

The politics of bandwidth

Network innovation and
regulation in broadband Britain

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James Wilsdon and Daniel Stedman Jones
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Executive summary

We live in a society of networks. Finding ways to shape, support and manage these networks in the public interest is one of the great challenges of our age.

This report explores this challenge in the context of the **electronic networks** that underpin the digital economy. These networks – whether fixed wire or wireless, narrowband or broad – will determine how far the economic and social potential of digital technologies are realised. This is an early stage in the evolution of these technologies. Now is the time to get the network architecture right, to create effective forms of governance and regulation, and to ensure the right balance between freedom and control.

Broadband internet is hailed as the next great platform on which entrepreneurs and technologists can build the ideas of the future. Its potential to unleash innovations in learning, healthcare, commerce and government are well documented. After a slow start, take-up levels are now showing real growth. In September, broadband welcomed its 1 millionth subscriber. Around 20,000 new connections are being made every week.

But there is a long way to go until the UK has ‘the most extensive and competitive broadband market in the G7 by 2005’, as called for by ministers. We may have improved enough for Italy to replace the UK as the worst G7 nation in terms of broadband connections, but that still leaves us at number six. We are catching up with France and Germany, but the US and Canada remain far in front. In South Korea, outside the G7, two-thirds of households have broadband access, compared with less than one in 20 in the UK.

The UK’s broadband growth is welcome. But will it be limited by regulatory and structural restrictions, especially the control BT enjoys over the local loop copper wire infrastructure? Is long-term innovation being sacrificed, in favour of short-term increases in the level of broadband take-up?

There is huge innovative potential at the heart of expanding digital platforms. Through tactical regulation and a more creative approach to the structure and ownership of key network resources, Britain could position itself as a leading digital economy. Without such radical measures, the UK will continue to languish in the second division.

Our starting point is the need for electronic networks to foster innovation. Government and regulators should act to preserve an ‘innovation commons’ where infrastructure and governance are shaped in such a way that promotes innovation, rather than stifles it.

Innovation is defined as an evolving open-ended process based on experimentation, resulting in real products and accessible practices that fundamentally alter the way people live. Two main types of innovation exist:

- *Incremental innovation* – companies and organisations innovate at the margins of their existing practices to improve incrementally the way they do the same things. This is the ‘new, improved’ school of product and service development.
- *Disruptive innovation* – innovation that upsets, supersedes and transforms established business models, user expectations and governance frameworks and creates a wider range of possibilities in a given field.

The most important forms of technological innovation are *disruptive*. Historically, disruptive innovation has usually come about through a cocktail of social and economic processes, seasoned by government and public rules. The priority for regulators is to frame an environment in which electronic networks can incubate disruptive innovation, while balancing public and commercial interests. This means governing the underlying technological infrastructure in ways which help to encourage further investment. Widespread access must be provided to the raw materials of innovation: the physical infrastructure and technical standards of the technology itself.

The danger is that the spirit of freedom and innovation that has characterised digital networks from the very beginning is being squeezed out by legal, technical and regulatory manoeuvres designed to entrench the power of incumbents and monopolies. Maintaining a proactive

regulatory focus on the public interest and ensuring the survival of an ‘innovation commons’ will be vital if the UK is to maximise the economic and social potential of digital technologies.

This pamphlet explores these challenges in the context of two important issues in the digital environment:

- The development of **broadband internet access** and particularly the role of the **local loop**, the part of the telephone network that runs from homes and offices to the local exchange.
- The **allocation of spectrum**, the swath of electromagnetic radio frequencies that are used for a range of purposes, from TV and radio broadcasts to mobile phones and emergency services.

Both of these issues fall under the remit of the newly created super-regulator, the Office of Communications or Ofcom. The progress through Parliament of the Communications Bill, which will formally establish Ofcom, has created debate about the type of regulation needed to fulfil the government’s objective of making the UK ‘the most dynamic and competitive communications market in the world’.¹

The battle for the local loop

Ofcom will need to take more radical action to increase competition and improve access to network infrastructure. The government has a ‘many networks’ policy, which attempts to create competition between different access technologies: xDSL, cable, fibre, wireless and satellite. Yet for large parts of the UK, BT’s local loop remains the primary means of broadband access. Competition between BT and cable exists over only 40 per cent of the country. Despite the process of local loop unbundling (LLU), the local network remains almost entirely controlled by BT. This situation hampers innovation, and runs counter to the public interest.

To tackle this problem, the government should undertake a fundamental review of competitiveness and innovation within the telecoms market, including a full analysis of the risks and opportunities involved in the structural separation of BT. Unless it takes decisive action, technological advance and convergence in the sector will steadily increase the complexity and level of detailed understanding required to monitor

the marketplace and shape the behaviour of firms. Ofcom is likely to find itself swamped by the need for ever-increasing, incremental interventions.

Such a review would be long and complex and if a recommendation favouring structural separation was approved it could still take another two years to implement. In the meantime, Ofcom should put in place a range of short-term remedies to improve competition within the local market, including legal requirements for BT to place its own broadband retail operations on an equal footing with competitors.

Spectrum allocation

New wireless, or WiFi, networks are now emerging in some parts of the country. Such innovation offers a model for improving broadband access in rural and disadvantaged communities. The recent report by Professor Martin Cave on spectrum allocation proposes a trading system to ensure that spectrum is used efficiently and the market attains some degree of fluidity.

Our analysis leads towards a clear proposal. Alongside the spectrum trading scheme that is now being developed, it is vital that Ofcom reserves a modest share of spectrum as a common resource, which can be used for grassroots innovations such as WiFi. We are not suggesting that the entire range of spectrum frequencies are suddenly deregulated into an anarchistic free-for-all. For large swathes of spectrum, trading will be by far the most effective means of allocation, and will indeed serve to improve efficiency and innovation. However, it is perfectly possible to imagine a mixed system, in which the bulk of spectrum is auctioned off to the highest bidder, while smaller slices of spectrum are preserved as common resources on public interest grounds. When analogue broadcasting services, on which terrestrial TV is currently carried, are finally switched off, a share of the spectrum currently used for public service broadcasting – BBC1, BBC2 and Channel 4 – should be made available as a spectrum commons.

A market structure could coexist with a spectrum commons, to the benefit of both systems. There is a danger that in rushing headlong into creating a market-based system, we repeat precisely the same mistakes that we have seen at the level of the local loop: giving large players sole ownership and control of the infrastructure and limiting the possibilities for dispersed and pluralised forms of innovation.

Ofcom has the opportunity to pioneer a radical new approach to spectrum management that could one day make Britain the envy of the wireless world. Given the uncertainties and almost limitless possibilities for the use of spectrum in the long term, a public/private mix offers by far the best recipe for disruptive innovation.

The opportunity of Ofcom

Key to achieving a competitive broadband environment and a new public space for innovation within spectrum frequencies is the establishment of a new, more responsive and adaptive regulatory regime. The establishment of Ofcom marks a refreshing attempt to create a more integrated and adaptive regulatory environment. Its success or failure will depend on its ability to respond quickly to rapid and complex change while maintaining a coherent overview. Ofcom's dealings with BT are a warning: it is easy for a regulator's attention to be deflected from the bigger picture through the need to make ever greater numbers of detailed interventions.

A central challenge for Ofcom will be developing modes of regulation capable of anticipating and adapting to the disruptive clusters and long waves of technological change that will inevitably characterise the communications environment over the next 10 to 20 years. One of the government's aims in the draft Communications Bill is to establish a policy framework 'characterised by both resilience and adaptability for the future'.

Achieving this will not be easy. Ofcom will need to build a culture that is flexible, adaptive and grounded in a cycle of continuous learning. It will need to invest considerable energy in building an integrated whole, and resist the tendency to slip back into a silo mentality. It should seek to experiment with its own organisational structures, management of information and of knowledge.

There is no doubt that, in the long run, digital and network technologies will contribute to deep change in British society. It will affect the sources of economic competitiveness and prosperity, the quality of life and the nature of governance and public decision-making.

But the most important dimension of this change, which will only occur through protracted and disruptive transition, is not the speed at which the technologies we know about are rolled out, but the innovative capacity of society as a whole and of key sectors within it. The

government's approach to communications policy has created a rare opportunity for a set of decisions that could genuinely influence the direction and the quality of technology-related change over the next generation.

If Ofcom can rise to the challenges set out, it will help to define a new mode of regulation that acts as a catalyst for disruptive innovation and helps to lead the world in showing how to harness the drivers of change for the common good. Taking the opportunity depends largely on recognising the value and rewards of long-term investment in innovation and infrastructure, even at the expense of short-term gains.

Recommendations

- 1 Ofcom, when it becomes fully operational, should immediately set up a review of competition in the telecoms market, and include within this a cost-benefit analysis of the structural separation of BT.
- 2 In particular, Ofcom should identify the blend of ownership and governance structures that would most effectively safeguard a common space for innovation.
- 3 While the review gets underway, Ofcom should put in place a range of short-term behavioural remedies to improve competition, by ensuring true non-discriminatory access to BT's local network.
- 4 Alongside the spectrum trading scheme that is now being developed, it is vital that Ofcom reserves a modest share of spectrum as a common resource, which can be used for grassroots innovations such as WiFi.
- 5 When the switch-off of analogue TV services takes place, it would be particularly appropriate to allocate a share of the spectrum that is currently used for public service broadcasting – BBC1, BBC2, and Channel 4 – to a public interest commons: a form of 'citizen's band' for the digital age.
- 6 Ofcom will need to build a culture that is flexible, adaptive and grounded in a cycle of continuous learning.

1. Introduction

We live in a society of networks. At every level of organisation, the network form is there; from the ski slopes of Davos to the streets of Seattle; from financial markets to mafia gangs; from CNN to Open Democracy. Networks constitute what Manuel Castells calls the new ‘social morphology’.² Although network forms of organisation have existed throughout history, the growth of digital technologies has enabled their expansion throughout our entire economy and society.

Often our dependence on networks is invisible to the naked eye. Yet, whether social or virtual, they are vital to the way we access services, communicate with each other, organise our lives and structure economic exchange. Although many institutions still retain a hierarchical form, a growing range of public and private goods, affecting competitiveness and quality of life, rely on networks in some form. Finding ways to shape, support and manage all kinds of networks for the common good is one of the political and regulatory challenges of our age.

This report explores this challenge in the context of the **electronic networks** that underpin the digital economy. These networks – whether fixed wire or wireless, narrowband or broad – will help determine the extent to which we unlock the economic and social potential of digital technologies. At this relatively early stage in the evolution of these technologies, it is vital that we get the network architecture right, that we create effective forms of governance and regulation and that we ensure the right balance between freedom and control.

Five years ago, in the midst of the technology boom, politicians were keen to position themselves alongside the ‘information revolution’ and the ‘new economy’ but following the bursting of the stock market e-economy bubble, the disappearance of a generation of dot.coms and considering the struggles faced by many technology companies as well as the

government's only halting progress in delivering e-government, the picture looks quite different. There is now far less certainty about what digital technologies can do for us. It is no longer clear how a path of development can be shaped which realises the technologies' long-term social and economic promise.

The quick and easy wins promised by many advocates of the 'new economy' have not materialised for most people. Politicians and regulators, as well as firms and citizens, are faced with the classic conflict between the short and long term. Most people are convinced that digital technologies will have a major long term impact on our lives and the workings of our institutions. But there is great uncertainty about how to take the decisions now which will maximise these benefits in the long term. This decision-making process is made all the more difficult, because future gains are difficult to predict and quantify – and they are unlikely to be evenly distributed among current players in the technology field.

At the same time, the communications and digital industries are among the most politically visible and heavily contested of all sectors, with different interests vying for influence, profile and strategic advantage. The current state of the government's various digital economy and e-government programmes is an indication of this confusion and uncertainty. While there has been plenty of progress, there have also been painful failures: the collapse of ITV Digital and the slow progress of e-government in meeting initial expectations and targets, for example.

One clear sign that the government recognises the need for longer term, more integrated thinking was the launch, in June 2002, of a cross-cutting review of electronic networks, to be carried out by the Cabinet Office Strategy Unit. The review is examining the importance of networks for productivity and growth, the likely range of technological and market developments over the next decade, and the resulting challenges for government and regulators.³

The importance of network innovation

Our starting point in this report is that electronic networks should foster innovation. By innovation we mean more than purely technical or commercial novelty. Innovation is an ongoing, open process based on

experimentation and learning, through which new ideas and inventions are converted into products and practices which change the way people conduct their daily lives. It can lead to the remodelling of institutions and community structures to facilitate new practices. It can contribute to the economic efficiency, as well as the quality and diversity, of social life.

Even in purely economic contexts innovation draws on and contributes to a complex set of social, cultural and organisational changes. Our argument is that the most important forms of technological innovation, as far as policy-makers should be concerned, are *disruptive*: they upset, supersede and transform established business models, user expectations and governance frameworks, creating a wider range of possibilities in a given field. A policy framework, which aims to unlock the maximum economic and social potential of new technologies, needs to wholeheartedly embrace the politics of disruptive innovation.

Access to the raw materials of innovation – the physical infrastructure and technical standards of the technology itself – must become as widespread as possible. Innovative systems depend on plural, diverse cultures of ideas and experimentation, which in turn depend on the extent to which base technologies can be used for a range of purposes. Unfortunately, capital intensive technology markets can easily develop in ways which choke off the innovative resources on which they depend to generate new demand for products and services in the medium to long term.

This presents a problem, especially for politicians and regulators under pressure to deliver quick, tangible benefits in return for public investment. Currently there is an in-built tendency for the sector to respond only to existing forms of demand, and to rely on the current dominant powers both to meet the demand and to extend access to new technologies and applications. The possibilities and interests of future innovators are rarely heard above the clamour of today's short-term controversies.

As we will argue, the drive to create an information society must involve more than a straight race to implement and roll out existing information and communication technology (ICT) applications. No one can pick the 'killer application' or definitive standard in advance, or with

any certainty. Ongoing success depends on creating a dynamic space within which the benefits of innovation can be maximised.

Investment and competition are important components of such a space. But the crucial dimension in the long run, especially from a public policy perspective, is *governance* – the set of structures and principles which determine the rules of engagement and access. Particularly in the field of electronic networks, which are a base for so many other forms of wealth creation and social value, the underlying structure of the industry and the way that its development is conditioned by regulation is fundamentally important.

In order to act on this insight, policy-makers need to adjust their perspective on the nature and timescales of technology-driven change. Efforts to accelerate, or to influence, the course of such change should be based on the fact that it occurs through **long waves**, whose specific outcomes are largely unpredictable, but whose general direction can be understood and shaped. They must also recognise that although technology products and services are initially marketed as making things that we *already* do easier, faster and cheaper they do not usually achieve this instantly. It takes much longer for our various means of communication and coordination to become genuinely inter-operable, to be absorbed into everyday practice and behaviour and to help people and organisations to operate in frictionless, flexible ways.

Often, a new technology or application is offered as if it will spontaneously and painlessly transform an aspect of our lives. The dot com boom was fuelled by this expectation: that somehow the ability to make, buy and sell online would create a virtual sphere of economic activity liberated from the normal laws of supply, demand and distribution. The reality is that radical transformation only occurs over much longer periods. While new and more powerful means of communication and information processing *may* be seen as goods in themselves, their true value should be understood in terms of what they make it possible for us to do differently. Unless they lead us to leave behind many of our existing expectations, organisational methods and practices, digital technologies are unlikely to add much value to our lives, our communities or our economies.

Politicians and regulators cannot predict the outcomes of disruptive innovation and they cannot pick and choose specific technologies with

any great success. They should instead pay attention to creating a network environment that is as sympathetic as possible to all forms of innovation that create economic and social value. Network governance must promote conditions which favour disruptive innovation. It should avoid the path of development where a continuous stream of small, incremental efficiency gains are all that is on offer.

The scope of this report

This report looks in detail at two specific policy and regulatory challenges, which are key to the development of the UK's digital economy, in order to develop and promote new models of network governance:

- The development of **broadband internet access**, particularly the role of the **local loop**, the part of the telephone network that runs from homes and offices to the local exchange
- The **allocation of spectrum**, the swathe of electromagnetic radio frequencies that are used for a range of purposes, from TV and radio broadcast to mobile phones and emergency services.

An examination of these issues is timely, as both fall under the remit of the newly integrated super-regulator, the Office of Communications, or Ofcom. Its creation will herald the greatest shake-up in communications regulation for a generation. Ofcom will be the product of a merger between five existing regulators: the Broadcasting Standards Commission; the Independent Television Commission; the Office of Telecommunications (OfTel); the Radio Authority and the Radio Communications Agency.

The drawing up and progress through Parliament of the Communications Bill, through which Ofcom will be established, has given rise to an intense debate about the type of regulation that will be needed to fulfil the government's stated objective of making the UK 'the most dynamic and competitive communications market in the world'.⁴ The quality of this debate has been encouraging, but there are aspects of Ofcom's role, particularly in fostering economic and social innovation, that merit further discussion. We hope that this report will contribute to the next stage of planning and preparation for Ofcom as it moves closer to becoming operational.

What do we mean by broadband?

Broadband refers to the amount of capacity or speed of data transfer within a network. The most common way to access the internet is still through a narrowband, dial-up connection.

Definitions of what constitutes broadband vary. Some specify a particular transmission rate: in the case of the International Telecommunications Union, more than 2 megabits per second (mbps);⁵ or in the case of the OECD, downstream access (from network to user's terminal) of at least 256 kilobits per second (kbps) and upstream access (from user's terminal to network) of at least 128 kbps.⁶

Others prefer a more qualitative definition, such as the UK's Broadband Stakeholders Group, which defines it as 'always on access, at work, at home or on the move, provided by a range of fixed line, wireless and satellite technologies to progressively higher bandwidths capable of supporting genuinely new and innovative interactive content, applications and services'.⁷ Given the speed at which bandwidth is increasing, it is worth remembering that what is regarded as broadband now may well be seen as narrowband within a few years.

In making the case for network innovation, we are revisiting ground first trodden by Demos in 1995 in a paper called *The Society of Networks*. This was written by Geoff Mulgan and Ivan Briscoe at a time when the impacts of the internet were still anticipated rather than felt. They argued for an end to vertically integrated monopolies in the telecoms sector and for structural separation between BT's core network and service providing activities. The pamphlet concluded that the basic network infrastructure should be owned through a form of open association similar in nature to Visa (the collectively owned banking payment and credit system) and that this innovation in governance should be combined with full deregulation of competing networks and service providers.

The authors warned that, without such separation, BT's local network would stifle both innovation and competitiveness. 'How this last link is organised, who owns it, and who gains access to it has become a central policy issue,' they wrote.⁸ It was a prescient warning. Seven years later, the local loop remains an innovation bottleneck which successive governments have failed to tackle.

Now, as in 1995, there are those who remain confident that a combination of the existing regulatory regime and the development of alternative infrastructure networks (cable, wireless etc.) will be sufficient

to deliver proper competition. Nonetheless, we cannot afford to waste another seven years.

BT's local loop is and will remain for some time the most effective means through which broadband can be delivered to large sections of the UK population. In theory, the local loop is now open to competition through the process of unbundling, where BT is required to make its local network available to competitors, but this process has failed. So far, only 1,100 loops have been unbundled, compared with the 357,000 high speed ADSL connections made by BT.⁹

After a sluggish start, broadband is at last taking off in the UK. The number of subscribers has passed the 1 million mark and 20,000 new connections are being made a week.¹⁰ After a lengthy period in which the UK languished at the bottom of the G7's broadband league table, the government's stated aim 'to have the most extensive and competitive broadband market in the G7 by 2005'¹¹ no longer sounds quite so ridiculous, but still represents a huge challenge.

The latest figures from the Organisation for Economic Co-operation and Development (OECD) are likely to show that the UK has overtaken Italy for the first time, and is growing its subscriber base at a faster rate than the OECD average. This is progress, but it still only places the UK in sixth place among the G7. Catching up with France and Germany is now a realistic goal, but achieving – let alone surpassing – the levels of broadband penetration found in the US or Canada by 2005 remains unlikely. The government's target also ignores the fact that the best examples of broadband leadership now lie outside the G7. In South Korea, 67 per cent of households have broadband, mostly with connection speeds of 2 mbps. In the UK only 4 per cent of households have broadband, mostly at only 512 kbps.

Our focus in this report is not on how the UK catches up with the rest of the G7 over the next three years. Instead we want to look five to ten years ahead, to consider whether the longer term conditions are in place to foster innovation. Our concern is that if policy-makers continue to duck the fundamental challenges in the structure of the UK telecoms market relating to BT's local loop, the short-term gain in the number of broadband subscribers may only be achieved at the expense of long-term pain.

We argue that more radical action is needed. Ofcom, once it becomes operational, should undertake a fundamental review of competitiveness

and innovation within the telecoms market. This would include a full analysis of the risks and opportunities involved in the structural separation of BT's local network. In this way, we build upon the conclusions of our 1995 report.

However, we also move the debate forward by identifying the emergence of similar problems elsewhere in the architecture of the digital economy, notably in the allocation of spectrum.

The spirit of freedom and innovation that characterised the internet from the very beginning is being squeezed out by legal, technical and regulatory manoeuvres designed to safeguard the power of incumbents and monopolies. If the UK is to maximise the economic and social potential of digital technologies, it is vital that the regulatory focus concentrates on the public interest. It must also ensure the survival of an 'innovation commons'.

Such an approach will involve Ofcom in a series of difficult structural decisions about existing industries. Yet unless it takes decisive action now, Ofcom is likely to find itself swamped by a need for ever more incremental interventions, as technological convergence steadily increases the level of detailed understanding required to monitor the marketplace and shape the behaviour of firms.

The next chapter looks in more detail at the case for an innovation commons, drawing in particular on the work of communications theorist Yochai Benkler and Stanford law professor Lawrence Lessig. Chapter 3 outlines the case for network innovation in both economic and social terms. Chapters 4 and 5 develop these arguments in the specific context of the local loop and spectrum allocation. Finally, Chapter 6 sets out a clear challenge for Ofcom in acting as a catalyst for disruptive innovation and for unlocking the potential of new technologies to serve the common good.

The research process

- This project builds on earlier research carried out by Demos and others. In particular, it develops ideas initially explored in *The Society of Networks* (Demos, 1995) by Geoff Mulgan and Ivan Briscoe.
- Over a period of six months, we interviewed 32 experts on telecoms, broadband and innovation, drawn from the communications industry, academics, government departments and regulators such as Ofcom and the ITC.
- On 1 May 2002, we hosted a half-day seminar on network innovation, attended by approximately 40 policy-makers and stakeholders in the communications industry.
- We worked closely with the economic consultancy Beaufort International, as it undertook a parallel study into telecoms, innovation and competitiveness.
- Our aim throughout the project was to listen to and engage with a wide spectrum of opinion from government, business and beyond.

2. The tragedy of the dot.commons

We move through this moment of an architecture of innovation to, once again, embrace an architecture of control – without noticing, without resistance, without so much as a question . . . The switch is now being thrown. We are doing nothing about it.

Lawrence Lessig¹²

In seeking to understand the underlying causes behind the slow uptake of broadband in the UK, we need to address a broad trajectory of legal, technical and regulatory change that is gradually stifling innovation across digital networks. In a recent article in the journal *Foreign Policy*, Stanford law professor Lawrence Lessig presents a stark warning that the days of network innovation are numbered:

The internet revolution has ended just as surprisingly as it began. None expected the explosion of creativity that the network produced; few expected that explosion to collapse as quickly and profoundly as it has. The phenomenon has the feel of a shooting star, flaring unannounced across the night sky, then disappearing just as unexpectedly.¹³

Lessig goes on to argue that a series of new laws and regulations are dismantling the very architecture that made the internet a framework for global innovation. The idea of a ‘commons’ – a shared resource to which everyone has equal access – was built into the internet from the very beginning. In its early years, the internet flourished precisely because its core resources were not privately owned. They were shared by everyone who wanted to use them. It was this commons that produced the upsurge in creativity and innovation that has been the hallmark of the digital economy over the past 20 years.

Commons are features of all cultures. They include a range of shared resources, from public roads, parks and beaches, through to knowledge, language and ideas. Some commons are *non-rivalrous*: they cannot be exhausted however many people seek access to them. The works of Shakespeare are free for anyone to use and copy; they will not run out.

Other commons are *rivalrous* and therefore open to depletion. A public park can only be used by a certain number of people at any given time. Rivalrous commons are subject to what the biologist Garrett Hardin famously described as the ‘tragedy of the commons’: everyone pursuing his or her own interest within a commons will ultimately destroy it.¹⁴

The internet was established as a non-rivalrous commons. At its core is an ‘end-to-end’ design that was new among large-scale communication networks. Traditionally, networks were designed as ‘smart’: they were designed by people who believed they knew exactly what the network would be used for and designed that specific function into the network itself. They located the intelligence and control of the network *within the network itself*.

The internet was shaped by a different approach, which placed humility above omniscience and anticipated that network designers would have no clear idea about the ways in which the network might come to be used over time. Relatively little intelligence was designed into the core technical specifications of the infrastructure itself. This left the network free to be developed in a way required by its own ends – the large and disparate group of hardware and software designers, who had a growing number of specific purposes and applications in mind. In other words, the intelligence and potential of the internet as a network, or a means of communication, distribution and exchange, was widely *distributed*.

The result was an unprecedented degree of flexibility. Because innovators needed no permission from the network owner, they were free to develop a host of new content and applications. Perhaps the most famous example is the World Wide Web, created by Tim Berners-Lee at the CERN laboratory in Geneva in 1990. To enable users to access documents dispersed across the network, Berners-Lee developed a set of protocols to enable hypertext links. These could be layered on top of the basic protocols of the internet. Without the inbuilt flexibility of its end-to-end design, such innovations would never have been possible.

The influential communications theorist Yochai Benkler suggests that we should think of the network as being built in three distinct ‘layers’ that together make communication possible.¹⁵ At the bottom is a ‘physical’ layer: the computers and wires that link computers on the internet. In the middle is a ‘logical’ or ‘code’ layer, and it is here that the end-to-end design was created through a series of protocols and the software that runs across them. At the top is a ‘content’ layer – the material (text, images, voice) that is transmitted across the network and appears in forms which are recognisable and valuable to real users.

In principle, each of these layers could be controlled and could be free, privately owned or organised in a commons. (It is important to recognise here that ‘controlled’ does not only mean charged for, but also the extent to which its standards and specifications can be accessed, refined or improved.) We can envisage a world in which the physical layer is free but the logical and code layers are not, or where the physical and code layers are controlled but the content layer is free.

The unique quality of the internet is the way in which it mixes freedom with control at different layers. The physical layer is fundamentally controlled: the wires and computers, across which the network runs, are private property. Similarly, at the content layer, a lot of what is on the internet is controlled by copyright, for example news sites and digital downloads. At the code layer, however, the internet remains a commons. By design, therefore, no one controls the resources for innovation that exist at this layer.

No other large scale electronic network has a free code layer like this. For most of the history of telephone monopolies worldwide, permission to innovate on the telephone network was vigorously controlled. Lessig gives the example of how, in 1956, AT&T persuaded the US Federal Communications Commission to block the use of a plastic cup on the telephone receiver, designed to block out background noise, on the basis that AT&T alone had the right to innovation on the network.¹⁶ The internet might never have emerged if AT&T had maintained this level of control.

At precisely the time when the internet was emerging, a new regulatory regime for the telephone network was being introduced, a process which led eventually to the break-up of AT&T in 1984. From this point onwards, the new ‘Baby Bells’ – smaller, area-based telecom providers – were no

longer allowed to discriminate against other uses of their lines. Internet Service Providers (ISPs) were granted equal access. The result, in effect, was the creation of another end-to-end innovation commons at the physical layer of the network.

At the code layer, another important source of neutrality is non-owned, open source software. This includes the Linux operating system, the Apache server and a range of ‘plumbing’ software that improves the overall efficiency of the internet. The ongoing battles over the right to monopoly control over computer operating systems are a graphic example of the troubled relationship between dominant industry incumbents, such as Microsoft, and the rise of more distributed forms of content and service innovation.

At first, it may be hard to see why such issues of network design matter as matters of public policy. But the architecture of the internet – its balance of control and freedom – produced an unprecedented explosion of innovation. As Lessig points out, entrepreneurs and technologists from around the world were able to build upon this open and neutral platform.

The World Wide Web was not invented by companies specialising in network access, but by a researcher in a Swiss laboratory. Web-based email was not created by an existing e-mail provider, but by Sabeer Bhatia, a migrant from India to the US. Online chatting was not developed by a large US telecoms company, but by an Israeli entrepreneur. All of these innovations are at the level of code – internet services. There are also thousands of innovations at the content level, from blogs and campaign sites, through to online support groups and archives of song lyrics. All help to change the ways in which people use ICTs to define and meet their myriad needs.

Digital enclosure

The history of the internet teaches us a powerful lesson. Almost every significant innovation which has added value for users has emerged from outside traditionally dominant providers. When the future is unclear, leaving technology uncontrolled is the best way of helping it find the right sort of innovation. As Lessig puts it: ‘Plasticity – the ability of a system to evolve easily in a number of ways – is optimal in a world of uncertainty.’¹⁷ Yet now, just as the full potential of the internet is being realised, old ways of thinking and patterns of corporate behaviour are reasserting

themselves. Just as we are beginning to understand the unique power and potential of an innovation commons, changes to the legal and technical architecture of the internet are eroding the freedoms which underpin it.

We can learn lessons from the history of competition within ICTs, as with past competition in other technology-related markets such as steel and oil. Those examples show us how market leaders establish their leading position. As a result of strategic innovation (or sometimes simply good luck), a company becomes dominant and then is able to control the terms on which others enter the market or access the product or service.

The rise of Microsoft, and its strategic success in retaining control of the code level, or operating system – the Windows software which it developed for IBM – is a classic example. Most of Microsoft's commercial strategy now rests on finding ways to bundle its specific content products and services, with a set of near-universal software operating systems, which it improves and refines incrementally.

Lessig points to three forms of digital enclosure, that will eventually undermine the end-to-end nature of the internet:

- *Accidental technicality* – where companies have seemingly plausible technical reasons for restricting or even prohibiting particular activities
- *Asymmetry* – where the capacity for sending large amounts of data downstream is not matched by the capacity to send similar amounts upstream
- *The defensiveness of dominant firms and organisations* – the tendency of vested interests (companies or governments) to protect their interests, to the detriment of innovation.

In the last case, as Lessig points out, businesses should not be criticised too harshly. Their priority is to maximise profits for their shareholders rather than contribute to wider social goods. It would be foolish to look to companies for the successful protection of much beyond their particular narrow interests, even despite the progress in the corporate social responsibility debate. So public policy and political decision-making is necessary to protect innovation and the public interest.

As the internet moves from narrowband to broadband, the regulatory

environment is changing. Currently, in the US, the leading technology for broadband is cable, which operates under a very different regulatory regime. Cable providers have no obligation to grant access to their facilities and they have begun to drive the development of a different set of principles at the code layer of the network. Cisco, for example, has developed 'policy-based routers' which enable cable companies to select which content flows quickly and which flows slowly. Through this technology, cable companies can pick and choose which content and applications can be accessed quickly and effectively on their networks and which cannot.

The environment for innovation on the broadband network will change, both in the US and the UK, as a result of the extent to which cable becomes the primary mode of access. Instead of a network that vests intelligence in the ends, the cable companies want to locate an increasing amount of intelligence within the network itself. The degree of neutrality at the code layer will be compromised and the longer-term opportunities for innovation will be reduced.

A related but rather different problem exists within the broadband market in the UK. Cable is unlikely to spread rapidly across the country so, for large areas of the population, BT's local loop remains the only cost-effective route to broadband access. Given the failure of local loop unbundling, the growing danger is that BT will emerge from the transition to broadband yet more firmly ensconced as the monopoly provider and will use this extra dominance to stifle new forms of network innovation.

In the light of such trends, Lessig proposes a general principle for ensuring network innovation: 'Where a disruptive technology emerges, there may be good reason not to extend the power of existing interests into power over that technology.'¹⁸

The crux of the problem is that if an open network provides a benefit to all, but the process of controlling use of that network benefits particular firms, there will be an inevitable tendency for the network to slide from freedom towards control. Where this narrows or restricts the diversity of participants involved in creating and developing applications, the capacity for network innovation is diminished.

Policy-makers and regulators need to resist this tendency and, wherever possible, safeguard the innovation commons for the public

interest. The challenge is posed in clear terms by economic historians Chris Freeman and Francisco Louca: ‘The fact that networks are everywhere forming does not dispose of the question of power within networks. A network may seldom be a partnership of equals. Some partners are usually more equal than others . . .’¹⁹

A failure to meet this challenge constitutes the ‘tragedy of the dot.common’s’. There are always powerful defenders of the status quo who seek to protect their position in the face of technological change which can disrupt their dominance.

In later chapters, we will examine how this tragedy has played out over the past few years within the UK broadband market, and how it is in danger of being repeated in the future through the process of spectrum allocation. First, though, we shall look in more detail at the precise nature of network innovation, the economic and social value it creates and why we should be trying to safeguard and promote it at all.

3. The promise of network innovation

Innovation makes enemies of all those who prospered under the old regime, and only lukewarm support is forthcoming from those who would prosper under the new.

Machiavelli²⁰

Politicians of all complexions have long placed technological change at the centre of their visions of renewal, progress and prosperity: from John F. Kennedy's moon landings and Harold Wilson's 'white heat of technology', to Tony Blair's enthusiasm for e-commerce and Bill Clinton's embrace of 'the information age', politics has long grappled with how to use technology as a managed engine of modernisation.

Yet few government projects have had a coherent understanding of the long-term dynamics of technological change. The timescales of politics encourage short-term decision-making and the tendency to over-promise. The statistics that government chooses to collect tend to reflect backward-facing categories of economic and social activity. This limited understanding needs to be overcome if the long-term promise of networked technologies is to be realised. This chapter explores the nature of disruptive innovation and the economic and social value it can create.

The potential impact of digital technologies can be better understood by placing them in a historical context. As Chris Freeman and Francisco Louca have shown, over the past two centuries, five separate technological revolutions have successively transformed the societies in which they were developed: water-powered mechanisation; steam-powered mechanisation; electrification; motorisation and computerisation. Drawing on Krondatiev and Schumpeter's 'long wave' theories, Freeman and Louca argue that

these revolutions can be understood as long waves of innovation, growth and institutional change which diffuse over time throughout whole societies.²¹ No single factor, whether cultural, economic, political, scientific or technological, is decisive in determining the path or character of change.

Instead, Freeman and Louca show that when technological innovations disrupt, rather than perpetuate, the more gradual process of technological advancement, they can create a whole shift in the future pattern of the society in which they occur. Following this critical shift the applications and impacts of the technology gradually become diffused across the society as a whole, but it can typically take half a century or more.

For example, the development of steam power, from Savery's pumping engine in 1698, through to Watt's engines and George Stephenson's first steam locomotive in 1814, had a hugely disruptive impact on the economy and contributed to the growth of industrial society.

Similarly, the innovations of the second industrial revolution, led by electricity and steel, generated a long wave of economic growth that enabled the US and Germany to catch up with the UK.

During the early part of the nineteenth-century, scientists such as Volta and Faraday experimented with electricity, and began to apply it to communications, especially the electric telegraph. In 1861, the first telegraph between New York and San Francisco was established. Alexander Graham Bell invented the telephone and telephone exchanges were set up in the late 1870s. Edison's light bulbs began to be used domestically in the 1880s.

The growth of telephone networks and electricity applications created huge demand for copper. At the same time, the steel industry began to supersede iron, through the development of new production techniques such as the bessemer process, which made it possible to supply cheap, high quality steel on a large scale.

These developments fuelled a complex process of social and institutional change. Copper, steel and electricity combined to transform the socioeconomic landscape of nineteenth-century society in ways that would have been entirely unpredictable when Cruickshank's primary battery was invented in 1800. The dominant industries of the first industrial revolutions, cotton, iron, water and steam, either lost their pre-eminence or were transformed by the fresh wave of innovations.

As the century wore on, a series of innovations in institutions appeared. They were also to have a profound effect on the shape of industrial society: a modern civil service emerged, organised around the principles of meritocracy and hierarchical administration. Joint stock companies were established, allowing a new way of pooling resources and risk for economic gain. The modern trade union developed, as a form of collective representation for the new working classes. And the modern school, which was to become the basic building block of a universal education system, emerged. And so on. All these forms of organisation played an important role in influencing the uses of and demands for the application of new technologies. All relied in different ways on the techniques made possible by technological innovation and the revenues created by them.

The life cycle of disruptive innovation

The challenge is to understand how these disruptive constellations emerge, spread and ultimately come to dominate economic and social practices, before giving way to the next disruption appearing behind it. Freeman and Louca distinguish six phases in the life cycle of a technology system:²²

- 1 The laboratory-invention phase, with early prototypes, patents, small scale demonstrations and early applications
- 2 Decisive demonstrations of technical and commercial feasibility, with widespread potential applications
- 3 Explosive take-off and growth during a turbulent phase of structural crisis in the economy as a new regime of regulation is established
- 4 Continued high growth with the system now accepted as common sense and as the dominant technological regime; applications emerge in a still wider range of industries and services
- 5 Slow-down and erosion of profitability as the system matures and is challenged by newer technologies, leading to a new crisis of structural adjustment
- 6 Maturity, with some 'renaissance' effects possible from fruitful

coexistence with newer technologies, but also the possibility of slow disappearance.

This framework should not be taken to mean that all technologically driven revolutions are identical: each wave of innovation has its own distinctive features, but there are also recurrent themes from which we can learn.

Disruptions take time to embed themselves and diffuse through society and depend on the capacity of the whole population to adapt and innovate. Such changes, like the shift from postal to email communication, can eventually be a decisive factor in the influence of technology – but the changes are themselves further disrupted by new technology applications.

From this perspective, it appears that we are roughly halfway through the wave of change stimulated by the invention of the computer. We are probably at a much earlier point on the curve of large-scale disruption, and adaptation, stimulated by digital networking. Such a long view cannot provide enough detail to determine daily policy priorities, but it can offer some clues on how to determine a pattern amid the noise and confusion of everyday change.

One important distinction which long wave theory helps to lay bare is between *disruptive* and *incremental* innovation.

- *Incremental innovation* is a continual process of small improvements in efficiency and performance within the fixed parameters of one product, business model, institution or social practice. In today's world, most organisations, from corporations to churches and from schools to hospitals, aim towards leaner budgets, higher output, expanded user groups and better market share. In order to achieve it, they eke out as much advantage as possible from their existing operations or product. This is incremental innovation: breakfast cereals are 'new improved'; schools achieve marginally better attendance records; governments allow tax returns to be completed online, rather than by post. Incremental innovation does not invest in innovations that may ultimately supersede existing products, ways of working or methods of service provision. Over the last 60 years, cars have gradually become more

aerodynamic, fuel-efficient and comfortable, but their basic shape, structure and the nature of the technology driving them has changed very little.

- *Disruptive innovation* produces changes of an entirely different order. It creates a product, business model or organisational system that drastically changes an entire field of practice. Disruptive innovation in management methods, for example, led to a lean production system pioneered by Toyota and subsequently adopted across the entire automotive industry. Teleworking represents a disruptive innovation in the organisation of work, in that it could revolutionise the nature of offices (though it has so far failed to spread in the ways originally predicted). Disruptive innovations tend to transform the landscape within which organisations operate, disrespecting or discarding traditional methods and products. The Microsoft Windows operating system, Ikea's impact on the furniture market or Amazon's approach to book retailing are clear examples. In education, home-schooling may yet prove to be a disruptive innovation which creates a change to the overall pattern of public education provision. In healthcare, the use of ICTs to facilitate home-based medical and respite care could be an innovation which eventually causes massive disruption and an overhaul of the organisation and practices of primary healthcare and hospitals.

In his book, *The Innovator's Dilemma*, Harvard academic Clayton Christensen illustrates the dangers of failing to understand the implications of disruptive innovation.²³ He suggests that companies sow the seeds of their eventual failure by only focusing on the practices and products that made them successful in the past. In the 1980s, IBM invested heavily in honing and improving its existing mainframe computers, while failing to spot the challenge posed by Apple's more user-friendly personal computers.

Christensen identifies several key characteristics of disruptive innovation which pose a significant conundrum for companies:

- Disruptive innovations tend to emerge from seemingly insignificant markets

- They initially underperform against market-leading products and brands
- Few consumers want or think they need the new product or application
- Disruptive innovations squeeze the profit margins of the older order.

By their very nature, therefore, it is often difficult for companies or governments to discern the value of disruptive innovations that are not yet fully developed. Soliciting from consumers or citizens their wants and needs, through traditional methods of market research or consultation, cannot reveal a demand that has yet to manifest itself. Many were deeply sceptical when the mobile phone first emerged. Now, those same people find it difficult to imagine life without one.

This unpredictability hampers the willingness of companies or governments to invest in risky new technologies, applications and services. The consequences of that risk aversion become starkly apparent when the new innovation arrives. Organisations are taken by surprise and have to embark on a painful, often costly, period of adjustment and assimilation. Often they find themselves, or large parts of their operation, made obsolete by the innovation.

It is equally important to realise the extent to which social, cultural, institutional and political factors influence how far disruptive innovations reach their full potential. Henry Ford's successful use of the innovation of the internal combustion engine relied, not only on his famous ability to produce cars cheap enough for his workers to buy one, but also on the creation of a public roads infrastructure. In turn, the development of roads changed the structure of major cities and the nature of retail industry – eventually, it changed the very rhythm of many people's family lives.

Likewise, the telephone, when it was first introduced, created disruption in traditional social relations. It allowed associations between people that had previously been forbidden. It unsettled customary ways of dividing the private and public realms.²⁴ Only through these wider cultural and infrastructural developments were cars and telephones fully embedded into mass society and everyday life.

Today, that same interplay between technological, economic and social effects can be seen unfolding in the digital revolution. While the long-term consequences of digital technologies remain impossible to predict, we can now map the broad contours of what ICTs are currently doing and might do in the future.

The economics of network innovation

Brad DeLong and Lawrence Summers, in their paper *The New Economy: background, questions, speculation*, remind us that digital technologies have already had a profound impact on the deep structure of our economy:

By the end of the 1950s, there were roughly 2,000 installed computers in the world: machines like Remington Rand UNIVACs, IBM 702s or DEC PDP-1s. The processing power of these machines averaged perhaps 10,000 machine instructions per second. Today . . . there are perhaps 300 million active computers in the world with processing power averaging several hundred million instructions per second. 2,000 computers times 10,000 instructions per second is twenty million. Three hundred million computers times, say, three hundred million instructions per second is ninety quadrillion – a four-billion-fold increase in the world's raw automated computational power in forty years.²⁵

But the relationship between technical advance and economic value is not straightforward. Some of the most breathless commentators of the dot.com boom argued that digital and network technologies had produced a new era of capitalism in which the normal rules of business cycle, including valuation and economic growth, had been suspended. But the technology-led stockmarket crash has led many to veer too far in the other direction. They dismiss completely the idea of long-term, technology-driven productivity growth.

In the long run, the truth is more equivocal. There is little doubt that ICTs can contribute in a number of ways to increased productivity.²⁶ Indeed, the idea that changes in the underlying technological basis of production will impact on the way economies work is well founded in economic theory. The fact that its effects are often not visible in published statistics is because change is gradual and occurs in ways that economics is

not used to measuring, such as when these effects become manifest in organisational structures or managerial culture.

There is strong evidence that the latter half of the 1990s saw a significant rise in the productivity of the US economy, some of which is attributable to ICTs. One study found that ICT was contributing about 20 per cent of economic growth in the UK by 1998. Another found that telecoms infrastructure itself contributes around a third of economic growth across the OECD.²⁷

Clearly the contribution of ICTs is not straightforward. The well-known Solow Paradox, named after the US economist Robert Solow's contention that 'you can see evidence of the computer revolution everywhere apart from the productivity figures', is still widely debated. His analysis of sector-by-sector productivity improvements during the 1990s suggests that a relatively small number of industries provided much of the aggregate increase in labour productivity in the US. While the technology industries themselves showed strong productivity growth, their wider impact was uncertain, he found.

Solow's own explanation for these improvements focuses on industries like retail and wholesale trade. He speculates that logistical, distributional and managerial reorganisation may have been the main factors in improved productivity performance. This kind of explanation takes us beyond the narrow bounds of economics, but it may illustrate further the long wave analysis. It is not the direct impact of leading edge technological innovation that produces broader improvements in economic performance. It is instead a more diffuse process of adaptation, in organisations and supply chains, which reduces transaction costs and enables innovative working practices.

This conclusion chimes with Danny Quah and Diane Coyle's suggestion, in their report *Getting the Measure of the New Economy*, that a broader range of indicators is needed to understand and monitor change in the digital economy. 'The basic lesson is clear: absence of evidence in this case should not be taken as evidence of absence,' they argue.²⁸

A recent study by Beaufort International of the role played by telecoms in the productivity growth and competitiveness of other industries also makes clear its strategic importance.²⁹ While the ongoing improvements in processing, switching and handling capacity contribute to incremental efficiency in all sectors, telecoms – and particularly broadband – play an

important part in the capacity of many key industries, such as pharmaceuticals, the creative industries and financial services, to compete.

Bandwidth and the capacity to handle large real-time exchanges of information are increasingly important to the provision of online advice services and call centres, network-based collaboration by film and animation producers and the use of modelling software by scientific researchers working in collaborative networks. The Beaufort study provides clear personal testimony, from senior figures in those industries, about the importance to their businesses of broadband availability.

Even more important is an understanding of how developments in telecoms infrastructure and access to its base technology are vital to the structure of competition and the prospects of widespread innovation. As Michael Porter's recent work on regional and industrial competitiveness has shown, the level of competition on factors like price is only one determinant of overall competitiveness and productivity.³⁰ If there is intense competition around a standard set of products and services, the chances of disruptive innovation are reduced.

In mature industries, where competitiveness arises mainly from brand and price competition, this may not be problematic, but the central premise of investment in digital technology is that it will yield more radical benefits by creating new industries and transforming old ones. This hope is often expressed in industry and government analysis by the vague expression 'high value added content and services'.³¹ This 'value added', it is generally assumed, will arise eventually from widespread access to increased bandwidth and basic services.

In Canada, which is acknowledged as a world leader in internet usage and penetration, the Broadband Task Force went as far as to recommend that government should establish a 'broadband applications development programme' to encourage ICT firms to develop innovative content and services. Yet, as our argument in Chapter 2 shows, there is no automatic reason for thinking that such applications will inevitably arise, nor that they will occur in time to compete with developments elsewhere, if the structure of competition is skewed in ways which restrict access by potential innovators to the base infrastructure and code of the broadband internet.³²

Such skewed competition can be understood as follows: that the level of competition is so low that there is little incentive to innovate, or that it

is intense and limited only to price competition around a standard set of service offerings.

Innovation is increasingly recognised as a good to be invested in, but competition policy and the legacy of regulatory approaches that we have inherited from the era of privatisation in the UK do not yet provide a coherent account of how disruptive innovation can be achieved.

Social and public innovation

Long waves of innovation need to be understood as social as well as economic processes. Indeed, the UK government has been criticised for emphasising gains in prosperity at the expense of this wider social potential and for lacking a coherent narrative which regards them both as progress.³³ This compares unfavourably with countries like Canada and Finland, where the information society, as well as the rollout of broadband, have been linked far more explicitly to a range of social and cultural possibilities.³⁴

The UK has no shortage of public and social technology initiatives. At central and local levels significant investment has gone into e-government and e-citizen programmes, but so far most of the activity has been about incremental innovation. Efforts have concentrated on the automation of certain services and the greater provision of online information. These activities should not be derided: very few citizens may want to read the minutes of council meetings online, but the provision of more government information is a positive step. It is particularly useful for non government organisations and advocacy groups. Automation of routine functions can also free up personnel to work on more valuable activities and it can save money.

However, the longer-term, disruptive promise of e-government is the development of radical new approaches to public services and greater interaction between citizens and government. To borrow from *The Cluetrain Manifesto*, a well-known statement of new economy principles, one of most exciting qualities of e-business is that 'hyperlinks subvert hierarchy'.³⁵

The potential of digital networks for facilitating more diverse, personalised and productive encounters between citizen and state therefore depends on it changing the traditional, hierarchical form that most public institutions still take. It also needs to transform the passive, bureaucratised relationship that most citizens experience in their dealings with public administration. It is not just a question of quicker, easier or

cheaper because much of what government provides depends on face-to-face or localised services. In that provision, there can be few easy productivity gains from automation.

Similarly, the reimagining of public services and community life is needed before we can begin to see the full potential of what digital networks might enable. Networks could make it possible for agencies to share information and policy processes with citizens, and for them to participate as co-producers of public goods rather than as passive consumers of standardised services. As Charles Leadbeater argued in a recent Demos pamphlet, while incremental innovation creates more efficient public services, disruptive innovation would create ‘new kinds of libraries, schools, hospitals and police services, capable of creating . . . learning, education, health and security in new ways.’³⁶

Many public technology programs have not been focused only on automation and improving efficiency, but also on tackling what has been called the ‘digital divide’. This is the gap between those who have good access to digital networks and services and those who do not have either the physical access, the financial means, the technical skills or the support and motivation to take advantage of the opportunities and benefits they provide. As these technologies continue to be incorporated and developed in mainstream societies, the relative marginalisation of those on the other side of the divide becomes ever greater. Those the other side of the gap find it increasingly difficult to catch up.

Many governments, especially those with geographically remote populations or substantial minorities of disadvantaged citizens, are concerned to ensure that access to technology connections and services is as widespread as possible, so that this gap is reduced. It is a major issue of social justice, as well as a question of the future capacity of whole societies to compete economically.

Yet, even in countries where public access through libraries and community learning centres is now widespread, the take-up of services and opportunities still depends on a complex range of factors which go beyond the physical and the economic. The danger remains, in public terms, that participation in the knowledge economy and in the digital society will become further polarised as the rate of development in knowledge-intensive sectors and geographical areas accelerates. A number of recent studies in the UK have made this clear.³⁷

In the rest of this chapter we sketch the contours of digital development in key public service areas and outline the major challenges still facing them.

e-learning

In the realm of learning and education, ICTs have already had a major impact on the administration side, but are likely to have even more profound effects when they begin to change the basic patterns of provision in schooling, work-based training and higher education. The promise of e-learning is one of an expert-rich content and curriculum, universally available, providing continual assessment, flexible combinations of instruction and learning opportunity, as well as increasingly personalised courses and guidance.

There is a clear distinction between incremental innovation, where new technologies can create gains in existing methods of delivery, for example by processing the results of millions of national tests, and disruptive innovation, where digital networks, combined with new content, may soon make entirely different forms of assessment possible.

There is already rapid growth in the provision of online content and courses, fuelled in the UK by the National Grid for Learning, a network designed to provide a mosaic of content and advisory resources and to connect every school and college to the internet. Another key initiative is LearnDirect, a university for industry that aims to provide incentives and opportunities for increasing the quality of work-based learning, primarily through virtual means.

The longer-term possibilities are genuinely radical. It could open up access to unprecedented levels of information; new connections between home, school and wider learning opportunities could be established; peer communication could be strengthened and new networks of learners, instructors and mentors could emerge. Far greater potential for accredited learning could take place in a wider range of settings.³⁸

As participation in formal education continues to grow, digital and network technologies will play a crucial role in increasing the capacity of our institutions to handle and coordinate greater numbers of learners. More than half of Canada's universities and colleges already offer online courses. Some countries, including Sweden, Singapore and the UK, are busy reinventing their national library networks to provide access to a far

wider range of information products, using digital archiving techniques.

But so far many, if not most, e-learning applications do not exploit the potential of higher bandwidth. They remain relatively pedestrian and uninspiring as a result. Furthermore, as the Chief Inspector of Schools in England and Wales has reported, IT is consistently the least well taught subject in the curriculum.

It is only when peer-to-peer technologies, combined with innovative content and applications, are developed to the point where they enable new forms of real-time collaboration and knowledge exchange that, we are likely to see these technologies integrated far more deeply into the routines of education institutions, with disruptive results. Nonetheless, again, there is a chicken-and-egg problem. Demand for innovative content cannot be forecast, while educational accreditation and practice remain stuck within the standard parameters of twentieth-century educational forms.

There can be relatively little incentive for a wider community of innovators to experiment with and develop new alternatives. This means the genuinely innovative educational software and networking tools will remain the preserve only of a small minority of institutions and visionaries. The mass of educational institutions will fall further behind the curve of pedagogical and technological development.

The government's recent creation of a Curriculum Online initiative, which will help to fund and shape the provision of digital learning resources, is an important step towards addressing this problem. Whether or not it can play a proactive role in shaping a wider innovation field remains to be seen. Understanding the anatomy of long waves of change is crucial here, because they help to expose the full range of factors which might influence the institutional transition. For whole systems to change, a critical level of pressure is needed, drawn from the unpredictable combination of economic imperatives, human inventiveness, rising public demand, changing values and political bravery. In education, as in most other areas, these factors have to be there before the full exploitation of digital technologies can take place. They are not a consequence of the technologies themselves.

e-health

E-health is another bandwidth-intensive application that demonstrates the value of a joined-up infrastructure. Its benefits derive from the ability

to link clinicians, patients, policy-makers, administrators and researchers into a shared knowledge base and to create reliable, distributed, communications links which enable clinical decisions to be made in real time between different physical locations. At the moment, the disruptive potential of e-health services is being held back by privacy and data protection concerns, as well as lack of bandwidth. Equally important, however, is that organisational and cultural innovations take place within the health sector. They are needed to ensure that innovations in communications give rise to genuine improvements in service quality.

Although the UK does not have a widely distributed or remote population as in Canada or Australia, remote diagnosis is likely to become more prevalent. The advantage of such systems is that they allow simultaneous viewing of the same material, such as X-ray images, ultrasound and other graphic and video material, involving the patient as well as other health care professionals in some or all of the process.

Online home care is also likely to become an important feature of many people's experience of health services, both for the elderly, who are enabled to live in their own homes for longer and also those recovering from surgery or illness. Again, current applications are limited by the lack of homes equipped with broadband, but evidence from pilot studies is encouraging. In Spain, broadband access has allowed 'televisits' by nurses and doctors to the homes of patients with chronic ailments. In Germany a fully interactive broadband communications project has had some success in helping the frail elderly and mobility impaired to live independently. The UK government's investment in NHS Direct and NHS Online, services which allow for referrals, initial consultations and preliminary diagnosis to be carried out over the telephone or internet, has also illustrated the potential of ICT in health. However, these services have also highlighted how lasting improvements in service quality depend on a much more complex range of other factors, such as the division of responsibilities between hospital doctors, nurses and paramedics and the protocols used to sort and prioritise cases.

e-democracy

Recent experiments with e-voting in UK local council elections had some success in improving turnout, but electronic means were trounced by postal systems in the same elections, which improved turnout by up to 11

per cent. Again this shows electronic services are not an attraction in their own right. People will use whatever medium is most convenient, and voting with pencil and paper is as easy for many as e-voting.

E-voting is perhaps the least radical of potential e-democracy applications. Other democratic activities – such as ‘online town meetings’ – do make heavy use of ICTs, but for them to work effectively, a number of social and practical changes are necessary too. Their effectiveness depends on the formation of online civic communities, so users need a new set of skills and habits. The relevant information and interaction must be provided and questions must be framed in a format that people recognise as relating to their own experiences and concerns.

One encouraging example from UK local government is the Lewisham Listens scheme, which has used digital networks as the basis for an extensive, community-based programme of consultation and negotiation with the borough’s young people about the issues that matter to them and the ways in which council and other services could be improved.³⁹

The real question is what sort of democracy do we want to be and how can ICTs help or hinder that? Most classifications divide applications of e-government into four broad categories:

- *Information* – a one-way relationship
- *Consultation* – a two-way relationship where citizens provide feedback on policies formulated by government
- *Active Interaction* – citizens actively shape policy options, organising themselves flexibly around issues and decisions to be taken over time, with government retaining overall responsibility for performance and final decisions
- *Integration* – full integration between the delivery of services at the front end and the ways that departments and agencies share information and knowledge to improve policy-making at the back end.

While information provision and consultation are increasing steadily, interactive experiments in participatory democracy, where citizens engage in framing the questions as well as the answers, remain rare.

Bandwidth is only the beginning

In each of these areas, the potential for ICTs to produce major gains in effectiveness, quality or legitimacy – in short, real improvements in quality of life – depends not just on their ability to generate new ideas or channels of communication. It depends also on reinventing broader patterns of culture, behaviour and institutional activity. Determining how we handle knowledge, who owns it, who controls it and how it is distributed is the key to social innovation in the networked society. In all of these cases, it is not just the specific content of the technology-based service that matters, but also the nature of the technology itself: its protocols and the extent to which it makes real-time, peer-to-peer collaboration possible.

In this sense, bandwidth is only a proxy for the other qualities and possibilities that broadband creates. It is not just the ability to handle ever larger quantities of data that matters, but the ways in which data can be manipulated, recombined and shared by a community of users. The real power of communications technologies can only be converted into economic and social value by an ongoing, widely distributed process of innovation. The terms on which the technology is available, and the ownership structures and forms of control which govern the technology and its infrastructure, will have a direct impact on the nature and quality of innovation over time.

The next chapter looks in detail at the problems that the UK has faced in accelerating the growth of broadband. In particular, we examine the role of BT and consider whether its control of the local access network means that the possibilities of disruptive innovation are being closed off in this crucial section of the network architecture.

4. Broadband Britain and the battle for the local loop

We have had some almost bitter conversations with BT during all of this year. . . . You hit BT with the club five times and on the sixth they finally come up with what you want. We have had almost trench warfare for much of the summer in trying to get this right.

David Edmonds, Director-General, Oftel⁴⁰

Nowhere are the dilemmas and challenges associated with network innovation more apparent than in the current debate over broadband take-up. Across government and business, there is widespread consensus about its benefits: it is always on and there is greater capacity for video streaming and other bandwidth-rich applications; it promotes improved levels of productivity and e-business, and allows higher levels of coordination when the participants in the network are far apart, even thousands of miles; and it creates a technological environment conducive to disruptive innovation.

Despite the government's lofty ambition 'to have the most extensive and competitive broadband market in the G7 by 2005',⁴¹ the UK still hovers in the lower reaches of the G7 league table. The broadband optimists, which include BT, Oftel and the DTI, accept that the UK has been slow to get started, but now point out that the pace is picking up. This is a fair point; as we have already seen, take-up has now passed 1 million customers.⁴² Retail prices for broadband in the UK are the third cheapest among G8 nations, at between £22 and £30 per month, and competition from different access networks, particularly from cable, should also help to push down prices across broadband provision. Furthermore, the process of unbundling BT's local loops, in order to create the conditions for proper competition has, however imperfectly, begun.

The broadband pessimists acknowledge these improvements in the UK's broadband performance over the past year, but still insist that unless more fundamental action is taken to increase the level and ease of access to the local loop, we will continue to under-perform internationally. Local loop unbundling has, so far, failed to deliver effective competition. Unless BT's *de facto* monopoly control of the local loop is reduced, competitors will be unable to offer innovative services through a key element of network architecture.

Such is the strength of feeling against BT in some quarters that, during the recent parliamentary hearings on the Draft Communications Bill, Lord McNally joked that BT's session in front of the committee would resemble the moment in a B-movie Western 'where they finally get the villain'.⁴³

Many networks

In order to assess the competing claims of the optimists and pessimists, it is important to determine how vital the local loop is to the successful roll-out of broadband: if there are several equally accessible networks, then the particular importance attached to the local loop is diminished. If, however, the local loop has unique qualities that are not replicated elsewhere, then the monopoly of one company over that particular asset is more problematic.

So far, the government's approach has been to encourage competition in service provision through competing networks. Its priority has been to remain neutral, while waiting for critical mass in broadband take-up before it addresses in detail the trickier political issues. One of those trickier questions is the lack of competition within specific product or service markets, another is the problem of getting rural and unprofitable customer groups connected.

This 'many networks' argument has been promoted by Oftel and by influential academics such as Martin Cave of the Warwick Business School. The argument suggests all networks should be encouraged and that competition between them will be enough to drive broadband take-up and foster innovation.

There are currently five broadband-capable networks operating in the UK: xDSL; cable; fibre; wireless and satellite.

xDSL (x Digital Subscriber Line)

DSL is a family of technologies that enable higher bandwidths by transforming a normal copper telephone line into a high-speed digital line. The speeds they enable range from a few hundred kbps, to 10–20 mbps. There are three major types of DSL technology:

- *High data rate DSL (HDSL)*, which has symmetrical bandwidth, and allows up to 2.3 mbps of data to flow in both directions
- *Asymmetric digital subscriber line (ADSL)*, which allocates most bandwidth to downstream flow towards the end-user; it enables only reduced flow in the other direction. This is the most common form of DSL in the UK
- *Very high data rate DSL (VDSL)*, which allows for far higher data transmission, but only over distances of up to 300 metres.

BT's copper infrastructure is everywhere, so DSL is the simplest means of rolling out broadband to the mass market. But BT, as infrastructure owner, has determined that ADSL will be the technology used to provide most broadband services in the UK.

Balanced against the fact that ADSL can be relatively easily deployed over an existing copper infrastructure, there are some inherent limitations in the technology. It can only be provided when the customer is within roughly 3km of a telephone exchange. It requires special equipment to be installed in the customer's home. And it inhibits the possibilities of peer-to-peer innovations, because only relatively small amounts of data can be send back to the network by users.

In addition, the cost of rolling out new infrastructure is high. That means there is little incentive to do so in rural areas. BT has tried to get around this problem by encouraging individuals to indicate their desire for broadband in particular areas. It has pledged to prioritise rolling out infrastructure where enough people close to a single exchange have signed up. But many areas lie more than 3km away from the nearest exchange. The actual pattern and layout of exchanges will need to be altered if ASDL is to become genuinely universal in its reach. Given the lack of incentives, such changes to the exchange network are unlikely to happen without some form of government subsidy.

The price of BT's wholesale and retail broadband service offerings fell significantly during the first half of 2002, leading to an acceleration of take-up. UK ADSL prices are now lower than in France and Germany, and are closing the gap on Sweden and the US.

Cable modem

The UK's leading cable operators, NTL and Telewest, compete with BT's local loop for broadband customers across around 40 per cent of the country. They are often cheaper than BT, especially for residential customers. Cable networks use a combination of coaxial and fibreoptic cable to provide a comprehensive bundled service, including digital television, voice telephone communication and internet access. Unlike DSL, which relies on a one-to-many connection model from the telephone exchange, cable modem users share a loop in a particular neighbourhood. That means there is a maximum capacity available, which is divided among the users online. That could lead to problems over variability of speed, once heavy use becomes normal.

According to the latest figures from Enders Analysis, in September 2002 there were 492,000 subscribers to cable broadband. Currently, cable can provide as much as 1 mbps of bandwidth, but it is worth noting that an estimated 140,000 of the subscribers currently using cable are connected to NTL's low-end product, which offers just 128 kbps. That's lower than the agreed definition of broadband.

Capital investment is unlikely to go into extending the reach of cable networks across the country, at least for the time being, thanks to the recent stock market slump and the struggles of many technology companies to convince the capital markets of their long-term potential for profitability. There are also deeper problems with the business model for cable rollout, which make extending the network unlikely in the short to medium term.

Fibre optic cable

Fibre allows for transmission speeds of 10 gigabits per second (Gbps), and is currently used in areas with a high density of demand for example in the business sector. However, installing fibre to replace the copper loop is expensive, which means it is unlikely to be rolled out for affordable domestic and small business use, at least in the medium term.

Fibre can also be used to extend the availability of ADSL to more

remote distribution points, where the copper loop from the exchange extends for more than 3km.

Wireless

Wireless technologies fall into two categories: mobile and fixed wireless. When third generation (3G) mobile networks arrive, they will in theory provide connections of 384 kbps, or up to 2 mbps when the user is stationary. There has been a great deal of hype about 3G, but there is also an understandable degree of scepticism, especially after the disappointing results of 2.5G systems such as General Packet Radio Services (GPRS).

The drawback of 3G connections, and wireless connections more generally, is that the quality of the connection can be very variable. To reach the maximum data flow, users need to be relatively close to a base station (so once again, speeds will be much lower in rural areas). Mobile network operators say that's not a problem. They argue they will use wireless in a different way from fixed technologies, but this problem of unreliability means that, at least initially, 3G is likely to be only a supplementary, rather than a primary platform, for communications. It will be used by employees when they are on the move, for example.

The second type, fixed wireless access, uses the radio spectrum to provide high-speed internet access without the need for wires and cables. Depending on the frequency of the spectrum signal, fixed wireless can offer speeds from 500 kbps up, to many mbps. Users have to fix antennae to the top of their buildings, which receive data from a central transmitter. It is an ideal technology for bridging that gap between the fibre backbone and the end-user one or two miles away – especially in a rural context.

The main disadvantages of fixed wireless access are high cost, the potential for unreliable connections, and the limited area it currently serves. However, with some form of government support, it could become a cheaper alternative to other technologies for reaching remote or rural communities.

Satellite

Theoretically, satellite services are the most ubiquitous solution. Transmission is available everywhere, more so even than the local loop, so satellite has great potential for servicing rural areas.

Satellite is currently mainly used only to provide one-way information flow. Its use as a two-way broadband technology is likely to be prohibitively expensive for the next few years. BT broadband satellite currently costs £70 a month, with an installation fee of £899. Also, there are logistical and planning barriers to be overcome in areas where satellites do offer only partial coverage.

Looking further into the future, however, satellite does have potential. A number of service providers are now testing the viability of broadband using the Astra satellites and there are also plans to launch a new constellation of low orbiting satellites. Cost permitting, satellite could prove to be an important part of the solution to providing access in remote and rural areas.

The pervasive problem of the local loop

According to the Broadband Stakeholders Group, it is estimated that nearly two-thirds (64 per cent) of the UK population can currently get a mass market broadband solution in the form of ADSL or cable, and competition exists between BT and cable across about 40 per cent of the country.⁴⁴ This is in line with the findings of a recent OECD study, which suggested that, throughout the OECD, 'DSL and cable modems will be the primary technologies for the short term'.⁴⁵

If we accept this analysis, we are forced to conclude that for several years to come BT's local loop will remain a vital part of the UK's broadband infrastructure.

Satellite or wireless may provide a cost-effective alternative, but that promise won't be viable for at least 5–10 years from now. Until then, BT's local loop offers the only ubiquitous access network that can operate effectively in both urban and rural areas. Internet Service Providers, among the main potential investors in and suppliers of innovation in both content and services in broadband technology, have to offer nationwide coverage, so they remain completely dependent on xDSL and the BT-controlled copper wire infrastructure. They cannot rely on an alternative platform like cable, because it does not offer wholesale products, nor cover the whole country.

BT is a vertically integrated operator offering wholesale services to suppliers of internet services, while simultaneously competing in the same retail markets for business or residential customers. Any rational analysis

would suggest that BT has a strong incentive to restrict the access of its potential competitors to its xDSL infrastructure. BT's continued monopoly of that network therefore presents a real challenge both to its competitors and to policy-makers.

In 2001, OfTel initiated a process of forcing BT to unbundle its local loops in a concerted effort to neutralise the company's dominance. One year on, it is clear that LLU has failed.

Only a couple of hundred access lines have been unbundled and BT still provides over 80 per cent of all access lines. OfTel suggests the reason for the failure is the lack of capital available in the telecoms sector following the technology slump. This may account for the failure of some competitors, but at least some viable alternative suppliers would be expected to emerge if the base technology through which broadband services could be offered was genuinely accessible. Around 40 companies originally participated in the LLU process, but now only a handful remain. Even if some companies' financial viability is open to question, this still suggests there are deeper structural problems in the marketplace.

Critics argue that BT, as a vertically integrated operator, has every incentive to exploit its market power at the level of the local loop, to the benefit of its downstream retail business. BT was actively deploying DSL in many places, getting a huge head start in rolling it out to customers, while its competitors were still struggling to get access to BT's local exchanges. Any competitor that does get access to the local loop still has to overcome BT's greater knowledge of the network and the 'information asymmetries' which mean that BT has immediate access to all the information it needs about quality and cost.

This problem of information asymmetry was brought to the fore during a recent dispute between BT and Freeserve. BT Wholesale, which supplies internet access to ISPs, is meant to place BT's own ISP, BT OpenWorld, on an equal footing with all its competitors. A so-called 'Chinese wall' exists which prevents privileged communications between the two.

Freeserve argued that this Chinese wall was not working and that BT was using its unique network knowledge to develop and market new products in advance of their competitors.

'The Chinese walls . . . may be fooling OfTel. But to the rest of us who understand the lead times needed to bring a new product to market, it's

obvious those walls are paper thin,' said John Pluthero, former Freeserve CEO.⁴⁶ In this dispute, Ofcom eventually ruled in favour of BT. The dominant incumbent held and still holds all the cards.

Since Ben Verwaayen took over as Chief Executive at the beginning of 2002, BT has attempted to counter criticism of its behaviour. It has adopted an aggressive strategy of price cuts and broadband initiatives which have attracted widespread media attention. These moves represent a perfectly rational strategy: one of taking incremental steps so that growing pressure from government and the regulator is alleviated. The result has been a new willingness on the part of many policy-makers to give BT the benefit of the doubt. 'Why does it matter as long as the UK is increasing its overall number of broadband subscribers?', we were asked by Whitehall officials. 'Shouldn't we just leave BT alone to get on with it?'

The argument against such complacency is twofold. First, the lack of competition at the level of the local loop means that many customers (in particular, those beyond the reach of cable) are faced with only *one* supplier from which to access broadband. That is profoundly anti-competitive and is likely to run against the interest of consumers in the medium to long term. The only 'competition' provided is the regulator, who can demand limits on the price that firms can charge for certain services. This is supposed to replace real competition which would drive prices down over time.

Much recent history in the telecoms industries revolves only around companies competing on price and reliability in fairly standard product offerings: after all, what people are able to do with one- or two-way communications links is relatively straightforward. Maintaining the current industry structure is likely to choke innovation, especially the disruptive innovation we have described in earlier chapters, which could create new products and services, or develop the sector. This applies both to the quality of the services being offered to customers at a retail level and to the level of investment going into developing, testing and applying innovative uses of the network infrastructure. The longer-term understanding of the economic and social potential of digital networks demands something more complex.

As we noted in the last chapter, uses of communications technologies rely on changing social practice and organisational structure, and therefore cannot be predicted solely from what people say they might

want in advance. Alexander Graham Bell is reputed to have first thought the major application for his telephone would be for people to receive music into their homes and workplaces. He could not imagine that people's rules of social etiquette would change enough for them to be able to conduct real-time conversations down telephone lines.

More recently, the explosion in text messaging took mobile operators completely by surprise. The minor handset bonus feature suddenly became one of the most popular mobile applications. Into the future, video conferencing and picture messaging offer new forms of real-time communication on a mass scale. They too will depend on people gradually adapting their expectations, social norms and behaviour.

But the broadband packages currently available do little more than offer increased speed and convenience. They do not deliver or foster innovation. The process of generating genuine innovations in the nature and quality of services depends on an open, pluralised process of experimentation, development and refinement. This kind of innovation depends on a degree of competition in wholesale services and it depends on widespread differentiation in broadband retail services. While large-scale access to the means of offering such services remains restricted to a dominant supplier, the likelihood of such distributed innovation taking root is slim. At the same time, without the promise of profitable markets in high value-added services, there is little incentive for other potential suppliers to invest in the research and development that would generate meaningful innovation.

The most concrete current illustration of this point is the case of VDSL, the new high-speed variety of DSL now being tested in BT's labs. At the moment, few envisage that VDSL will become a viable alternative to ADSL for the mass market, but a few years ago, no one would have predicted the high levels of bandwidth now achievable through ADSL on a basic copper line. The capabilities and therefore the potential applications of technologies are routinely underestimated in the medium to long term. Realising their potential depends on developing them to the point where they can be taken up at levels which make them profitable. Nonetheless whatever innovation in network capability BT introduces, BT will control.

Unless we open up the local loop to competition more effectively, we will never know for sure if VDSL could become more widely available, or even if a superior alternative to VDSL might become possible using the

same copper wire. Indeed, it can be argued that BT's early choice of ADSL as its primary access mode further reduces innovation – its asymmetric nature makes real-time, interactive peer-to-peer applications more difficult. Without better access to relevant information about the network and its possibilities, potential competitors have no means to develop alternatives. We are stuck with the chicken-and-egg problem – a linear, incremental path of broadband development, rather than one which would foster disruptive innovation.

Structural separation

Are there real alternatives to this situation? In 2001 the OECD published a recommendation concerning vertically integrated companies, which stated: 'When faced with a situation in which a regulated firm is or may in the future be operating simultaneously in a non-competitive activity, member countries should carefully balance the benefits and costs of structural measures against the benefits and costs of behavioural measures.'⁴⁷

Many of BT's competitors and an increasing number of independent commentators have argued that BT should be separated in order to speed up the development of innovative products and services and to create a level playing field for genuine competition in broadband.⁴⁸

Clare Spottiswoode, who successfully presided over the break-up of British Gas in the mid-1990s, has argued that there are significant regulatory benefits to be gained from structural separation. What was particularly instructive about the gas experience was that relationships across the industry were completely transformed, she suggested. Suddenly both regulator and regulated were pulling in the same direction, sharing an interest in improving productivity through innovation and quality improvement. Gone was the constant, damaging cat-and-mouse game between operators seeking to maximise short-term prices and market share, and regulators intervening to compensate for structural bias arising from vertical integration. The antagonism was replaced by a much more constructive and transparent relationship.

The recent study undertaken by Beaufort International examined the economic arguments for and against structural separation. Beaufort's study (using available evidence and widely accepted theories of productivity growth) produced two scenarios of the possible effects that

separation might have on incremental and disruptive innovation. It concluded that business as usual, in which BT retains its vertically integrated and dominant position, would produce low levels of disruptive innovation. The structural separation of BT, on the other hand, would produce high levels of disruptive innovation, and would have a beneficial effect on innovation and investment across the telecoms market. This in turn would be beneficial for all the sectors dependent on telecoms throughout the UK economy.⁴⁹

The economics of structural separation are rarely questioned in theory. The political reality is somewhat different. If an appetite existed to separate BT in the recent past, BT's new strategy and nervous policy-makers have stalled efforts to further this argument. The key players in policy terms – the DTI and Oftel – remain unconvinced of the merits of structural separation, a view which is perhaps best summarised in a recent paper commissioned by Oftel from Martin Cave, which concludes its benefits would be 'limited and conjectural'.⁵⁰ Ironically, it is the disruptive effects that separation would have on the progress of broadband rollout that appear to be the major source of concern.

It remains to be seen whether the creation of Ofcom will shake up this established view, and present a bolder alternative vision. In the final chapter, we look in detail at how Ofcom could create a more innovation-friendly regulatory environment. But first we attempt to anticipate similar problems of control and dominance elsewhere in the network architecture. The next chapter explores another area where innovation needs to be encouraged and sustained: the use and allocation of radio spectrum.

5. Spectrum trading and the wireless commons

Small groups of engineers who dared to think differently about collaboration and the concepts of free, open standards in networking technology built the internet. Now those same minds are looking to the freedom of the airwaves to complete their project of bringing access to the world.

Niall Murphy⁵¹

Imagine a network that is truly free. A network that you can plug into anytime, anywhere, with no more than a laptop and some simple software. A network that operates beyond the control of any telecoms company or ISP, set up and maintained by a small band of hackers, bloggers and web enthusiasts.

It may sound like a digitopian dream, but travel to Cardiff and you can plug yourself in. Arwain.net is a fast-growing, not-for-profit venture that aims to provide free broadband access using the wireless standard 802.11b. It operates as an informal club, with members placing wireless transmitters or ‘nodes’ on their homes and offices, in order to create a network mesh across a particular area, with no need for large transmitter power at the centre. Chalk symbols, known as ‘war-chalkings’, are daubed on buildings or in the street, to alert users to the presence of a nearby node. With a laptop and network card, anyone within range can access broadband speeds of up to 10 mbps, fast enough for video-streaming, gaming or downloading MP3 files.

‘It’s a no-brainer,’ says Evan Jones, who acts as Arwain’s ringleader. ‘Our network is 20 times quicker than cable, the fastest alternative. We’re happy to share the technology with anybody at all. Anyone can put up an aerial

and share the bandwidth. Even a Pringles tin can be used as a makeshift aerial.’

Providing the network originates from a stable, high-speed broadband connection (for example, through a satellite link), a succession of repeater transmitters can spread that access far and wide, creating a wireless link into high-speed communications over a large surface area. Although some ISPs have attempted to ban users from sharing their bandwidth, there’s very little they can do to stop it.

Arwain’s longer-term vision is of a wireless data cloud blanketing the whole of Wales, bringing the benefits of high-speed broadband to urban and rural areas alike, and all for a fraction of the cost of rolling out alternative networks, such as 3G or satellite.

Arwain is just one of hundreds of local WiFi networks that are springing up all over Europe and the US. Groups such as Consume.net in London, and Bawug (Bay Area Wireless Users Group) in San Francisco, are encouraging the rapid proliferation of a new generation of neighbourhood area networks.⁵² Groups are also experimenting with the same model in Edinburgh, Reading, Luton, Sheffield and Brighton. They are proving so successful that some see WiFi as posing a serious threat to the economic viability of 3G, especially as the mobile operators will need to charge high access prices to recoup their massive investment in 3G licences. While the launch date of 3G is repeatedly pushed back, WiFi is already offering a faster and cheaper option.

This is network innovation in action, and it demonstrates powerfully the argument we have made about the opportunities that are created by open and unregulated access to network infrastructure. The rise of WiFi was only made possible through the existence of a common resource: the radio spectrum 2.4GHz, on which the 802.11b standard operates. Until recently, the Radiocommunications Agency dismissed the 2.4GHz frequency as worthless. It was seen as hard to secure, vulnerable to adverse weather conditions, and too low quality for commercial applications. As a result, it was left free and open to all, a small sliver of spectrum which has provided an astonishingly fertile climate for peer-to-peer innovation.

Policy-makers and big business are now playing catch-up. In June 2002, the DTI announced that it would allow commercial services to operate at that frequency, and BT recently announced plans to create 400 WiFi ‘hotspots’ in the UK by mid-2003. Microsoft has also struck a deal to

establish WiFi networks at all branches of Starbucks in the UK and US. Yet for the moment, although they may not be as slick as commercial alternatives, the community-based networks definitely have the upper hand.

Managing spectrum

What lessons does the growth of WiFi have to offer to the wider process of spectrum allocation? Spectrum is a vital raw material for the network society and is regarded by government as a resource of growing economic importance. The consumer and business benefits it generates in the UK are worth over £20 billion a year, according to estimates by the Radiocommunications Agency. In 2001, reflecting the enhanced significance of spectrum, the Treasury asked Professor Martin Cave to undertake an independent review of spectrum management. His conclusions, which were published in March 2002, have shaped debates about Ofcom's role as the guardian of UK spectrum, once it absorbs the functions of the Radiocommunications Agency.

The Cave Review sets out an approach to spectrum management over the next ten to fifteen years, which is designed 'to encourage efficiency in spectrum use and create opportunities for innovation'.⁵³ It surveys the many existing uses of spectrum, from 3G, satellite and wireless broadband, to defence and the emergency services and suggests that the next decade is likely to see many further innovations, which will place 'an important premium on flexibility – particularly the ability to make unused spectrum in the higher bands available to users, and to redeploy existing spectrum for new purposes'.⁵⁴

The mechanism by which Cave proposes to achieve such flexibility is the introduction of spectrum trading, combined with the auctioning of new spectrum as it becomes available. This is in line with a wider trend in spectrum policy worldwide. Cave suggests that trading will give firms incentives to 'husband the nation's resources for spectrum and direct it into the most profitable uses'.

Where demand grows for a particular use of spectrum, so a trading system will ensure that more spectrum is deployed for that purpose. Over time, some of the spectrum currently reserved for the exclusive use of the Ministry of Defence and other public services could be released for alternative uses. Similarly, when analogue broadcasting services are finally

switched off in favour of digital, the spectrum that is currently taken up by the terrestrial TV channels could be reallocated for new services.

Preserving a spectrum commons

Cave's trading system has much to commend it and it does look set to be implemented through the new Communications Bill. EU legislation will make spectrum trading possible from the middle of 2003, around the same time that Ofcom becomes operational. However, while applauding the objectives of a trading system – to improve efficiency and innovation – we also need to consider whether such a system would enable autonomous, bottom-up forms of network innovation to flourish. Would it make the emergence of autonomous, peer-to-peer networks such as Arwain more or less likely?

The network theorist Eli Noam has distinguished three distinct phases in the allocation of spectrum resources. In the first phase, spectrum was allocated on a first-come, first-served basis, with no government or regulatory intervention. In the second phase, government (in the UK, through the Radiocommunications Agency) chose who got what spectrum through a system of licensing. In the present phase, it is the market that decides. Trading systems and auctions are popular with governments on right and left, who see them as great exemplars of the market in action and useful revenue-raising exercises. The billions of pounds raised by the auctioning of the 3G licences in the UK is a particularly acute example of the latter.

Yet there is an alternative model of spectrum allocation entirely ignored by the Cave Review. This is not allocating it at all, or at least not allocating all of it. Rather than assigning rights to particular parts of spectrum, another option would be make it a common resource: to allow all users access as, and when, they need it. This is the model that underpins the success of the local WiFi networks. Such innovations are in danger of being stifled by a purely market-based approach.

The main argument against such an approach in the past has been that more than one user could not share a particular slice of spectrum without causing interference. However, as Lessig makes clear, new technologies are emerging that allow some spectrum uses to be 'overlaid' on top of others. In this way, spectrum *can* be shared, and surplus capacity within the network can be diverted to the user who needs it.

The main drawback of a market-based trading scheme is that it allocates spectrum primarily on economic grounds and allows no room for public interest considerations. The Draft Communications Bill does leave some leeway for wider concerns, by stating that ministers will ‘retain powers to make essentially political judgements over the distribution of spectrum and to specify other public policy objectives and criteria that Ofcom should take into account in managing spectrum’.⁵⁵ But nowhere in the Bill is there any explanation of what would justify a political intervention in the process of allocation.

No one is suggesting that the entire range of spectrum frequencies are suddenly deregulated into an anarchistic free-for-all. For large swathes of spectrum, trading will be by far the most effective means of allocation and will indeed serve to improve efficiency and innovation. There are also technical reasons why some spectrum will always need to be reserved for single purposes: it could be dangerous if the frequencies used by the emergency services were opened up to all-comers, for example, but the mistake is to assume that we have to adopt a single approach. It is perfectly possible to imagine a mixed system, in which the bulk of spectrum is auctioned off to the highest bidder, while smaller slices of spectrum are preserved as common resources on public interest grounds.

Both Eli Noam and Lawrence Lessig have demonstrated the ways in which a market structure could coexist with a spectrum commons, to the benefit of both systems. The danger is that in the headlong rush to create a market-based system, we repeat precisely the same mistakes that we have seen at the level of the local loop: giving large players sole ownership and control of the infrastructure and limiting the possibilities for dispersed and pluralist forms of network innovation.

Key to achieving a competitive broadband environment and a new public space for innovation within spectrum frequencies is the establishment of a more responsive and adaptive regulatory framework. In the next chapter, our analysis turns to the opportunities created by the establishment of Ofcom.

6. The opportunity of Ofcom

Though it is true that we need Ofcom to be efficient, slim and effective, that is not the most important thing we need it to be. We need Ofcom to be well-founded on sound principles . . . We need Ofcom to be ambitious . . . So that, over time, it is capable of acquiring moral as well as economic authority – not something the British ever accord lightly to any body.

Ian Hargreaves⁵⁶

As we have seen, the discourse around broadband has been characterised by a mixture of hyperbole and disappointment. This is a common pattern. New technologies emerge and public expectations, fuelled by utopian journalists and the odd evangelical politician, rise to impossible levels. The temperature then plummets when it becomes obvious that these technologies are not the answer to everything. If the argument we put forward above is correct, disruptive clusters of innovation will *only* change the ways that we live and work after a lengthy period of experimentation and confusion.

The haphazard and at times contradictory approach of policy-makers can be seen, in this light, as an attempt to keep pace with the unpredictable effects of technological change. Oftel's regulatory aims and statutory powers have become increasingly inadequate as telecoms services expand and evolve through convergence. This is not surprising, given that lawmaking and the working of public agencies often move at a slower pace than markets and social life. Globalisation, the convergence of previously separate industries and general increases in the level of specialisation make the task of regulation even harder.

Now, regulators are dealing with larger, more sophisticated companies – most of which have the resources of a global corporate group behind

them. Increasingly, information about what is really happening in the regulated field is widely distributed across networks and markets. The knowledge base within the modestly sized and resourced regulator is stretched by the need simply to understand what is going on. Moreover, there is the problem of information asymmetry between large companies, the regulator and competitors. This has been particularly acute in the case of BT.

These trends help to explain why Oftel's dealings with BT have increasingly come to resemble a Tom & Jerry cartoon. The regulator and regulated expend ever more energy and resources both targeting and evading each other. This process requires the regulator to make increasingly detailed interventions and its attention to the bigger picture is lost in the melee. This process has coincided with a period of transition in the criteria used by regulators to assess whether intervention is needed. During the era of privatisation, this was mainly determined by a narrow definition of competition and often involved using price as a proxy for economic efficiency. Today it is more complicated.

Ofcom and disruptive innovation

Ofcom opens up an exciting new chapter in UK communications. Its establishment is a welcome attempt to create a more integrated and adaptive regulatory approach, but its success or failure will depend on its ability to maintain a coherent overview across the whole field and to play a positive role in the evolution of the communications environment.

To fulfil its promise, Ofcom will need not only to promote competition and consumer interests, but also to foster a climate conducive to disruptive innovation. Ofcom must not be afraid to intervene in direct and imaginative ways, to defend long-term principles against short-term vested interests and to help extend the time horizon in which decisions about technological change are made. The cautious incrementalism that has been the hallmark of some economic regulators must be replaced by a new model of regulatory leadership, confident in its defence of the public interest.

Broadband is a case in point. A simple conception of the 'consumer interest' is inadequate to cope with the complexities of this debate. Most people are not yet inspired by broadband technology, which leaves policy-makers facing a dilemma. Broadband's economic and social potential is

immense, leading some to argue that access to it should become a universal right. Yet, at the same time, the deprivations that arise from a lack of access to broadband are of a different order from those that arise from a lack of water, electricity or public transport. The sorts of public interest arguments that are made about access to the railways do not readily apply here. As a result, politicians are reluctant to intervene.

So how can Ofcom's duties and powers be framed to reflect such complexities? This chapter considers how Ofcom could approach the specific challenges of the local loop and spectrum allocation, and concludes with a wider argument about Ofcom's role in safeguarding the long-term public interest and preserving the innovation commons.

Ofcom's duties

Over the course of the Communication Bill's progression through Parliament, there has been an intense debate over what Ofcom's responsibilities should be. The communications white paper, published in July 2000, proposed that Ofcom should have three central objectives:

- Protecting the interests of consumers in terms of choice, price, quality of service and value for money, in particular through promoting open and competitive markets
- Maintaining high quality of content, a wide range of programming, and plurality of public expression
- Protecting the interests of citizens by maintaining accepted community standards in content, balancing freedom of speech against the need to protect against potentially offensive or harmful material, and ensuring appropriate protection of fairness and privacy.⁵⁷

To these overarching objectives, the Draft Communications Bill adds a set of seven duties, which include the need 'to further the interests of customers', 'to promote competition' and 'to encourage, in the interests of all persons, the optimal use . . . of the electromagnetic spectrum'. It then sets out eight factors to which Ofcom 'shall have regard' in performing its duties. These include the need for regulatory action to be 'transparent, accountable, proportionate, consistent', the interests of children, the

disabled, the elderly and those on low incomes, and ‘the different interests of those living in rural and urban areas’.⁵⁸ Finally, it notes that that all Ofcom’s duties need to fit within the wider requirements set down in Article 8 of the EU’s recent Communications Framework Directive, which is explicit about the need for innovation.⁵⁹

Among the 200 or so submissions to the parliamentary committee set up under Lord Puttnam to scrutinise the draft bill, many recommendations were made for revisions to Ofcom’s duties. Several called for the focus to shift towards citizens or consumers rather than ‘customers’. Others argued for a particular duty to take priority, or for a clearer hierarchy between the duties to be established. The committee’s final report criticised the lack of clarity in Ofcom’s objectives, and proposed a more succinct formulation, which accords far greater primacy to the public interest.⁶⁰ It also recommended that a requirement to encourage ‘investment and innovation in communications markets’ be added to the list of duties.

The terminology is important, because it defines the duties and the governance framework of the new regulator. The Puttnam committee’s recommendations are sensible, and would go some way to ensuring that Ofcom has a stronger focus on innovation and the public interest, but there comes a point where rules give way to interpretation. Much will depend on the way in which Ofcom’s Chairman and Chief Executive interpret their written mandate.

Lord Currie has wisely maintained a diplomatic silence since his appointment, no doubt awaiting the safe passage of the Communications Bill. However, some insights into his likely approach can be gleaned from a thoughtful paper that he and John Cubbin published earlier this year on regulatory creep and regulatory withdrawal.

The paper challenges the widely held view that regulatory creep is inevitable: that regulators will be unwilling to let go and indeed will be inclined over time to increase the range and scope of what they control.⁶¹ The most effective way of avoiding such tendencies is to use competition to achieve regulatory objectives. It is inevitable that natural monopolies – ‘the pipes and wires part of the business’ – will require regulation, but this monopoly element should be defined narrowly, and competition introduced wherever possible. Excessive sector-specific regulation can stifle innovation, especially where a situation of double-jeopardy arises

from companies being subject to both price cap regulation and competition policy.

If competition is promoted with sufficient vigour, Cubbin and Currie argue that regulatory withdrawal then becomes feasible. They give the example of the UK gas and electricity sectors, where less than 25 per cent of the market is now subject to price control, compared with the whole market at privatisation. Competition followed by withdrawal is infinitely preferable to regulatory creep because ‘regulation, however well it is conducted and however good the regulator(s), will always get it wrong’.⁶² Regrettably, withdrawal has not taken place in the telecoms sector.

Cubbin and Currie conclude by arguing that Ofcom should avoid a ‘shopping list’ approach to its responsibilities. Instead, they propose a single duty: ‘To promote the interests of consumers (current and future) by ensuring they have access to a diversity and pluralism of content provision, economically supplied and distributed, in the telecommunications, broadcasting and media sector’.⁶³ To achieve this, they argue that Ofcom should be charged with using competition wherever possible to achieve its regulatory objectives. This will avoid the dangers of regulatory creep and ensure that Ofcom is not so overloaded that it is unable to make effective interventions if it needs to.

Ofcom and the local loop

The most controversial section of Cubbin and Currie’s paper concerns the role of industry structure in enabling regulatory withdrawal. In the gas and electricity industries, it was the separation of distribution from supply that allowed Ofgem to withdraw from price controls, but in the telecoms sector, structure still acts as an obstacle: ‘Telecommunications and water now stand as islands of vertical integration in a sea of competition.’⁶⁴

Their solution: ‘We believe that the fastest and best route to regulatory withdrawal in telecoms is for BT to separate its distribution business from its business of supplying services . . . A dominant vertically integrated player provides the perfect justification for regulatory intervention.’⁶⁵

They suggest that Oftel’s current approach to regulating BT creates a self-perpetuating need for more regulation. Vertical separation would not only avoid regulatory creep, but in the longer term it would create the conditions for regulatory withdrawal. Wireless, cable and other networks would present real competition, on equal terms, for the local loop,

replacing the regulator's need to act as dummy competition in other ways. Most importantly, it would remove the problem of BT's integrated monopoly and would shift the regulatory focus away from issues of discrimination towards price regulation.

Our research supports this position. Policy-makers should not allow BT's belated success in boosting the number of broadband subscribers to blind them from fundamental questions about industry structure, and the extent to which BT's monopoly, at the level of the local loop, could inhibit disruptive innovation in the medium to long term. There is a compelling case for Ofcom to look afresh at this issue. We recommend that Ofcom, when it becomes fully operational, should immediately set up a review of competition in the telecoms market, and include within this a cost-benefit analysis of the structural separation of BT.

If such a review were to conclude that structural separation should proceed, what form would it take? It is usually envisaged that BT's entire local access network would be hived off into a separate LoopCo. The new company would supply access to the local loop on a non-discriminatory basis to all retailers, service providers and network operators. Because it would not be allowed to provide retail services, LoopCo would no longer have any incentive to act in favour of a vertically integrated retail business. The regulatory burden currently enjoyed by Oftel would diminish for Ofcom. There would still be a need for some price regulation of the access network, given its monopoly nature, but this would be far simpler than the current regulatory tussles between Oftel and BT.

Ownership structures

For separation to work effectively, the two businesses would need to be entirely distinct entities. Attempts elsewhere to separate dominant businesses under the umbrella of a single holding company – for example, NTT in Japan – have failed to overcome the problem of discrimination.

It is generally assumed LoopCo would exist as a public limited company. Indeed, in 2001 BT received a bid for its network from Earthlease, reinforcing the idea that LoopCo could operate as a viable business in its own right.⁶⁶

But LoopCo plc is not the only option. In 1995, Demos argued that structural separation should form only part of a process of fundamental reform. Just as important as questions of structure are questions of

ownership. In imagining LoopCo, we need to think about the type of ownership structure that would best reflect the properties and possibilities of the network era.

This question links to a wider discussion that is ongoing about the future of ownership and the public interest within the former utilities. Twenty years on from the privatisation of BT, a growing number of commentators are questioning the success of the privatisation experiment. This questioning has been accelerated by the disastrous management failures at Railtrack and deepening public scepticism about private sector involvement in the London Underground, air traffic control and other public services. In a recent article, the economist John Kay argues that ‘the plc model has not worked especially well for natural monopoly businesses, and in several cases – railways, air traffic control, water – is currently unwinding’.⁶⁷

A particular problem he identifies is that the plc structure lacks legitimacy. In a market economy, where legitimacy is derived either from success in the marketplace or from accountability to a political process, plcs which are monopoly providers of public services fall uncomfortably between two stools. As a result, ‘their activities are resented, their failures seized on and exaggerated’.

There is a relatively simple reason for this. Plcs have proved an enduringly robust form of risk-sharing and capital pooling for investors. They are an organisational form which succeeds in competitive markets. The primary duty of a plc’s directors remains the creation of shareholder value. That can be problematic where a major source of the revenue needed to make the company viable comes from government subsidy, as was the case with Railtrack.

Such companies have to contend directly with public interest concerns, and therefore with politics. The playing field becomes a very muddy one.

Where the entity itself needs to operate in a way which facilitates innovation among the wider range of contractors and service suppliers using its infrastructure, as is the case with many forms of natural monopoly, the considerations affecting priorities and investment decisions are yet more complex. There are likely to be conflicts between the demands of shareholders and institutional investors, and the medium- to long-term interests of the public in terms of access and innovation.

Kay believes the way forward may lie with a new generation of ‘public service corporations’, which are not plcs, and necessarily require some

degree of political involvement to resolve difficult trade-offs in the public interest. At the same time, they would still be sufficiently removed from direct state control to deliver the improved efficiency and customer service that has accompanied most privatisations. As Kay puts it, ‘the freedom to drop bedpans, and the obligation to pick them up later’.

Will Hutton has made a similar argument, by suggesting that the provision of a universal broadband network is a public good that should not be privatised.⁶⁸ Railtrack’s change of ownership structure to Network Rail reflects the government’s desire to find a different kind of solution, albeit one that was forced by events. Yet big questions remain about the structures and qualities that such entities would need to succeed.

Back in 1995, Mulgan and Briscoe’s preferred solution was the Visa model: an organisation equitably owned by all participants, which distributes power and function and does not allow any one faction or organisation to dominate decision-making. How did they see this working in the telecoms market?

*All service providers would have a share of the ownership of the main network infrastructure. Instead of consumers paying the infrastructure operator for the privilege of communicating, service providers would pay for the privilege of accessing networks of consumers.*⁶⁹

The central idea is that the infrastructure ownership is dedicated only to maximising the volume and range of applications that could be possible using its core of common resources: in this case primarily the local loop, but conceivably other kinds of network infrastructure in the future.

The Visa Corporation provides the means for thousands of different financial service providers to offer their own specific services through a shared network. It should likewise be possible to create a common interest in base network technologies. The physical architecture and supporting technologies would be made as widely available as possible and be able to support the widest possible range of applications. This would add value for users, accelerate and deepen the process of innovation, and embed an interactive broadband culture more widely in British society.

If such a corporation were regulated by an authority which took innovation seriously, the combination of competition and public interest

pressure could become potent in a way that the government's various efforts to digitise society and the economy currently are not.

It might be possible to create a network-based, Visa-style public interest corporation, that would combine a dispersed, network-based structure with a high degree of public interest accountability. Finding the right governance arrangements would be key. One option would be to create an Executive Board made up of LoopCo customers, in turn accountable to a wider network of stakeholders. Membership of the network consortium should be open to new entrants, so that service providers could come and go as the communications marketplace continued to change. The Ofcom review could be asked to devise the best framework. To further develop thinking in this area, **we recommend that Ofcom, in its review of competition in the local access network, should identify the blend of ownership and governance structures that would most effectively safeguard a common space for innovation.**

Interim remedies

An Ofcom review along these lines would inevitably be lengthy and complex. In the meantime, **we recommend that Ofcom puts in place a range of short-term behavioural remedies to improve competition within the local access market.**

There are several ways in which this could be done. One would be to push for a legal, rather than the current financial, separation of BT. This is a less onerous form of separation. As in the gas industry, it could act as a halfway point between the existing system of accounting separation and a full structural separation. It would provide a far higher degree of transparency, which in turn would lessen the information asymmetries between BT and its competitors and improve Ofcom's ability to regulate the local loop.

Second, if the main feature of a separate LoopCo, when it is established, is that it would treat all operators equally, then BT Wholesale could perhaps now be required by Ofcom to operate a single ordering process for all operators, including BT Retail.

A third improvement would be to reverse the burden of proof. Instead of requiring Ofcom to identify that an action will be discriminatory, BT would have to show that any action would not be.

Finally, Ofcom should introduce some general improvements to

procedure which could speed up the process of conducting investigations. In evidence to the Puttnam committee, several of BT's competitors complained about the painfully slow pace of Ofcom decision-making. 'Economic regulation needs to take place at internet speed: and by this, we mean broadband internet, not dialup,' NTL said in its submission.⁷⁰ This point was picked up on by the committee, which called for a new time limit of four months to be placed on Ofcom investigations.

Each of these remedies could play an important part in improving the effectiveness of regulation under Ofcom. Yet it is also important to remember that moving from a structural remedy to a behavioural remedy represents a move away from the promotion of pro-competitive behaviour, towards the constraint of *anti*-competitive behaviour. Intervention to change detailed behaviour also increases the pressure towards regulatory creep. Overall, *behavioural* remedies are likely to be less efficient than *structural* ones, especially in the medium to long term.

Ofcom and spectrum allocation

Turning to the debate over wireless spectrum, the challenge for Ofcom here is to develop a system for allocating and managing spectrum that sets innovation and the public interest alongside economic concerns. Should all the spectrum that becomes available over the next 10–15 years simply be auctioned off to the highest bidder, or is there an argument for ringfencing a 'spectrum commons', which would allow autonomous, peer-to-peer innovation to flourish?

As we noted earlier, the Puttnam committee has asked for clarification on the circumstances in which political judgement might need to be used alongside economic considerations in determining the allocation of spectrum. It has also called for closer parliamentary scrutiny of the framework for spectrum trading than is proposed by Professor Martin Cave's review. The committee's concerns appear to centre on questions of the public interest, but they have been insufficiently bold in defining what the public interest requires in this instance.

Our analysis leads towards a clear proposal. **Alongside the spectrum trading scheme that is now being developed, it is vital that Ofcom reserves a modest share of spectrum as a common resource, which can be used for grassroots innovations such as WiFi.** The ideal mix would be a spectrum framework that includes both a commons and a traded component.

Furthermore, when the switch-off of analogue TV services takes place, it would be particularly appropriate to allocate a share of the spectrum that is currently used for public service broadcasting – BBC1, BBC2 and Channel 4 – to a public interest commons: a form of ‘citizen’s band’ for the digital age.

Ofcom has the opportunity to pioneer a radical new approach to spectrum management that could one day make Britain the envy of the wireless world. Given the uncertainties and almost limitless possibilities for the use of spectrum in the long term, a public–private mix offers by far the best recipe for disruptive innovation. As Lessig has argued, ‘We should begin, as much as possible, as we began with the internet: by building a regime that by design leaves a significant part of these resources in the commons. And once we see how that commons gets used, we can then change how that commons gets controlled.’

Surfing the long waves

One of the government’s aims in the Draft Communications Bill is to establish a policy framework ‘characterised by both resilience and adaptability for the future’. A central challenge for Ofcom will be developing regulations capable of anticipating and adapting to disruptive innovation and long-wave technological development. Both will inevitably characterise the communications environment over the next 10–20 years. Achieving this will not be easy.

As David Doherty of Telewest remarked in his evidence to the Puttnam committee, ‘If this committee had been sitting around in 1992 thinking about the next ten years, it would . . . in all likelihood . . . have missed the internet, and it would probably have missed broadband and digital, which are the three main transformers of the modern industry over the past ten years.’

Ofcom will need to build a culture that is flexible, adaptive and grounded in a cycle of continual learning. It will need to invest considerable time and energy in building an integrated whole, resisting the tendency to slip back into the silo, or compartmentalised, approach that has defined communications regulation in the past. It should seek to experiment with its own organisational structures, management of information and knowledge of how innovation occurs in the various spheres where it will have an interest. This may seem like a detailed,

technical and relatively insignificant issue, but it is crucial to Ofcom's wider capabilities and effectiveness as a regulator. It should be able to operate as flexibly as possible. Its role should not so much be to intervene only in a single demarcated area of market activity or public policy, as to maintain a proactive interest in the broader field. As a result, it could engage with a wider range of expert knowledge and harness other capacities for intervention, such as through competition authorities.

Conclusion

There is no doubt that, in the long run, digital and network technologies will contribute to deep change in British society: to the sources of economic competitiveness and prosperity, the quality of life, and the nature of governance and public decision-making.

This report has argued that the most important dimension of this change is not the speed at which the technologies we know about are rolled out, but the innovative capacity of society as a whole and of key sectors within it.

This capacity is itself determined by many different factors, but the underlying structure and governance of the industries most directly concerned with technological invention and application is absolutely fundamental. The British government's approach to communications policy has created a rare opportunity for a set of decisions that could genuinely influence the direction and the quality of technology-related change over the next generation. If Ofcom can rise to the challenges set out, it will define a new mode of regulation: a mode that fosters disruptive innovation and leads the world in showing how to harness the drivers of technological change for the common good.

Taking the opportunity depends largely on the extent to which we are prepared to value the rewards of long-term investment over tough decisions in the here and now.

Notes

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'We recommend that it be the principal duty of Ofcom, in carrying out its functions –
(a) to further the long-term interests of all citizens by – (i) ensuring the availability of a diversity and plurality of high quality content in television and radio and (ii) encouraging the optimal use for wireless telegraphy of the electromagnetic spectrum; and
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