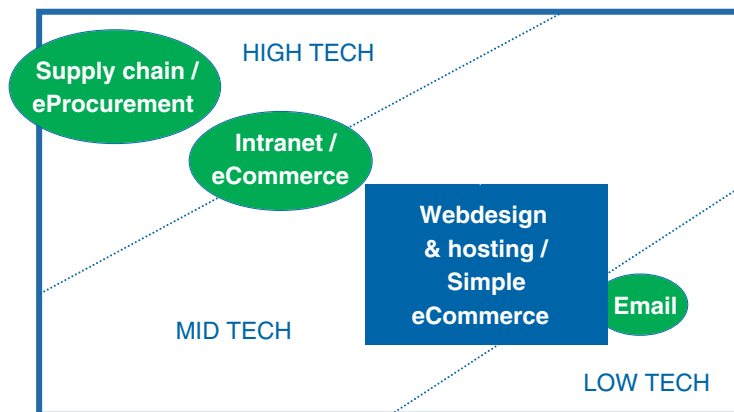
So the benefits are becoming apparent, but those who are using broadband today are mainly using it to make existing applications work faster, rather than discovering completely new ones. One of the new applications is video on demand, available in some areas with suppliers such as Home Choice.

There has been some public sector uptake – for example, a project linking local authorities in London. But it is early days here. Public sector usage is

important because it creates access for many users – for example in schools or libraries – and also draws in suppliers and partners.

So why are people not using broadband?

Awareness is one obvious issue. A survey of small businesses showed that half were not even aware of what the technology offered. Another factor is the shortage of new applications. In my view we have only just begun to explore the potential of the technology. As we discover how to use the power of



Applications needs

At end September 2001:

- 13 million households
- 60% UK exchange lines
- 52% of schools
- 71% of public libraries
- 70% of internet users



BT's ADSL coverage

broadband in new ways, new customers will be attracted to the services.

Price is also relevant: consumer broadband access typically costs between £25 and £40 per month. Some businesses can clearly see that this is outweighed by the savings achieved, for example, on couriers. But for others the price is currently more than they want to pay because they have no feeling for the benefit to their business.

There are some special factors at work in the UK. For example, we have one of the cheapest rates of narrowband Internet access in the world and, more importantly, we have flat-rate unmetered tariffs everywhere. In other European countries, broadband is the only way to get flat-rate services and so demand is driven by budgetary considerations. This means that in order to sell broadband in the UK we have to promote services and content that fully exploit speed, always-on access and interactivity, since there is no attraction in the flat-rate tariff alone.

Policy

The Government's target is to ensure that the UK has 'the most extensive and competitive broadband market in

the G7 by 2005'. The e-Envoy, Andrew Pinder, has proposed that the Government's role should be to set targets, promote competition, stimulate demand and look at pump-priming the market in rural areas. To this end the Government has set up a Broadband Stakeholders Group to bring together providers, users and others involved.

Challenges

I have looked at the inputs to the broadband process and the desired output. What observations and conclusions can we now draw?

Local loop unbundling has dominated the public debate about broadband, when it is a relatively minor aspect of the process – and one that BT wants to encourage, not discourage. The supply of broadband has been a major preoccupation, when demand is in fact the main issue. Another misconception is that broadband is the answer to everything. Even with relatively low take-up of broadband, the UK is faring well in the so-called 'new economy'.

There are more people online in the UK than in many European countries. Since the introduction of unmetered access, the UK has pulled ahead of other European G7 countries in the number of secure servers per million

inhabitants. Secure servers are the warehouses of the digital world and a good indication of the intensity of e-business. So 'e-Britain' is competing well internationally, despite the challenges of creating 'broadband Britain'.

However, the Government's target for broadband is a stretching one. Our analysis has shown that there are several challenges to address if we are to meet it. These are chiefly:

- lack of awareness
- lack of applications
- lack of public sector take-up
- technical limitations
- economic issues
- regulatory issues.

I will look at each of these in turn and ask what action can be taken.

Boosting awareness

We need to boost awareness of what broadband can offer to businesses and individuals. This is an issue for everyone: Government, local government, operators and content providers. The need is for marketing programmes, education and opportunities for people to see broadband in action – whether at a school, library, business or other location. Companies need to become aware of what broadband can offer their particular businesses. The Broadband Stakeholders Group is well positioned to take a lead in promoting broadband awareness nationally.

Building applications

We must have more compelling content and new applications for broadband. This is another case for partnership – in this case between service providers, content providers and applications designers. Projects are in progress around the country. For example, BT has set up a Broadband Applications Lab to evaluate and test broadband applications which designers hope to bring to market.

For example, we are conducting trials of a service entitled 'software-to-go'. This enables an individual to rent many kinds of software online – lifestyle, education or entertainment. You can hire software for an evening or a weekend, with titles ranging from French tutorials to action games.

There is also a great deal of scope for new applications for interactive TV or video streaming. Interactive TV offers a world of new possibilities – with viewers participating by buying, voting or responding to questions. Instead of having a studio audience of a few hundred, Question Time could become a debate involving millions. The fate of Big Brother contestants could be decided in seconds rather than hours – although that might still be too long for some!

Building public sector adoption

Another driver for demand is the public sector. As the EU's eEurope action plan says, 'the public sector must lead, not trail, in the take-up of new technologies.' Much could be achieved by the deployment of broadband to more schools, colleges, hospitals and public libraries. This would encourage adoption by other suppliers and stakeholders. There are models for this approach in countries such as Ireland and Sweden.

Addressing technical limitations

A great deal of work is going on to upgrade the technology. For example, this summer in BT we began to deploy a DSL enhancement called 'rate adaption', developed by Fujitsu. Before this, DSL would only reach customers within 3.5 km of exchanges – rate adaptive DSL extends the range to 5.5 km.

BT Wholesale is also staging trials of self-installed DSL, or 'broadband in a box'. This is equipment which users can fix in their own premises, rather than having an engineer call on them.

There are many other emerging technologies which will extend

broadband services even further. For example, many offices now use very high speed gigabit ethernet services. These are now migrating to wide area networks as well as local area networks or LANs. The wireless LAN is also becoming more commonplace. In practice this means you can walk into the office, flip open your laptop and have immediate broadband access.

Addressing economic issues

The key economic issues are the price of the service to the customer and the cost of the investment to the supplier. BT is working to reduce prices where possible. For example, BT Wholesale dropped the prices of one of its most popular products by £5 a month to £30 this summer and it has now halved the wholesale installation charge to £75 for a three-month period.

However when it reduces prices, BT has to be careful that it is not judged by Ofcom to be unfair to competitors. This aspect of regulation needs to be very carefully handled – otherwise a no-win situation could be created for BT and its customers, not to mention the Government's targets.

While price is an issue for customers, investment is the issue for operators. Currently there is much unused capacity, but in time we will have to consider how to equip those areas where the roll-out of ADSL is not commercially viable. I think the logical way forward here is to establish a partnership approach, embracing private and public sectors, suppliers, potential users and other stakeholders.

This is not a pipe dream. In fact in Wales and Scotland projects of this kind are already planned or underway. BT has proposed that a challenge fund should be set up for regional partnership schemes on similar lines.

Reforming regulation

Turning finally to regulation, the fact that there are 179 DSL providers – plus competition between DSL and cable –

suggests that insufficient competition is not a major problem. I think the priority is to shift the focus from the concentration on unbundling the local loop towards promoting competition in a way that extends choice and encourages investment. The Better Regulation Task Force under Lord Haskins has produced a report which recognised that regulation can stifle investment if it restricts returns too severely.

Ofcom will be wound up in 2003 and replaced with a new 'super-regulator', Ofcom, to oversee telecoms and broadcasting. This is a chance to take a fresh look at regulation across the digital industries.

Conclusion

Once again, engineers find themselves at the heart of a transformation in society. Our task is to integrate engineering and commercial skills to create a sustainable broadband future. In order to achieve that, we need to get both the technical and economic models right. There are major challenges, but the potential rewards are greater still.

We will all want more personally relevant information, delivered any time, any place, by voice, data and video. That is the broadband opportunity, covering many different technologies and approaches. It will not happen overnight, but it will happen. ■

Sir Peter Bonfield has been Chief Executive of British Telecommunications plc since January 1996. Previously he was Chairman and Chief Executive of ICL plc and on the Board of STC plc. He began his career with Texas Instruments Inc, gaining wide experience in semiconductors and computers. He has received numerous awards and accolades for his work. He was awarded the CBE in 1989 and knighted in 1996.

