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Enabling the Information Society by Stimulating the Creation of a Broadband Environment in Europe

Analyses of Evolution Scenarios for Future Networking Technologies and Networks in Europe

Maarten Botterman, Robert H. Anderson, Paul van Binst, Jonathan Cave, Martin Libicki, Andreas Ligtvoet, Robbin te Velde, Gert Jan de Vries

RAND Europe

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TABLE OF CONTENTS

Executive summary

How can Europe become, "*the most competitive and dynamic knowledge-based economy in the world, capable of sustainable economic growth with more and better jobs and greater social cohesion*"?

Central to this goal are networks and networking: not only telecommunications but also information technology writ large. Their capability and performance are crucial for creating a globally competitive environment. Accordingly, the European Commission's eEurope Action Plan focuses on investing in a cheaper, faster, and more secure Internet. Increased competition is seen as a crucial step in the way forward to achieve cheaper Internet access and higher bandwidth capacity.

This report is the result of a study commissioned by the Directorate General Information Society of the European Commission to create a better understanding of the pace and direction of developments in this area, mapped against an uncertain future, and to recommend policy options for government intervention as a background against which political decision making can take place.

The study provides an analysis of the development of electronic networks in Europe and North America and its technical, economic and political drivers. It includes four scenarios depicting possible futures of electronic networks in Europe, a framework for policy formulation, analyses of selected current policies and observations regarding possible policy measures and the input of experts and stakeholders in the field during a workshop in Brussels, and concludes with a series of observations and recommendations for policy action and further research.

Networks in general, and broadband networks in particular, present a unique opportunity to public authorities. Because they are open, common resources where market and regulatory decisions are likely to affect a wide range of participants, they challenge existing conceptions of governance. In the wake of recent (positive and negative) developments in the unfolding of the 'New Economy,' expectations are heightened and volatile. Novel technological possibilities combined with European leadership in 2G mobile telephony put European government institutions squarely on the 'hot spot' - there is abundant evidence that private (and civil society) entities are looking to public bodies to provide leadership in shaping the unfolding of the network and realising its enormous potential social and economic benefits.

Starting from the analysis of historical development and identification of drivers for the evolution of broadband the experts that gathered for the workshop agreed on the following observations and recommendations:

1. The primary carrier for broadband in the EU will be fibre optic cable to businesses, institutions and homes (bridging the years to come in combination with copper etc, and also in the future with satellite as back-up option for remote areas).

2. Broadband, ubiquitous networking infrastructures should be based on open, non-proprietary standards. Governments should be active stakeholders in the development of these standards, but not assume sole responsibility.

3. Public sector bodies can act as 'launching customers', using procurement to encourage and support appropriate and sustainable broadband development.

4. Municipalities should have a primary role in creating environments that use and nurture the deployment of fibre optics. Their actions should include the development of plans for establishing a network of conduits and points of aggregation to complete existing networks and, crucially, to allow multiple service providers easy access to a common infrastructure.

5. Further research is needed regarding the appropriate role of competition and economic stimulus in providing the necessary conduits, fibre and services.

    a. Study is needed on appropriate models for investment and operation.

    b. The principle is to use competition wherever appropriate. However, for some aspects of these networks, unfettered or ill-regulated competition may lead to redundancy, lack of investment money, prices that inhibit uptake, gaps in network coverage or structural changes in the industry that destroy co-ordination advantages or create too much market power. To prevent this, additional measures may be needed.

    c. Allocation of public resources should be co-ordinated at the right level of authority. For example, allocation of scarce electromagnetic spectrum should be harmonised at a European level, while siting of local conduits and poles and allocation of scarce Point-of-Presence space (i.e. servers etc.) should be undertaken at a municipal level.

6. IPv6 is necessary for effective broadband scaling and security and is a precondition for effective 3G mobile access to broadband networks. For that reason government should consider facilitating this transition. Research topics requiring attention include:

    a. Policy and technology solutions to overcome gaps with trading partners that lead or lag in the migration towards an IPv6 environment.

    b. Analyses of financial impacts on European businesses and institutions that must convert extensive private IPv4 networks to IPv6.

    c. Policy incentives and technology solutions to reduce transition costs and stimulate migration towards IPv6.

7. Co-ordination of research and technology development among trading blocks is crucial in the area of global technologies.

8. Security is vital for trust and confidence within the emerging broadband network and must be considered at all layers.

    a. Identification of online individuals and institutions should be the norm, but with anonymity an available option. For security purposes, and with appropriate legal authorisation, tracing should be possible under all circumstances.

    b. Individuals should have access to and control over information gathered about them.

9. It is vital for broadband services to provide access to increasing amounts and types of content, including public information. Limiting copyright to a period comparable to patent protection should be strongly considered.

10. Universal Service entitlements should be upgraded to include a minimum level of broadband access.

    a. Completion of the network, including assuring that broadband is available in rural areas, may require government subsidies.

    b. For some rural or remote regions, satellite-based access to broadband services may be the most effective means of providing universal service.

11. To ensure that 3G networks develop in a way that provides an appropriate complement to fixed broadband networks, research is needed to identify policies that address dangers to competition and innovation arising from fragmented spectrum allocation and licensing procedures.

12. While it seems inappropriate to forgive or buy back debts incurred as a result of 3G licence allocation procedures, consideration should be given to measures designed to minimise their impact on equitable, efficient and rapid development of wireless broadband.

Although the *areas* of necessary policy activity were well established by overwhelming consensus of the workshop participants, it is clear that in many areas more socio economic research and policy analyses are needed to pin down *what* can be done and how to ensure its (cost) effectiveness. This includes *mapping* of the current state-of-the-art, *benchmarking* and "*best practice*" research at strategic and more practical levels. For new approaches and new technologies for which such experience does not exist, facilitating *pilots* of interest complements this.

The policy recommendations of the workshop emphasised the following need for action:

- Getting the right infrastructure in place:
    - Open, non-proprietary and user-led standards;
    - Standards co-ordination across trading blocks;
    - A dependable information infrastructure built for massive participation, mobile access and built-in security (NB: IPv6 is an important step in this direction!); and
    - Reaching out to "everybody" through ubiquity and inclusiveness.

- Support by the right regulation:
    - Appropriate use of competition and economic stimuli in providing infrastructure and services (including revision of licensing regimes);
    - "Upgraded" universal service bundles, obligations and payment mechanisms; and
    - Identity, privacy and security protection in context.

- The role of government as actor in the market:
    - Establishment of network of conduits and poles (or even fibre) in the local community;
    - Leading by example; and
    - Supporting the standardisation process in order to protect the interests of society at large.

- Research and development:
    - R&D collaboration across trading blocks;
    - Technologies for cheaper and faster access to information and communications
    - Technologies to enable "remote regions" to participate in the broadband network against affordable costs

Most cost effective would be an approach in which a balance of regulatory reform and development assistance creates the right environment for a self-sustaining state-of-the-art network environment in Europe, based on the considerations presented. Public networks and research networks can play a distinguished role in ensuring the long-term success of European telecommunication networks in two ways: acting as leading customer, or temporary assistance to overcome barriers to commercial sustainable network development stemming from (perceived) financial risks or excessive short-sightedness on the part of investors.

It is important to recognise that broadband is useless without content and services. In this the public sector can play two vital roles: (1) as a provider of –more– information and services and (2) as a stimulus to increased availability of cultural and artistic content through subsidies for creation and dissemination and –possibly– by reconsidering the appropriate scope and extent of intellectual property rights protection to balance availability and incentives.

Competition is one of the key drivers to the development of broadband. However, there are limits to the extent to which competition can be relied upon, particularly in areas in which investments or other scarcities tend to inhibit entry, or where economies of scale would lead to economic inefficiency associated with an excess of competition. The guiding principle is to recognise the advantages (diversity, efficiency, transparency) associated with competition in traditional markets, and to adjust public policies in such a way as to reap those advantages in the broadband networked environment.

Direct involvement of public actors in the *provision of infrastructure* is considered. In particular, in areas where the market may not be able to develop inclusive information infrastructures, government may consider playing a more direct role. Public funds to help matching investments in (broadband) infrastructure for remote areas are already available under the European Structural Funds.

This public leadership must recognise both the need to act in certain areas and the equally pressing need to refrain from acting in areas where self-governance will be sufficient or where critical technological and market uncertainties must be resolved before appropriate policies can be identified.

The upheavals of the past few years, from widely-varying costs associated with 3G licence allocation to 'corrections' in overheated new technology company stock markets predictably lead to calls for support, if not outright subsidy. Many of these have merit, and clear identification of the appropriate roles of government, market and civil society forces is an essential prerequisite to sorting out, those areas where intervention is warranted, from those areas best left to market forces or other forms of self-regulation. This is not a call for laissez-faire inaction: government cannot avoid its responsibilities in this area without missing vital opportunities and taking on unnecessary risk. Rather, it is a clear recommendation for a transparent, unbiased and determined policy response to this challenge. It is patently obvious that government will make a difference in the evolution of this vital underpinning of the Information Society evolving. The framework developed in this study and the perspectives and recommendations developed in the study and the workshop represent a sound basis for facing up to this challenge, and act in a cost effective way.

Foreword

In supporting and stimulating the creation of an inclusive Information Society an important emphasis has been given on creating the enabling information infrastructure (eEurope Objective 1: Fast and secure Internet). This report is the result of a study commissioned by the Directorate General Information Society of the European Commission to create a better understanding of the pace and direction of developments in this area, mapped against an uncertain future, and to recommend policy options for government intervention as a background against which political decision making can take place.

The study provides an analysis of the development of electronic networks in Europe and North America and its technical, economic and political drivers. It includes the construction of four scenarios depicting possible futures of electronic networks in Europe, a framework for policy formulation, analyses of selected current policies and observations regarding possible policy measures and the consultation of experts during a workshop in Brussels, concluding in a series of observations and recommendations for policy action and further research.

The workshop brought together a group of distinguished experts and stakeholders, and resulted in a number of policy observations and recommendations. These observations and recommendations, as shared by the experts and stakeholders participating to the workshop, are presented separately in chapter 5.1. Further analysis of this leads up to our conclusions as presented at the end of chapter 5.

From the study it is patently obvious that government will make a difference in the evolution of this vital underpinning of the Information Society, even though non government forces will play the major role. The most cost effective approach will exist from a combination of regulation and assistence of market developments, depending on political choices. The framework developed in this study and the perspectives and recommendations developed in the study and the workshop represent a sound basis for facing up to this challenge.

The work involved many consultations with world leading experts and stakeholders. The project team has greatly benefited from their insights. In particular the workshop helped focusing the analysis on the issues as perceived by industry and academia. A full list of experts participating in the workshop is presented in Annex 1, a list of other experts consulted is presented in Annex 2.

Finally, special thanks are due to Stephan Pascall, Bernard Fabianek and in particular Owe Borgstrom and Stuart Carruthers of the European Commission for their support and constructive feedback during the last phase of the project.

1 Scenarios for the future of broadband networking

How can Europe become, "*the most competitive and dynamic knowledge-based economy in the world, capable of sustainable economic growth with more and better jobs and greater social cohesion*"?[1]

Central to this goal are networks and networking: not only telecommunications but also information technology writ large. Their capability and performance are crucial for creating a globally competitive environment. Accordingly, the European Commission's eEurope Action Plan focuses on investing in a cheaper, faster, and more secure Internet.[2] Increased competition is seen as a crucial step in the way forward to achieve cheaper Internet access and higher bandwidth capacity.

Hence the need for, "*Analyses of evolution scenarios for future networking technologies and networks in Europe*." A better understanding of the pace and direction of developments in this area, mapped against an uncertain future, and the potential of government intervention (both in terms of regulation and for support of R&D efforts) will provide the necessary background against which political decision making can take place.

Were there a single word to describe the goal of all this it would be "broadband." Put simply, Europe is said to want and need broadband networks. But before plunging into investigating precisely which policies are most likely to get Europe there best, one must be explicit about what broadband is, and why broadband is in Europe's public interest.

1.1 What is Broadband?

Broadband is conventionally defined simply as the ability to receive (and in some cases transmit) information at high rates of speed. The exact boundary between narrowband and broadband is a matter of dispute, with various estimates running all the way from 128,000 bits/second (e.g., the 2B lines of full-fledged ISDN) to something in excess of 2,048,000 bits/second (e.g., E1).

At present, there are *six* competing ways to get broadband into homes and small offices.

- Via cable and cable modems. In essence, a time-slice of the neighbourhood coax line is devoted to Ethernet-like service that patrons access via cable modems. Although current implementations of this service run at one to two megabits per second, service slows down during peak hours.

- Via telephony and ADSL (asymmetric digital subscriber lines). This is a full-fledged high-capacity circuit that permits broadband from the Internet to the user and narrowband from the user back to the Internet (hence "asymmetric"). Rates vary from 500,000 to 2 million bits per second. The roll-out of this service has been hobbled by limitations (users have to be within a few miles of a switch, certain types of analogue equipment must be removed from phone lines, and ADSL installers need to be trained).

- Via third-generation (3G) digital wireless. 3G wireless promises anywhere from 384,000 to 2 million bits per second, but these are under laboratory conditions. Although European phone companies have spent 110 billion Euro to purchase the necessary spectrum the infrastructure to take advantage of such spectrum has yet to be built. An interim second-and-a-half generation (2.5G) wireless service may appear sooner and persist; it promises 64,000 to 384,000 bits per second.

- Via satellite. Two manufacturers of very small aperture terminals (VSAT), Gilat and Boeing (née Hughes Aircraft), are among those offering or planning broadband (500,000 bit per second) service delivered via satellite. Such service can be received in the most remote locations, but

[1] The explicit strategic goal adopted by The European Council on 23-24 March 2000 in Lisbon, Portugal.

[2] Creating a common framework for all converging sectors, for instance, motivated the EC to launch a 1999 Communications Review.

because the economics of satellites are improving much more slowly than its competitors, almost anything else is more cost-effective in the long run if connectivity exists.

- Via fixed wireless: multi-channel multipoint distribution systems (MMDS) and local multipoint distribution systems (LMDS). In the United States they have been granted some spectrum (at the 38GHz band) for experimentation. They promise up to a megabit per second of service, largely in major metropolitan areas, but suffer from technical limitations, security problems and are of limited relevance outside cities[3].

- Via fibre. Fibre is a technology, not a service, although services (such as ADSL) can be run over it. But see below.

But broadband may also be understood in terms of what one can do with an infrastructure, more than the characteristics of the infrastructure itself. As such, it has three dimensions: depth, breadth, and mobility.

Depth is analogous to transmission speed. Today's service levels largely top out at 64,000 bits per second. The quest is for what lies beyond: seamless video telephony, multi-party conferencing, the rapid transfer of detailed two-dimensional images, white-boarding (the ability to exchange voice, data, and graphics in a single application), simulation, and ultimately video-on-demand. Note the emphasis on interactivity and social functionality in this list, which only terminates in the single passive use mentioned.

Breadth refers to what percentage of the population enjoys certain de *minimus* levels of capability. This is more than simply a social concession to the have-nots. Instead, just as one phone does not make a network, a certain level of social participation is necessary to enable network-based functionalities. Until such time, the opportunities for digitising the delivery of services, for instance, becomes a cost driver while the systems for serving everyone else through analogue methods has to be retained at full cost.

Mobility responds to the need for flexibility in time and place of communications. Desktops have their place (for those who have desks, at any rate), but being able to deliver high-quality communications to mobile portals permits people to take advantage of network connectivity everywhere they go. Besides making connectivity more useful, it emphasises the one aspect of information technology where history suggests Europe can expect to build and maintain a global lead.

The three goals -- a deeper, broader, more mobile network -- would all contribute to making Europe an information society. It is easy to claim they are antithetical goals; in some cases the tension is apparent: for instance, universal service is often purchased by subsidising basic service and taxing extended service. Nevertheless, policy should, at least *ab initio* treat them as complementary goals.

The rationale for a proactive EU policy for broadband would rest on three premises.

First, as with most infrastructures, the more of it Europe has (in terms of availability, affordability, access and quality), the more competitive it will be internationally. This holds for both users and suppliers. Europe's early and successful plunge into second-generation cellular service goes a long way to explaining why European companies dominate over half of the global market for handsets; ditto and conversely for U.S. dominance of the personal computer (assembly) and Internet markets. Insofar as the advent of broadband technology may call forth new media (just as movies created Hollywood, or computers brought forth the Japanese video games industry), Europeans may, if sufficiently wired, get a new chance to compete in a field that has yet to be locked into a particular geography. So, broadband is part of the competitiveness package.

Second, if broadband technology intrudes into European society without any guidance, its long-term effects may be at variance with European values. Whereas European policies aim at an "Information Society for All", greater informatisation in the United States has been associated with a winner-take-all mentality. Many fear that the attraction of cyberspace may come at the expense of traditional communities; paradoxically, the easy welcome tendency of users to see themselves as citizens of a cyberspace without national boundaries may divert people's attention from historic reciprocal obligations to the person next

[3] Two of the market leader, Winstar and Inteligent, are on the verge of bankruptcy

door, and may even support strengthening of a community spirit through electronic communications (e.g., Irish Community). With eighty percent of the world's Web content in English, the viability of every other language, notably those with few speakers, is in play. Finally, although the EU has generated distinct policies to protect privacy, in a borderless cyberspace, many such policies can be routed around with ease. It should be added that broadband can be positively used to hold up and strengthen "European" values.

Third, by contrast, national policies to guide and promote broadband development cannot do the complete job. The EU as a whole has economies of scale (e.g., for research and development, or for effective standardisation) that greatly exceed those of any member governments. Further, many of these governments have only recently shed their former PT&T monopolies, and lingering ties may introduce artificial constraints into policymaking.

1.2 Objective and Outline

The objective of the study is to identify the drivers for broadband development, both in historic terms, and through the use of scenarios, in terms of potential futures, and subsequently to recommend policy actions in order to boost broadband development in a cost effective way.

For this, building on the concept of drivers, this report articulates and assesses a set of policy levers that would not only accelerate the deployment of broadband but do so consistent with European values (e.g., a society for all, identity). The aim is to contribute to increasing European competitiveness and providing state of the art networks in Europe

The route from drivers to policy is made up of several segments that start from history, evolve into a set of futures, and then return to the present to consider what policies may best deliver Europe to the kind of future it wants.

Chapter Two examines technologies and markets, notably in the context of the Internet, with its roots in research networks, only recently being overtaken in capacity by commercial networks. It quickly moves to a focus on the role played (or not played) by government policy: which policy aims were pursued, with what policies, and to what effective ends. By subtopic, the chapter discusses successively: the U.S. experience, the European experience, research networks, and wireless broadband before concluding with an analysis of common and divergent drivers.

Chapter Three is about the future. The first part looks at existing trends and programs, notably convergence as a trend, and future research networks as the focus of programming. The second half takes a look at four alternative futures: roses, tulips, bromeliads, and snowdrops – with the aim, not of prediction, which is anyway impossible, but to span the likely event space within which policies must work.

Chapter Four brings us back to the present, and to policy. The first part of the chapter reviews the various major policy packages competing for attention and favour: eEurope, TEN, and IST. This review will delimit the scope for policy in broad terms. The second part focuses on specific policy options. At very least, governments ought not hinder the blooming of broadband networks. At best, they should find ways to contribute to it so that the Information Society becomes an inclusive society for the good of all.

2 Technology and market developments

Policymaking is bound in the paradox of the human condition: although we all will live the rest of our lives in the future, everything that would guide us in making choices about this future is based on the past. So it is with broadband. To frame the range and gauge the consequences of today's policy choices on tomorrow requires stepping back to see what worked yesterday.

Accordingly this chapter takes on five historical topics:

- technology developments,
- policy developments and their outcomes in the United States, which, as the birthplace of the Internet is thus the touchstone for broadband policy development in Europe
- policy developments and their consequences in Europe (with a nod toward Korea)
- academic research networks (which, after all, spawned the Internet), and
- the special case of the wireless route to broadband.

Following these four sections, this chapter then extracts the lessons to be learned from them to determine the relevant drivers of broadband development *to date.*

2.1 Technology Developments

In the beginning was the circuit, an electrical connection whose voltage could be modulated on one end in ways that could be detected and interpreted on the other; thus the telegraph (Samuel Morse, 1843) and the telephone (Alexander Graham Bell, 1868). In a circuit, sender and receiver are directly connected in real time although neither need be human, as the invention of the facsimile (Blakewell, 1850) proved. Over time, the switches for these circuits evolved from manual to automatic and from electro-mechanical to software-driven devices of ever-increasing complexity. Multiplexing permitted various multiple virtual circuits to travel together on a single wire. Nevertheless, the basic circuit model remained. Economies of scale coupled with the national importance of communications networks meant that the industry was organised as a monopoly either regulated (as in the U.S.) or owned by governments (as in Europe). Prices were determined by allowable costs (e.g., for building or using circuit networks) rather than supply and demand.

Packet-switching and the Internet grew out of the Cold War. The former was invented by RAND's Paul Baran in 1962 in order to permit the command and control of nuclear forces when many communications nodes and links would be disabled. In packet switching, every message is divided into discrete packets of bits. Each bit is launched into the network along a pathway that traverses a series of existing circuits. This pathway could, in theory be different with every packet. These packets, being numbered, are then reassembled by the receiver to form a coherent message. A hybrid scheme, X.25 connection-oriented packet-switching establishes a specific pathway for the duration of a session but then inserts a greater or lesser number of packets along the pathway (whose circuits are shared with others) as data flows require.

The Internet was initiated in 1969 by the U.S. Defense Department's Advanced Projects Research Agency (formed in the wake of Sputnik's 1957 launch).[4] At the time, highly capable computers for scientific research were large, costly and scarce. Multiple users would seek to share time on a given computer system but this required them to be physically present to load tapes or punch cards. ARPA was looking to help researchers access distant computers on a time-sharing basis and a packet-switched network of cooperative time-sharing computers appeared to be a good solution. In 1970, ARPANET hosts started using Network Control Protocol (NCP), first host-to-host protocol. Later that year, the first cross-country link was installed in the U.S. by AT&T between UCLA and Bolt Beranek and Newman, Inc. (BBN) and another between BBN and RAND.[5] The first international connection to ARPANET was made in 1973 with the

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4 See Interim Report 1 - *Drivers of Change for Networking Evolutions*, Chapter 2.1 for more details of the Internet's creation.

5 For a general discussion of the history see Vint Cerf *et al*, "A Brief History of the Internet and Related Networks" (www.isoc.org/internet/history/cerf.html also info.isoc.org/internet-history/brief.html), and Hobbes' Internet Timeline v5.2 (www.zakon.org/robert/internet).

establishment of a link to the University College of London. Similar networks were established, primarily among universities and absorbed into the Internet. Starting in 1986, the Internet was augmented by the U.S. National Science Foundation's establishment of NSFNET to connect scientific supercomputers funded at key research centres; it was a backbone that linked regional networks into a global whole. NSF spent $200 million to hike capacity from the original 56,000 bits/second to 45,000,000 bits/second by the early 1990s; NSFNET took over from ARPANET. During the period, the NSF maintained an "acceptable use policy" (AUP), which mandated that its backbone be used only for non-commercial business traffic (in practice, this worked to exclude consumer online services and civilian businesses).

Two important changes in the early 1990s commercialised the Internet. The consortium assembled to build the NSFNET established a for-profit subsidiary in 1991 to carry commercial traffic. The NSF, for its part, dropped AUP as part of its departure from the NSFNET backbone business.[6] The Internet moved from being a "playground for academics" into being a commercial service (more than half of all subscribers in 2000 were commercial businesses).

Connecting all these new users was a system of protocols known as TCP/IP for Transmission Control Protocol (TCP) and Internet Protocol (IP). Such protocols were indifferent to what type of data was contained in the packets. This enabled the flexible development of applications that did not need to know what was in the packets in order to send, receive and store them. Several organisations were created to manage and provide technical guidance for the Internet: the Internet Engineering Task Force (IETF), the Internet Society (www.isoc.org) which now oversees the IETF, and, in the mid-1990s, the World Wide Web Consortium (W3C).

With the rapid development of electronics and fibre optics, the stage was set for the debate over how to construct what was then-called the Information Superhighway -- broadband. At the time, the two primary contenders were cable networks connecting through set-top boxes into souped-up televisions, and telephone networks which would offer switched connections, first through ISDN and then through higher-rate lines. Neither vision was without problems. It was unclear to many why public policy and fiberisation (at roughly $1,000 per person investment) should be devoted to what appeared to be adding yet more cable television channels.[7] The telephone industry understood data (and thus its fungibility) better than the cable industry did. Yet, having standardised on the basis of identical (64,000 bps) circuits, it had a difficult time mapping the transition into a universal system of identical higher-capacity circuits (bundling many small circuits to make a big circuit was by no means trivial).

As luck would have it, two key innovations resolved the question in favour of the Internet. One was the development at CERN (Switzerland) of the hypertext mark-up language (HTML) and the hypertext transfer protocol (HTTP); together they began the World Wide Web which could handle the transmission of complex data forms. CERN had already been experimenting with data communications since the early 1970s but did not manage to arrive at a standardised system until it adopted IP in the early 1980s. In 1981-1983 it established a satellite link between the Rutherford laboratory and Pisa. The latter had ARPA connections and the construction of the link was certainly inspired by the latter's IP model[8]. By 1990 CERN had become the largest Internet site in Europe. By that time CERN's Internet facility was ready to become the medium within which Tim Berners-Lee would create the World Wide Web.

The spread of the WWW was greatly boosted by the development of Mosaic (at the National Center for Supercomputing Applications at the University of Illinois), a user-friendly graphical interface on top of the basic protocols, and its later commercial variant Netscape, which permitted complex data to be viewed as fast as it was transmitted via a simple, graphical interface. Browsers, of which Netscape and Microsoft's Internet Explorer are the most recent versions, showed how all types of information, text files, images, audio, and even video, could be transferred over the Internet in data packets indifferent to the medium over which they were conveyed.

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[6] The NSF continued, however, to fund a few network exchange points, and dedicated university networks. In 1995 NSFNET became the Very High-speed Backbone Network Service (vBNS) which reached a bandwidth of 2.4 gigabits/second on its main trunks.

[7] Bruce Springsteen's 1992 song, *57 Channels and Nothing On.*

[8] Ben M. Segal / CERN PDP-NS / April, 1995

By 1995, although the primary hardware and networks that would carry broadband were still contested (as it is today), how information would be packaged -- in packets -- was set. So was the backbone over which such packets would be delivered -- the Internet (which admittedly started life mostly as a service atop the phone system's wires). Needless to add, the usage of the Internet grows at enormous rates and data traffic over the telecommunication networks will overtake voice traffic within the next two years.[9]

All this helped solve the broadband riddle, but this still left many challenges before a fully informaticised society and economy could be realised:

- Extending the Internet backbone into underserved regions (of Europe in this case).
- Developing applications, services, and protocols that could make maximum use of broadband transmission capabilities.
- Bringing broadband into homes and small businesses (sufficiently large users can more straightforwardly aggregate their networks, and buy routers and fibre to link into the Internet backbone).

2.2 U.S. policy developments

The United States can be considered to be in the forefront of deployment of broadband technologies. U.S. Internet penetration in 2000 lagged only behind Sweden and Canada. A fair percentage of U.S. penetration (approaching eight million households, and most business-connected users) is broadband, and its E-commerce infrastructure (and market) is far more developed then any country in the world. In general, a person who wants Internet access and broadband versions of it can get it, and at costs which compare favourably world-wide.

Nevertheless, such success must be qualified. Although the U.S. Government has generally removed obstacles to broadband, it has done very little to accelerate its deployment (apart from continuing to support research on next-generation internet technology); broadband is not a national priority as such. For reasons explained below, the United States is expected to lag in the rollout of high-speed digital mobile services (i.e., 3G telephony). Finally, many of the hopes of broadband competition associated with the Telecommunications Deregulation Act of 1996 have been vitiated by the behaviour of local phone providers (a.k.a. the Regional Bell Operating Companies or RBOCs).

The policy factors that have influenced the pace and direction of broadband development can be discussed in terms of telephone system regulation, Internet support, and ancillary norms.

2.2.1 Telephone Regulation

Historically, broadband service has rested on the capabilities provided by the public switched network, the regulation of which has had a great influence on the incentives for investing in and purchasing such capacity. Although there is very little direct broadband regulation, there is quite some regulation on telephony that helped shape the conditions for rolling out broadband.

From its inception and consolidation until its break-up in 1984 (creating Bellcore and the seven RBOCS: regional Bell operating companies), the U.S. phone system has been based on a regulated monopoly, AT&T, which served 85% of all households. The states regulated local phone operations, notably through the rates they charged and their obligations to provide public service. The federal government regulated long-distance operations and exercised considerable influence over the structural elements of the phone system.

Early regulation was limited to ensuring reasonable rates; federal power was administered through the Interstate Commerce Commission (a body established to regulate railroads). The Communications Act of 1934 established the Federal Communications Commission (FCC), which regulated phone companies through its Common Carrier Bureau.

[9] IDC 2000.

Telephone regulation at both the administrative (i.e. FCC) and judicial level (i.e. US Department of Justice and the courts) have consistently reflected a broad desire to minimise interference with the market consistent with the need to control what was considered a "natural monopoly." This has made regulators eager to see whether specific services fell outside the realm of natural monopoly and could therefore be deregulated (with some attention paid to whether deregulation would nevertheless confer unchallengeable market advantages to the monopoly provider).

The Carterphone decision[10] is a minor but telling illustration of this. Carterphone was a company that tried to sell an acoustic coupler (a device that would sit next to the telephone and pick up the electrical signals without direct metallic connection). AT&T prohibited the use of the device "to prevent damage to the network". The FCC ruled that the device was legal. It initially conceded that AT&T could insert a protective device between the third-party equipment and the network but, in 1975, replaced even that restriction with a registration program: devices deemed by the FCC to comply with certain design constraints could be directly connected to the network. This ended AT&T's monopoly on consumer premise equipment (e.g., handsets) and yielded robust competition in that market -- notably in modems. Contrast this, for instance, with the historic restrictions placed on modems by Deutsche Telekom -- an organisation subject to few higher regulations because it was part of the Administration until many years later.

The key FCC decisions that permitted the eventual emergence of a broadband market were encapsulated in its First, Second, and Third Computer Inquiries (or Computer I, II, and III).[11] Computer I, which ran from 1966 to 1971, explored the potential convergence of computers and communications. It essentially concluded that the spirit of the 1934 Communications Act would be best served by permitting computer services to evolve with the least regulation -- providers were simply not common carriers. However, common carriers who wanted to offer computer services had to establish separate affiliates so as to reduce the temptation to dominate the computer business through cross-subsidisation from regulated activities.

Computer II, which ran from the late 1970s to 1980, focused on the distinction between "basic services", which were to be regulated, and "enhanced services", which were not. The former was defined by the FCC as services, offered over common carrier transmission facilities used in interstate communications, which employ computer processing applications that act on the format, content, code, protocol, or similar aspects of the subscriber's transmitted information; provide the subscriber additional, different, or restructured information; or involve subscriber interaction with stored information. Examples include voice messaging and alarm monitoring, as well as Internet access in general.

Computer III, which ran from the early 1980s through 1986, carried through on the logic of its predecessors but emphasised the use of non-structural safeguards (e.g., accounting rules) that would inhibit cross-subsidy between unregulated and regulated activities.

Alongside the FCC decisions has been the overall deregulation of the telecom industry. In 1969, the FCC permitted MCI to enter the intercity private line market in direct competition with AT&T. By the late 1970s, the proliferation of alternative long distance companies eroded the assumption that long-distance was a natural monopoly. Unchecked, the proliferation of long-distance companies would upset a pricing structure that had long-distance cross-subsidise local calling. The 1984 break-up of AT&T therefore freed it to compete in long-distance, with results felt initially in the business market. Inasmuch as a large share of all broadband capacity in the U.S.A. is dedicated to business uses, business's ability to lease high-speed telephone lines as the backbone for institutional and corporate networks has been central.

Such corporate networks, in turn, have been increasingly part of the entire Internet infrastructure. Building these backbones has been greatly facilitated by the practice, starting in 1977, of leasing 1.5 megabit/second T1 lines from long-distance providers (Europe's equivalent, E1 lines, are roughly two megabits/second).

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[10]See, e.g., In re Carterphone, Decision, 13 F.C.C.2d 420, modified by Memorandum Opinion and Order, 14 F.C.C.2d 571 (1968). AT&T even went so far as to argue that a plastic protective cover over a phone book was a "foreign attachment" with the potential to harm the quality of network service.

[11]For a general discussion see Jason Oxman, The FCC and the Unregulation of the Internet (Office of Plans and Policy, FCC, July 1999). Computer I is First Computer Inquiry, Tentative Decision, 288 FCC 2d. Computer II is Computer II Final Order, 77 FCC2d 384 (1980). Computer III combines Computer III FNPRM 1998, 13 FCC Rcd. At 6052 and Computer III Order 1999, 14 FCC Rcd at 4294.

Such leasing accelerated with the AT&T break-up to where T1 equipment sales doubled between 1985 and 1987, and again from 1987 to 1990. U.S. rates for T1 leasing used to run roughly ten times less than they are in, say, the UK (where $64,000 buys a megabit per second of service) largely because of abundant competition. In 1999 a European Commission study on tariffs for international and national tariffs of leased lines concluded that the average prices for a standard leased line is roughly three times higher in Europe than in the United States. There are substantial differences in prices for short distance leased lines (up to 5 km).

The broader deregulation of the local telecommunications market, however, has been slower (largely it has more obvious monopoly features). Over the last two decades, several companies arose to offer less-expensive and more versatile local service to business clients (e.g., by investing in fibre optics more vigorously) but they have encountered barriers in connecting their niche equipment to the broad-based infrastructure of the incumbent telephone companies.

As part of Computer III the FCC developed a loosely defined Open Network Architecture that would permit vendors of enhanced services to connect to the network substrate on an unbundled and equal-access basis.[12] The RBOCs generally resisted ONA, and even ultimate compliance on paper did little to foster the alternative local loop market. By 1993 it accounted for only 400,000 lines (roughly .2 percent market share). The Association for Local Telecommunications Services now estimates[13] that as of February 2001, several hundred competitive local exchange carriers (some of which are subsidiaries of giant inter-exchange carriers) account for 16.2 million access lines up from 10.4 million in 2000 and 5.5 million in 1998 - with service predominantly to the business market. Market share (roughly 8 percent) is up tenfold since 1996.

The Telecommunications Act of 1996[14] tried to add muscle to the goals of ONA by permitting the RBOCs to get into the long-distance business in exchange for permitting competitors to access local facilities in a fair manner (which includes putting equipment in RBOC-owned facilities). Although the RBOCs wanted such businesses they were still reluctant to open up their own services enough to merit the right to provide long-distance service. Legislation under consideration would make it far easier for RBOCs to merit this right. However, some of the current legislative initiatives are seen by ISPs as possibly favouring RBOCs too much.

2.2.2 FCC Non-Regulation of the Internet

As chapter one has already explained, the Internet was born as a defence program, and matured, in part as a research and education-oriented program of the National Science Foundation, before emerging on its own as a commercial service.

There is no easy analogy from older technologies for the Internet that would guide the choice of appropriate legal and regulatory regimes. Although most of the Internet goes over the phone lines (and although Internet telephony may, some day, be a serious competitor to plain old telephone service), it is not entirely a point-to-point communications medium. Many Internet features such as web sites or streaming audio/video make it appear to resemble broadcasting, but unlike broadcasting it rarely relies on the public airwaves and, only incidentally relies on appropriated rights-of-way. Internet service provision does not credibly appear to be a natural monopoly. Hence FCC jurisdiction is hard to justify and has been largely avoided. Nevertheless, in the aftermath of the spontaneous 'de-peering' of smaller ISPs by UU-Net, Holub (former CEO of The Well, a small but elite electronic community) it has been argued that Internet backbone Providers could very well be considered as 'common carriers'.

Narrowband Internet usage has been encouraged by a nearly universal desire of state telecommunications regulators that local calls be tariffed at flat monthly rates rather than charging by the minute (which is more common in Europe). Flat-rate charges encourage greater use (a fact that AOL discovered to its chagrin

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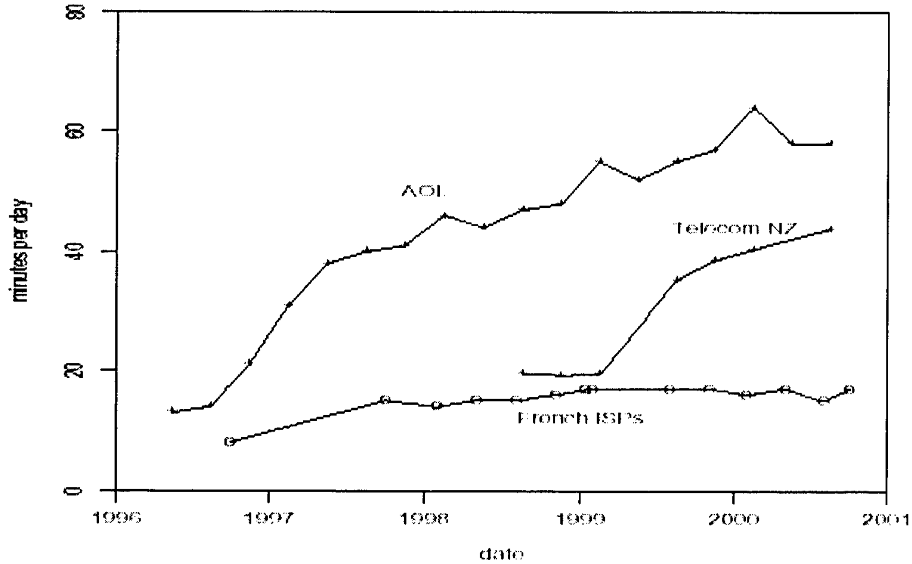
[12] Tim Valovic, "ONE: The Gateway between Public and Private Networking," Telecommunications, 22, 3, (March 1988), 34.

[13] TS, The State of Local Competition, 2001 (see http://www.alts.org/Filings/022001AnnualReport.pdf).

[14] Identified as 47 U.S.C. 151 et. Seq (1996 Act).

when its 1996 transition to flat rate access pricing pushed usage past available capacity. Their per-session use roughly tripled).

Figure 1: Minutes of Internet Usage per Day



Source: Oldyzko, IDC 2001

Greater use, in turn, fosters the proliferation of content providers, which, in turn, have encouraged the current level of interest in broadband consumer access; of note is that broadband access is usually charged at a flat rate monthly fee in large part because it is "always on" (one need not dial in). By contrast, ISDN's architects had envisioned that local users would not only pay per-minute charges for phone service but would pay differently for data than for voice calls. But ISDN never achieved critical mass in the United States - and that may be why (see table 2 in paragraph 2.3).

In 1983, the FCC specified that enhanced service providers (a superset of ISPs), unlike interexchange carriers (i.e., long-distance companies) would not be taxed to support local exchange carriers. Furthermore, calls to ISPs were to be tariffed no differently than voice calls. In the longer run, if and as Internet telephony becomes popular, the difference in prices created by the different tax regimes may be significant.

In the meantime, however, the lower quality and greater difficulty of making Internet phone calls (coupled with the rapidly falling prices of all long-distance calls) makes this a moot point. Finally, in recent years telephone companies have complained that dial-in calls to ISPs, being longer in duration, have levied unfair costs on the phone system; more recent studies have shown that the tendency of heavy computer users to order multiple telephone lines more than makes up for such costs.[15]

2.2.3 Routes to Broadband

Of the six routes to consumer broadband mentioned in chapter one, three -- cable modem, ADSL, and satellite dishes -- have customers. None are heavily regulated.

The latest estimate is that there are roughly 2.4 million DSL lines. Thanks, in part, to the 1996 Telecommunications Act, third parties (e.g., Covad, Northpoint) have been more able to lease lines from the phone company and thereby become DSL providers (although their financials have been suffered along with the dot-coms recently); they account for roughly a fifth of the market. In late 1998, the FCC concluded

[15]A study by Economics and Technology, Inc. found that (LECs) received approximately $1.5 billion from additional local phone lines to serve online access - a number far in excess of what even the LECs claim network congestion costs them in terms of additional network upgrades. See Lee L. Selwyn and Joseph W. Laszle, *The Effects of Internet Use on the Nation's Telephone Network* (January 22, 1997).

that DSL services were properly classified as interstate telecommunications services and should be tariffed at the federal rather than state level.

Cable broadband - which serves an estimated 5.5 million customers[16] -- has had its controversies. The 1992 Cable Act, which introduced federal rate regulation for the first time over cable service. For years thereafter, cable firms argued that regulation would prevent them from amassing the capital required to increase system capability to accommodate two-way broadband communications.

Table 2: Share of U.S. Households by Type of Internet Access

	March, 2001	Growth during 2000:2001
Paid Dial-Up ISP	49,606,798	7.61%
Free ISPs (active subscribers)	10,260,000	-19.44%
Cable Modems	4,931,419	18.01%
Internet TV	1,204,000	0.00%
Digital Subscriber Line	2,404,000	1.97%
Satellite (new category)	75,000	N/A
Total	68,481,217	-0.29%

Source: TSR (2001)

The 1996 Telecommunications Act (whose regulations were implemented in March 1999) eliminated price regulation on higher-tier services, thereby deregulating cable modem rates. The Internet Freedom and Broadband Deployment Act, proposed in 1999 by congressmen William Tauzin (R-LA) and John Dingell (D-MI), would amend language in the 1996 Telecom Act which provided that the FCC shall not require an ILEC to "provide unbundled access to any network elements used in the provision of any high speed data service or offer for resale at wholesale rates any high speed data service." The Bill is based on the premise that RBOCs will deliver broadband Internet access if they receive sufficient financial incentives. If they provide broadband, they will be exempt from competition - they are not obliged to resell their infrastructure to competitors.

Another concern arose with the merger of cable companies (such as AT&T/TCI and Time-Warner) and ISPs (notably Excite@Home and AOL respectively): would cable companies force broadband users to use in-house ISPs? Portland, Oregon sued AT&T to prevent the possibility of such behaviour. Although the courts ruled against Portland, (citing the 1996 Act as evidence that Congress vested regulatory authority in the FCC) AT&T went on to ink contracts with multiple ISPs and thereby defusing the issue.

To date, broadband via satellite remains unregulated (except insofar as satellite spectrum use is constrained) largely because satellites are not recognised as common carriers. Many corporations have combined centralised data centres and myriad distribution points (e.g., General Motors, K-Mart, and McDonald's) to build networks using satellite and VSAT combinations.

2.2.4 Support for E-Commerce

Two prevailing policy-related norms in the United States have done a good deal to drive the demand for business-to-consumer E- commerce, and thus, indirectly (e.g., via increased overall demand and greater business revenues), promote broadband Internet capability.

One norm is that credit-card companies have assumed liability for erroneous credit-card purchases, beyond $50.00. This assumption has helped persuade customers to entrust their credit card information to a still-insecure Web infrastructure (e.g., the recent theft of 300,000 credit cards from the CD Universe Web site). This norm is heavily influenced by the common law practice in the United States that puts the burden of proof on vendors rather than consumers for discrepancies (cf. the UK where the presumption favours banks).

[16] See www.cabledatacomnews.com/cmic/cmic16.html.

Another norm is the use of sales tax at the state rather than national (e.g., European VAT) level. Although in theory consumers are supposed to pay sales tax (to the jurisdiction where they receive the product) on any items purchased from out-of-state vendors, in practice they rarely do. Mail-order firms have historically resisted collecting such taxes and so, more recently, have E-commerce firms. This has resulted in an implicit subsidy for E-commerce vis-à-vis brick-and-mortar stores, which has been estimated to increase E-commerce sales by roughly fifty percent. Various attempts to equalise the tax treatment between virtual and physical stores have been quickly batted down as a "tax on the Internet" To the extent this attitude persists this will be an incentive for business-to-consumer E-commerce and one more reason for consumers to seek broadband access to the Web.

2.2.5 Government Policy and Future Broadband Growth

The influence of Government policies on the *future* of broadband service in the United States will continue to depend on regulatory policies that govern the supply and price of bandwidth. Yet, it may increasingly depend on policies that would influence the demand for bandwidth by affecting the terms under which content is offered.

Consider bandwidth. Business-to-business bandwidth, at this stage, is largely a matter of price and, in only some cases, availability (since most businesses are situated close to bulk communications lines). Thus, regulatory policies that encourage competition without suppressing the investment patterns of erstwhile telecommunications monopolies (e.g., RBOCS) are likely to increase bandwidth fastest. The policy choices to increase broadband to consumers are more varied because (1) the broadband infrastructure has yet to be built out, and (2) consumers have more ways to receive high-bandwidth services. Spectrum and deregulation choices loom large.

The proliferation of high-bandwidth services to consumers, however, may also rest upon whether there is enough content to justify their provision. Content, in turn, may be a matter of which business models prevail (the belief that advertising can pay for expensive Web content has fallen out of favour in the last year). Decisions about business models are, in turn, affected by intellectual property rights regimes.

After all, the most recent high-bandwidth driver, Napster (and its clones) has been deemed tantamount to intellectual piracy. Whether video-over-the-Web works has a great deal to do with how syndication rights are worked out. In recent years, the challenge of digital copying has been met through tougher intellectual property protections but it is unclear whether the current regime will provide the maximum amount of content flow.

2.3 European Policy Developments

Europe is a heterogeneous region and trends in broadband development have been similarly heterogeneous. Much attention has gone to the success of the European GSM standard and the possible use of mobile wireless for broadband. But almost all broadband is currently being delivered via fixed networks -- a contest between cable and ADSL via the existing fixed wire telephone infrastructure. In the longer run, digital satellite (on which countries like Spain and France heavily rely) and fibre optic might join the battle in Europe, as they already do elsewhere. Future developments will be strongly influenced by pan-European and country-specific telecommunications policy actions.

Although broadband availability seems to be rising in most of Europe, the development of broadband applications has fallen afoul of chicken-and-egg economics: without networks there is no demand for such powerful applications; but without such applications there is no demand for broadband networks.

Faster access to conventional Internet services remains the driving force behind the diffusion of broadband Internet access. One bottleneck is the traditional European regime of metered dial-up access that keeps down the online time spent per day per user [Nielsen/Netratings, 2001]. The metered regime is however in the midst of an overhaul in several European countries right now – notably for broadband services such as ADSL and cable.

Business to consumer E-commerce has not fulfilled its promise yet, not in the US and certainly not in Europe. This is often explained by the general distrust of credit cards in Europe. Yet, the absence of micro-payments also merits note; services such as video on demand and games may have a rosy future if small payments can be settled over the Internet. However, innovative use of existing billing and pricing schemes might boost such services without the need for radical technical changes (like flat-rate subscription fees). Cross-fertilisation in billing and pricing practices might occur between the institutional frameworks and traditions of narrowcast and broadcast services that have historically been very different, but are now converging.

2.3.1 Telecommunications regulation

To cope with the increasingly blurry distinctions between telecommunications, Internet, broadband and narrowband services, the EC has recently revised its telecommunications regulation framework. The 'status aparte' for the telecommunications industry (cf. 'public utility'/'common carrier' provisions in the US) will be abolished. The converged framework will apply to *all* communications networks, including the Internet. However, the most relevant Directive - the Interconnection Directive[17] - is still phrased in terms of typical switched-circuit concepts (call origination, transit, and termination) that bear little relevance to packet-switched networks such as the Internet. Furthermore, the material on pan-European markets – relevant to the development of European high-speed backbones - is not very specific. The Directive merely formulates a possibility for the Commission to define such markets at a later stage.

The new regulatory regime will lean heavily on generic competition policy and law, based in large part on imputing specific obligations to telecom operators with 'significant market power' (SMP) -- currently defined as a quarter of the market by value. The revised Framework has a broader definition of 'relevant markets' (including packet-switched, mobile, satellite, broadcasting and cable TV networks) and introduces the notion of 'collective dominance'[18]. These changes stretch the span of regulatory control of the EC to a considerable degree.

National regulatory agencies (NRAs) have more discretionary power under the new Framework and can select from a 'shopping list' of access and interconnection obligations leading to greater diversity across Europe. By contrast, the U.S. regulatory system remains plagued by the two-tier division of labour, wherein states regulate local rates and the FCC regulates only interstate rates. The EU system is not based on a highly artificial distinction between intra- and interstate matters but the present trend to delegate more discretionary power to NRAs might move the EU in a similar direction as the U.S.

The unbundling of the local loop is probably the most important contribution of the ONP Framework to the development of broadband Internet in Europe - developments in the backbone network will be much less influenced by EC policy. The most important obligation a NRA can impose on a SMP operator is the requirement to give third parties access to their network facilities[19]. This has already led to the unbundling of the local copper wire and the boom in competing ADSL services.

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[17] COM 97/33/EC

[18] This comes close to the collusion/oligopoly/market concentration principles of traditional antitrust and competition law, with the important distinction that under the ONP Framework 'collective dominance' is defined beforehand not afterwards. It has been notoriously difficult to establish collusion cases. From a legal point of view, the rather loose and somewhat arbitrary definition of 'collective dominance' (Annex 2 Framework Directive) might give rise to much litigation.

[19] Specifically, it must provide

- access to specified network elements and/or facilities (e.g., switches);
- access to operational support or similar software systems;
- open access to technical interfaces, protocols and other technologies *indispensable for the interoperability of services or virtual network services* (e.g., VPNs);
- specified services on a wholesale basis for resale by third parties;
- specified services needed to *ensure interoperability of end-to-end services to users* (e.g., facilities for intelligent network services or roaming);
- co-location and other forms of facility sharing (e.g., duct sharing); and
- interconnections with other network and network facilities.

Note that the notion of 'Intelligent Network' refers to a *telephone* network in which the service logic for a call is located separately from the switching facilities, allowing services to be added or changed without having to redesign switching equipment. Possible future end-to-end services for the Internet such as quality-of-service guarantees under IPv6 are *not* considered here.

With the broader definition of 'relevant markets', other access networks (satellite, cable TV) could also be unbundled. The Dutch NRA is currently studying the possibility of opening its dense cable TV infrastructure to third party service providers. Conditional access systems (e.g., decoders for cable and satellite services) are still permitted but the European Parliament has recently stipulated that such systems should have a common interface and provide access to third parties against "fair, reasonable and non-discriminatory prices".

The unbundling process, still fraught with delicate little practical matters (such as matters of co-location), appears to have gained considerable momentum in Europe -- in contrast to the United States where RBOCs exercise considerable control over the local loop and third-party competitors such as the struggling Covad or the bankrupt Northpoint, neither with their own infrastructure, are still at the mercy of RBOCs.

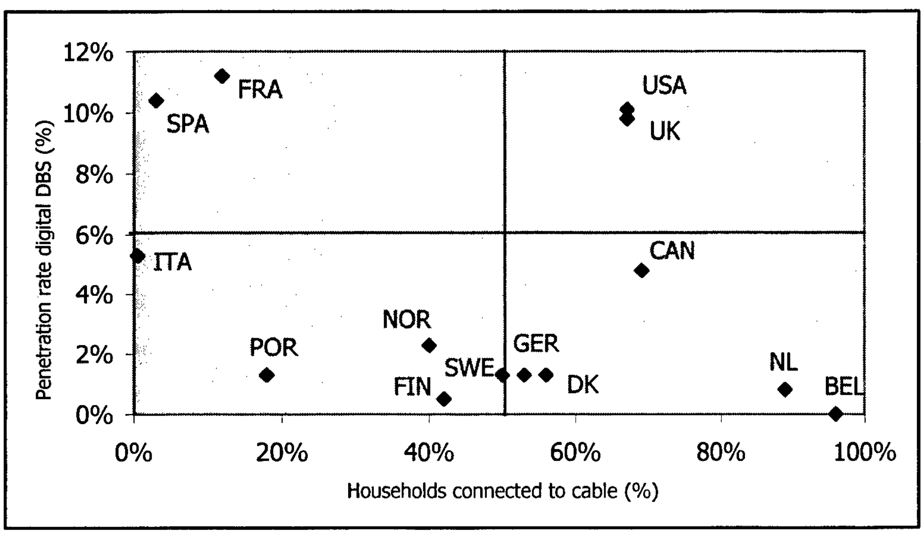
Current legislative proposals to provide market incentives for the rapid delivery of advanced telecommunications services seem to be firmly based in the traditional public utility doctrine.

2.3.2 Routes to broadband

As Figure 2 suggests, there are great differences among European countries in how they get their television service. Of note is that countries with little cable service for television, are, for that reason, unlikely to get broadband through cable lines. This leaves countries such as Spain with ADSL (or satellite). This has given ADSL its big head start in the race for broadband. In The Netherlands, Internet access via TV cable has been a huge success but in terms of growth figures has now already been overtaken by ADSL. Growth of both is heavily favoured by the flat rate access schemes that come with it.

As current experiences with cable access have been disappointing ISDN still keeps a substantial share in the market for local Internet access.

Figure 2: Cable and DBS Penetration in Europe



Source: **OECD (2001); Rand Europe (2001)**

The slow substitution from ISDN has had a peculiar negative effect on the rollout of broadband services in The Netherlands. As ISDN services are a solid source of income of the incumbent telecom operator KPN, an early introduction of its own DSL service (Mxstream) would cannibalise the revenues from the already existing ISDN network. At the moment, the product has reached breaking point and KPN is now trying to rollout its broadband services as fast as possible in order to built a solid installed base before competitors enter the market.

Table 3 below shows that ISDN never took off in North America and the UK, hence there is no installed base to deal with there. Incumbents in France (still high growth potential), Norway (high installed base) and Germany (high installed base + increasing growth) might behave in the same strategic way the Dutch incumbent originally did, that is, delaying DSL's introduction to protect the established ISDN niche.

Table 3: ISDN Subscribers (x1000, based on 64 kbps equivalents),1995-1999

	1995	1996	1997	1998	1999	per capita (1999)
Belgium	78	146	270	507	870	8.5%
Denmark	42	90	176	346	662	12.4%
Finland	13	54	116	329	467	9.0%
France	0	1600	2128	2,638	3,600	6.1%
Germany	2744	5203	7341	10,093	13,320	16.2%
Italy	159	341	897	1,735	3,049	5.3%
Netherlands	104	321	810	1,570	2,280	14.4%
Norway	46	149	410	769	1262	28.3%
Portugal	57	98	183	314	477	4.8%
Spain	28	219	457	505	979	2.5%
Sweden	49	100	187	319	645	7.3%
UK	0	0	1100	1700	2400	4.0%
Canada	0	0	451	757	999	3.3%
USA	0	0	0	1554	2016	0.7%

Source OECD 2001

2.3.3 Flat Rate Pricing

Economic theory suggests that efficiency is maximised by prices that reflect costs. Staying on the line should from that perspective ideally be charged on a time equivalent basis. However, prices that attempt to recover a significant percentage of *total* costs from usage charges greatly lower demand. This is clearly illustrated by the relatively high demand for telephone services in the US, which has had un-metered local calling for a flat monthly fee for residential users throughout the 20th century. While the industry revenues in the US do not significantly depart from those in other countries, the traffic generated by the users is substantially higher.

Table 4: Telephone Industry Revenues and Usage, 1997

	Revenues as fraction of GDP (%)	*Minutes of phone calls per person per day (1997)*
Finland	2.52	16.6
France	1.93	10.6
Japan	2.06	10.6
Sweden	2.05	20.7
Switzerland	2.66	13.0
UK	2.51	12.7
US	2.86	36.9

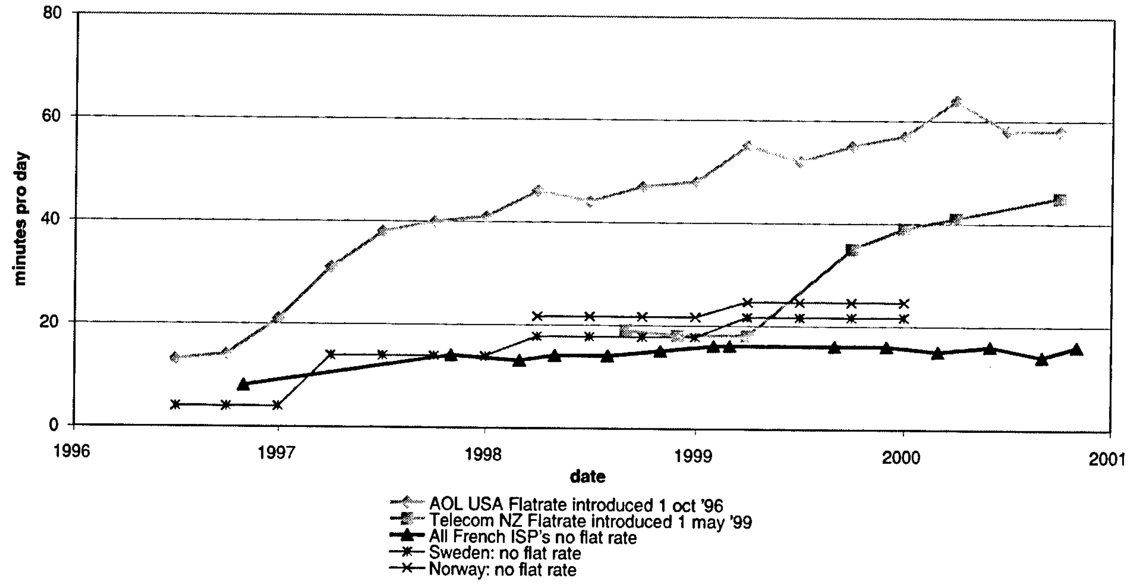
Source: Odlyzko (2000); OECD (2001)

On the Internet, increasing usage is the main imperative for service providers. They do have to make enough money to recover their costs but in the long run, they have to encourage their customers to increase usage of the network. Transmission technology is increasing available bandwidth very rapidly. To avoid ruinous competition due to ever-decreasing unit costs (as is happening in long-distance voice services), service providers have to persuade users to take advantage of the new capacity. *Ceteris paribus*, policy makers who want to encourage Internet usage should strive for the introduction of flat rates.

AOL Europe and Worldcom have made official complaints to the British, Dutch, French and German NRAs that the current European regime of metered dial-up puts a brake on utilisation and diminishes the potential for e-commerce. Data as presented in Figure 3 support the strong positive effect of the introduction of a flat rate on online time spent per day per user.

Figure 3: Average Online time per Day per User

online time pro day for an average user shows the effect of Flat Rate Internet Access



Source: OECD (2001)

The tariff structure certainly does influence web surfing behaviour. Time per month spent on the Web is significantly higher in North America, which has a flat rate system. Germany is an odd exception to this pattern but follows the other European countries when it comes to 'stickiness[20]' of web surfing behaviour. The US-based home users concentrate themselves on average on a limited number of unique sites. Users at other countries are more exploratory[21].

European ISPs have traditionally made money from revenue-sharing arrangements with telephone companies. 'Free' ISPs depend almost entirely on the fees they receive back from the telecom operator in return for the extra usage minutes which they generate -- but that only works when metered phone usage is in effect.

In the case of flat-rate ISPs, the providers absorb the phone charges themselves, not the end-users. As in the case of AOL and Telecom New Zealand average usage soon tripled and all around Europe flat-rate ISPs ran into severe trouble when customers where surfing more than the calculated break-even point. In the case of Versatel's German subsidiary, Sonne, 80% of the network capacity was used by people who stayed on-line 24 hours a day. Under such circumstances, paying the phone company for every minute that your customers surf the Internet is a shaky base for a robust business model.

Meanwhile BT, the biggest telecom operator in Europe, has started to offer flat-rate Internet access ('SurfTime'). BT has however explicitly stated that 'flat-rate access' is "not intended to support continuous or unattended Internet access."[22]

[20] How long users "stay" on the web

[21] Note that Table 5 only covers websurfing. More than half of the Internet time is spent on other activities such as e-mail, chatting, and MP3-downloading, the latter of which has boosted the demand for broadband.

[22] A common practice to control traffic is to time-out idle channels automatically after a specified amount of time.

Table 5 - Websurfing Panel Measurements (April 2001)

	Number of Sessions per Month	Number of Unique Sites Visited	Time Spent per Site	Time Spent per Month	Time Spent During Surfing Session	Duration of a Page viewed
US work	43	33	40:09	22:05:22	30:54	00:56
US Home	19	10	55:40	09:33:13	30:35	00:52
Canada	20	20	27:31	09:03:45	27:48	00:46
Denmark	13	18	17:13	05:13:32	24:07	00:34
Germany	17	26	19:09	08:08:40	29:28	00:37
Finland	11	16	17:15	04:35:08	24:32	00:38
Netherlands	14	23	16:57	06:36:39	27:56	00:42
Norway	13	16	18:40	05:06:40	28:56	00:37
Sweden	13	13	26:46	05:47:31	27:13	00:37
UK	12	19	18:46	05:55:08	29:19	00:43

Source: Nielsen/Netratings

The complaints from AOL Europe and Worldcom on the fact that incumbents such as BT and KPN did not offer flat-rate Internet access as a wholesale product, but did introduce flat rate to their clients themselves are therefore obvious. After an official complaint from WorldCom, OFTEL has mandated BT offer SurfTime as a wholesale service. Germany's Court recently forced Deutsche Telekom to offer a similar service *in case* the company offers such services itself. In March 2001 Deutsche Telekom withdrew its retail flat rate services. Since then the courts have upheld ISPs access to the service at a wholesale charge.

In The Netherlands, the NRA (OPTA) has decided in favour of WorldCom which demanded a flat rate service from the incumbent KPN, which had argued that (1) its network capacity was insufficient to accommodate the significant extra demand that will probably be generated after the (forced) provision of flat-rate Internet access, and (2) broadband services over the unbundled local loop (e.g., ADSL) were a substitute for flat-rate narrowband service and that these services are already open to MCI. Whereas OPTA acknowledged the possible extra load on KPN's backbone network, it blamed prior under-investment. OPTA explicitly referred to BT's introduction of SurfTime. It argued that services such as ADSL are not a viable substitute for flat rate pricing of narrowband because they require significant additional investments from the end-users (modem) and will not be widely available; flat rate pricing can be implemented at short notice without significant technical changes. OPTA explicitly refers to the statements of the European Council at the March 2000 meeting in Lisbon (quoted in the paper's introduction) that stress the importance of Internet access to Europe and the role that price reduction can play in stimulating it.

At present, KPN only has to offer flat rate pricing to MCI-WorldCom and not to the market as a whole because the incumbent does not offer flat-rate access services on its own behalf[23]. Furthermore MCI-Worldcom is to get only limited services with an upper limit on interconnection ports and a proviso that idle connections will be terminated after 15 minutes.

2.3.4 The Internet in Europe

Until recently, the global topology of the Internet was effectively a star network that radiated from the United States. Thanks to the oversupply of capacity on transatlantic routes (esp. NY-London) and expensive leased lines in Europe, intra-European data transport relied heavily on the U.S. backbone, with packets switched in MAE-East in College Park, Maryland. This is less true today (although a large share of intra-Asian traffic is still switched in MAE-West in Mountain View, California). The capacity of the European backbone, having risen quickly in recent years, has approached that of the U.S. backbone. Prices of national leased lines in Europe vis-à-vis North America also fell sharply after 1998 (partly because the latter prices rose: OECD, 2001).

[23] If this would have been the case (as it is in the UK) FRIACO would have been open to all other parties because of the non-discriminatory clauses in the ONP framework.

Content also becomes more and more local - the number of web sites in French, German and Spanish is steadily rising - although the US remains by far the most dominant source of content. As a consequence, a much greater part of intra-European traffic now stays within Europe and Internet exchanges in Europe (esp. London, Amsterdam, Frankfurt, and Paris) have grown quickly.

Table 6 - OECD Basket of National Leased Line Charges, August 2000 (USD PPP, excl. tax)

	Index 2 Mbit/s (OECD average=100)
Belgium	86
Denmark	21
Finland	19
France	65
Germany	66
Italy	119
Netherlands	87
Norway	39
Portugal	110
Spain	154
UK	63
Canada	123
USA	63

At first sight there seems to be enough capacity at the European backbone to cope with a significant increase of demand in the case of massive broadband access at the local loop (currently the most pressing bottleneck, both in the US and in Europe). Yet, not all installed capacity is operational; lighting dark fibre by putting in the necessary hardware to send and receive the light waves across the wires is relatively expensive. Hence when the slosh of the Internet traffic moves up into the core of the network the major bottleneck might be the prohibitive high prices to expand supply, not the physical lack of capacity. The peculiar economic characteristic of the market for bandwidth, which functions essentially like a real estate market, is aggravated by tendencies to hoard and hold up capacity. This requires far-reaching co-operation (read: collusion) between market parties[24]. Governments can do little about such practices since there is hardly any regulatory control over the Internet backbone market -- although the revised EC Framework leaves at least some space for future interventions.

2.3.5 Comparing the U.S. and EU Experience

One of the most striking differences between the US and EU is the current state of competition in the local loop. Despite some practical problems (e.g., in unbundling the pricing of co-locating facilities), most European countries and the EC, as a whole, support competition in the local loop. In the US, RBOCs still have a near monopoly position and pending legislation only seems to strengthen their position. By contrast, both the US and the EU limit government control of the Internet backbone market to antitrust and competition law. The revised ONP Framework does leave some space for regulation of pan-European networks. This might give the EC some leverage in the possible case of network sharing.

The US and the EU are following different paths to broadband. In the US (at least at the aggregate level) both broadcast and narrowcast technologies are widely deployed. Developments within Europe are very different.

[24] The submarine cable industry for instance is quite good in managing supply brought on the market - and hence preventing prices from declining sharply. With an initial 40 Gbit/s (now 140 Gbit/s) capacity, Global Crossing's AC-1 was the largest cable system; it accounted for almost half of all North Atlantic capacity between February 1999 until November 2000. While it was considered as a dramatic oversupply in 1998 they nearly sold out in 2000; new capacity was postponed until the second half of 2000. TAT-14, with 640 Gbit/s capacity was delayed until January 2001. Also during the first half of 2000 Level 3 and Global Crossing joined their new planned cables and split the investment. GTS Ebone and FLAG Atlantic, Teleglobe, and 360Networks have made a similar move of joining investments. That the global supply of underwater cable-laying equipment is limited and concentrated in a few hands helps preserve oligopolistic tendencies in this market (at least as compared to landlines).

Fibre to the home is slowly becoming feasible. Projects are being rolled out in both North-America and Europe. Whereas in the USA public utilities (Bonneville, Grant County) take the lead, in Canada and Europe municipalities (Stockholm) are the main drivers. In The Netherlands, local projects (Eindhoven municipality) are embedded in a national public-private policy initiative (GigaPort). In Europe and Canada, the focus is at large to medium-large cities, with lagging roll-out in the countryside.

Flat rate pricing is being introduced for broadband service in Europe. Cable operators led the way; this pushed telecom operators to act similarly for DSL. The obligation of incumbents in Europe to offer flat-rate pricing for wholesale lines (hence enabling third party access) is usually based on non-discriminatory arguments. In Germany this seems to slow down the development of a market for DSL services.

The current demand for broadband does not require new types of content, but a transition to mass-market penetration is likely to do so. Intellectual property right (IPR) regimes are of tantamount importance for the further development of a supply side. From a technological point of view, narrowcast and broadcast services are converging. From a legal point of view, considerable differences still exist between the two contending regimes. The implementation of a coherent (multi)media - read: content - policy will determine the eventual success of the broadband service industry.

The South Korean Experience

South Korea is a world leader in the number of Internet subscribers but the number of hosts is relatively low. The driving force behind this growth it the high penetration of broadband access (DSL).

	Subscribers	Hosts	Subscribers/host
South-Korea	23.2	1.08	21.5
Sweden	23.0	10.60	2.2
Denmark	21.3	7.25	2.9
Canada	20.2	12.72	1.6
US	18.2	23.42	0.8
Netherlands	17.9	8.16	2.2
UK	12.4	5.25	2.4
Germany	11.0	3.17	3.5
France	5.1	1.92	2.7
Japan	8.4	3.25	2.6

Source: OECD (2001), [a] Residential users; data as of January 2000, [b] Computers with assigned IP numbers; data as of October 2000, [c] OECD Internet access basket, USD PPP.

South Korea's broadband success *cannot* be ascribed to far-reaching deregulation of its telecom market (but see, for a dissenting voice; Hong, 1998). Although the incumbent Korea Telecom was already separated from the Ministry of Communications in 1981 liberalisation only took place in the form of granting foreign investors access to the domestic market via participation in existing Korean companies. The actual level of competition is keenly controlled by the government – there is no such thing as an independent telecom regulator in Korea (Cho, Choi and Choi, 1996). One instance of this is that foreign firms are effectively excluded from winning a license in one of the major telecom areas (Rüdiger, 2001). The 'regulated' competition has nevertheless resulted in relatively low access prices, especially for DSL. Flat rate access for 1.5 Mpbs comes in at a monthly fee of US$25, a premium 4 Mbps costs only US$9 extra. Free 256 Kbps access is available for schools, for US$25 a month that capacity is doubled (Rao, 2001). The low end-user prices indicate the strong 'visible' hand of government intervention. The 22,000 kilometres backbone was built in just a couple of years in the classical Korean way of state-directed industrial policy. The high fixed costs of the network are not, or only partly, passed on to the end-users. The central government has taken most of the bill.

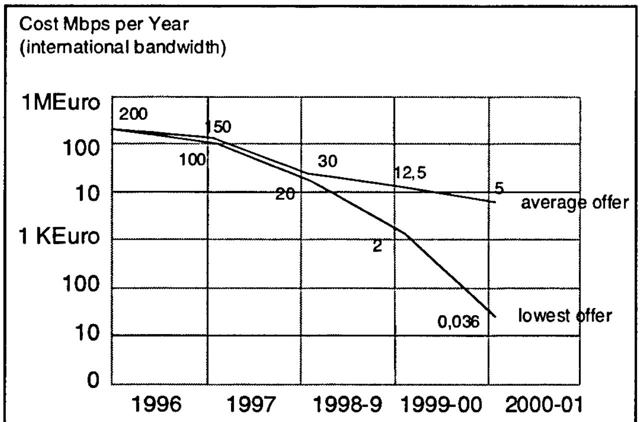
Finally, by contrast, the South Korean government has deregulated its telecommunication industry and removed many barriers to Internet start-ups to stimulate information technology businesses. Today, 3.5 million households have broadband connections (see text box) versus eight million households in the United States, whose population is six times larger. In contrast, Japan has only 640,000 homes and businesses combined with broadband access.[25] Japan has spent considerably more on a wide variety of satellite and ground-based demonstration projects and funded associated research, but the high price of its telecommunication services has blocked wider public acceptance. Even NTT's famed iMode phone can be seen as a rational result of consumers who want Internet access but are discouraged by the cost and difficulty of wire line services.

Europe still has the lead in the development of broadband wireless systems but the success of the past (GSM) is no guarantee for the future. The phasing of the two contending migration paths might be of decisive importance here. In the longer run, a technology-neutral application or even service-based policy might contribute most to a wider diffusion of broadband wireless services. In the short run, important decisions have to be made with regard to network sharing (UMTS). The exemplary co-operation (sic!) within the submarine cable industry - a non-regulated market - could be used as a policy model.

2.4 Research Networks

Research networks merit special attention in any broadband strategy because they are important test-beds for new technologies in general and voracious consumers of bandwidth. Beta versions of Cisco's latest routers, for instance, are usually deployed at academic networks several months before they hit the commercial market, not only to satisfy demands for bandwidth but because academics are more prepared to test such systems to the maximum in order to increase their understanding of the technology -- and report bugs and other constraints as they do so.

Research networks in both Europe and the US also continue to be built with about as much bandwidth as their commercial counterparts. As research networks bring together a lot of purchasing power, volumes go up, and prices (initially only for the research network partners, but later followed by the market) go down, as demonstrated in the graph that represents the development of price offers per Mbps per year to the DANTE[26] Research Network.



Development of prices in Europe,
(based upon the cost of the Research backbone).

The prices indicated are not only based on changes in market prices, but also on the increase of the volumes DANTE was tendering for, on behalf of its network of research organisations. However, there is a clear effect of the liberalisation per 1 January 1998 visible, as from that point onward the price offers start to diverge much more between highest and lowest offer. For the same amount of money DANTE can now buy 250 times as much capacity as in 1996.

Dr. Davies, managing director of DANTE, indicated that one of the major problems with getting the right prices in all European regions is the availability (i.e. willingness) of local providers to offer full wavelength (2.5G) instead of capacity on SDH basis. In his experience the overhead of SDH equipment leads to pricing up to 200 times the amount per MB, as would be calculated for wavelength without SDH overhead.

The trickle down effects from research networks to industry are high. Many commercial networks are managed and run by former academic users. Students and scientists that have got used to high speed connections at the university are leading at-home users of broadband applications. The down-scaling of expensive high performance applications to somewhat more modest but much cheaper residential user applications (e.g., Linux, video compression) has been -- and is -- driven by communities of student hobbyists.

[25] "South Korea Wires Up" by Donald Macintyre, *Time*, January 22, 2001, p. B10.

[26] For further explanation of DANTE, see section 2.4.1

2.4.1 European Networks

Since the early 1980s, European researchers have pushed for more broadband capacity at reasonable cost. Originally, broadband connoted 64,000 bps (vice the 9,600 available from expensive X.25 or leased lines). Networks served the space physics community (SPAN: anchored at ESTEC in the Netherlands) and the high energy physics community (HEPNET, anchored at CERN in Switzerland). Both ran proprietary DECnet protocols, as well as some of the "coloured books" protocols[27] -- upper layer applications and services (e-mail, file transfer, remote terminal access, etc.) running atop X.25. The latter made it compatible with the public X.25 networks operated by the phone companies (international leased lines being unaffordable). At the same time, most European countries had plans, some quite advanced, to deploy national research networks with better functions and fewer costs than what phone companies offered.

In 1984, IBM sponsored EARN (European Academic and Research Network) and paid for international 64,000 bps leased lines among large European computer centres (about one per country) to develop a pan-European networking infrastructure linked to BITNET (a counterpart US network). Both ran IBM proprietary protocols. Although researchers appreciated international connectivity, they recognised that IBM's generosity was also aimed at blocking the spreading use of DECnet[28] and X.25 protocols that appeared more open and modern. EARN was thus incompatible with SPAN, HEPNET and other X.25 based networks.

Against this background emerged OSI (Open Systems Interconnect) -- a set of open (and thus vendor-independent) networking standards. DEC championed OSI ideas (while still actively selling its DECnet products). IBM was openly fighting X.25 as being the creature of incumbent European telephone companies.

The next year, the EC invited European research networking people to attend a conference -- as long as they were clearly "open systems" minded, i.e., anti-IBM and anti-EARN. Under the aegis of ESPRIT[29] the EC established IES (Information Exchange Services) through which funding could be allocated to support the development of research networks in Europe (ostensibly to help exchange the research results funded by other parts of the ESPIRIT and foster the young European ICT initiatives). This was the EC's first sally into research networking and had to be done indirectly due to the lack of an explicit budget line for such endeavours. Such indirection stands in marked contrast to the U.S. approach. However, in the Fifth Framework Programme of the European Commission research networking has become an explicit budget post. The lack of transparency in the European funding model and policy for advanced networks persists; since there is a great divergence of opinion on whether the development of advanced networks should be linked with the operational aspects of networking (which are today in the hands of a dynamic and liberalised market). As a result, although the EC (through successive Framework Programmes) has generously funded advanced networks it has always portrayed its funding as support to science rather than as a deliberate attempt to improve the state of the art in networking.

Nevertheless, research networks do drive technologies. One example is Grid[30] computing; another is advanced deployment of the sixth version of the Internet Protocol (IPv6). The latter is still a matter of research because many operational aspects remain to be studied, understood, and mastered before commercial exploitation). Yet 3G may hinge on IPv6, which was designed with mobile networks in mind (whilst 3G was not a factor when IPv4, its predecessor, was designed).

Today's research networks date back to the late 1980s and early 1990s:

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27 Developed by the UK-sponsored Joint Network Team that would later construct the UK's Joint Academic Network (JANET).

28 IBM a the time was the world's largest computer company; DEC, number two -- but growing faster, with a stronghold in the scientific and technical community.

29 European Strategic Programme for Research and Development in Information Technologies. It was part of the European Framework Programmes for Research prior to its absorption in the current IST Programme.

30 Grid computing attempts to construct a virtual supercomputer by identifying and exploiting the idle computing cycles of large numbers of networked computers used for other purposes (e.g., a secretary's workstation).

- RARE (Réseaux Associés pour la Recherche Européenne) was the first federation of European research networks. It was instrumental in IXI (International X.25 Interconnect), the first pan-European "broadband" (64 Kbps) network as well as the EUREKA project, and COSINE (Cooperation for OSI Networking in Europe);
- Initiatives such as EBONE (European Backbone) were started in 1991 to hasten the introduction of IP networking in Europe.
- In 1993, DANTE (Delivery of Advanced Networking Technologies in Europe), a not-for-profit entity owned by European National Research and Education Networks organizations (bringing together 29 NRENs as member per ultimo 2002), was established as the vehicle to contract with and operate pan-European advanced networking infrastructures. TEN-155 in the past, GEANT today, are pan-European networks tendered for, contracted and then managed by DANTE on behalf of those NRENs, who provide the main funding for it, the EC providing additional funding through IST contracts.
- In 1994, RARE and EARN merged into TERENA (Trans European Research and Education Networking Association), the structure that currently organizes scientific and technical activities (e.g., conferences, task forces, pilot projects).
- Major "regional" networking initiatives for research include NORDUNET (Scandanavia) and CEENET (Central Europe, now fully integrated into the European backbone).

A "European Advanced Networking Agency" has, from time to time, been mooted as a catalyst for providing Europe with leading-edge broadband networking infrastructures, developing applications and services in, from and for the research world, serving as a high-quality test-bed for future industrial deployment, and interacting with the commercial world.

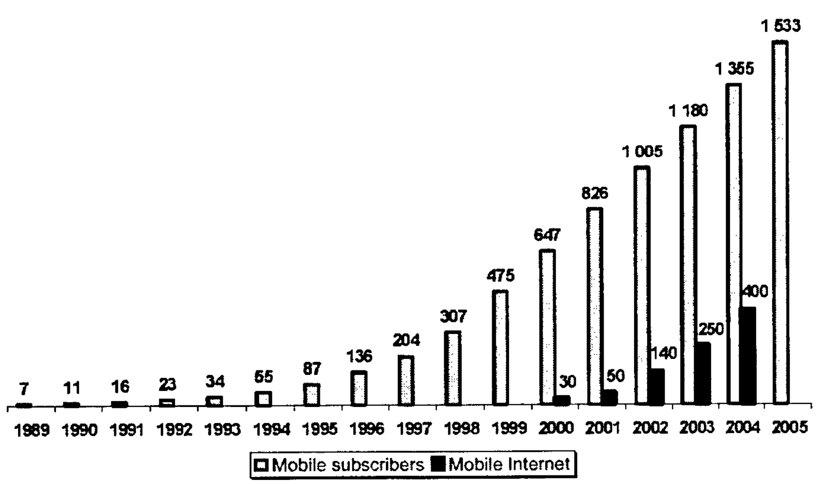
2.5 Wireless Routes to Broadband

Third-, or at least second-and-a-half-, generation wireless remains a viable access route to the Internet of particular interest to Europe as it assumes a global lead position in mobile telecommunications (GSM) on which it can build. Digital telephony standards (absent in the United States) and spectrum (with many eager claimants in the United States) help explain why.

2.5.1 History

In the 1980s, the spread of cellular telephone networks led to mass use of mobile phones, hitherto scarce and expensive. With volume came lower prices and smaller handsets, both of which spurred volume further.

Figure 4: Mobile Telephone Users: 1989-2005 (in millions)



Source: *Sweden in the Information Society*, the Teldok yearbook 2001

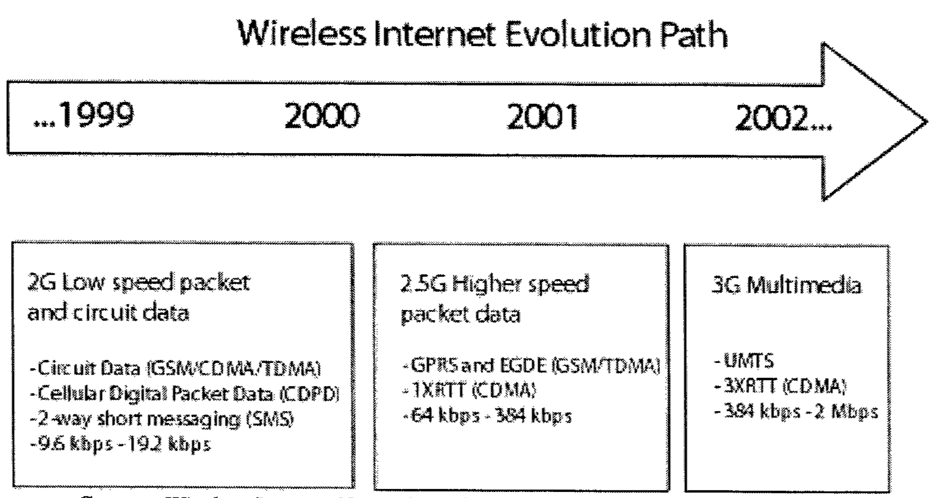
Although AT&T's 1983 roll-out of an analogue standard (AMPS: advanced mobile phone system) kick-started cellular telephony in the United States, its success prompted Europe to leapfrog it with a common[31] digital system in 1991, Groupe Speciale Mobile (GSM), a time-division multiple-access (TDMA) standard. GSM phones were not only clearer than their analogue counterparts, they could be used in many countries around the world, a capability known as "roaming." Incidentally, the possibility of global roaming from terrestrial cell phones, essentially killed off the market for erstwhile competing satellite systems such as Iridium and Globalstar.

In the United States, the lack of a unified digital standard[32] allowed Qualcomm, a start-up, to introduce in 1990 another convention for digital telephony, code-division multiple access (CDMA). CDMA, in turn, has become the technological basis for both competing 3G standards (CDMA-2000 favoured in the U.S.A. and W-CDMA favoured everywhere else). Nevertheless, because GSM is a global standard whereas Qualcomm's CDMA was but one of many national standards, GSM phone users could roam overseas as well. As of 1998, GSM had claimed 64 percent of the world market -- well over 90 percent outside North America. Cellular telephony stands out as a high-technology market unique because its major players, Ericsson and Nokia, are European.

2.5.2 3G and 2.5G

European technology and telecommunications firms, buoyed by the success of GSM, now seek further success with a new generation of wireless phones. A new international standard for 3G phones, IMT-2000 (for International Mobile Telephone 2000) was developed within the ITU (International Telecommunications Union) and global spectrum has been allocated for its use. IMT-2000 seeks to extend the seamless, global roaming capability of GSM phones to include new Internet-compatible services, such as streaming video and Web access at speed up to 2 megabits per second (see evolution path depicted below). Yet the race between the two competing 3G standards UMTS and W-CDMA is not run yet. CDMA can serve bigger cell sizes and has less strict line of sight constraints than UMTS. Hence it seems to perform better in less populated, mountainous terrain as is witnessed by the current migration in Australia from GSM to CDMA.

Figure 5: Delivering Wireless Internet



Source: *Wireless Internet Network Evolution*, Nortel Networks white paper, 2000

31 The positive effect of the European Telecommunications Standard Institute (ETSI: born in 1988) in establishing a 2G cell phone standard should not be overstated; success was as much due to the bandwagon effect. More frequently, attempts to create such effects by a single actor (in this case, the EC) or a single group of actors (such as suppliers) fail. Hence, Bekkers (2001) argues that EC policy has had little influence on the success of GSM; after all, it did not prevent other failures. Such policies did, however, discriminate against other, non-formal standards, and therefore stimulated the emergence of one standard.

32 The FCC of the 1980s (and early 1990s) was, by contrast, reluctant to get into the standards business (its refusal to mandate a digital AM radio standard was a prime factor in preventing the emergence of such a technology). See S.M.Besen and L.L. Johnson, *Compatibility Standards, Competition, and Innovation in the Broadcasting Industry* (RAND R-3452-NSF, 1986), 32-60.

The most important advantage from UMTS over CDMA is the huge installed base for GSM. However, it lacks the incremental migration path that W-CDMA has. While field trials were held with pre-standardised versions of WDMA in the late summer of 2000, due to a great deal of work still needing to be done to arrive at standard specifications for UMTS further delays are to be expected. Despite the fact that WCDMA seems to be moving faster at the short run, potentially large markets like China have been cautious with the deployment of CDMA - although China's Unicom supposedly has postponed a decision pending CDMA upgrades, and not because of second thoughts about CDMA, itself. Handset vendors typically held risk and have thus spread their products across the two competing standards; they do not expect great losses if a single standard emerges.[33] Standards problems however remain a nightmare for service providers who have invested heavily in current and previous generation equipment as well as in developing services and marketing them to subscribers.

Spectrum allocation appears to be a key determinant of how quickly and widely 3G service will be introduced. European governments seized the opportunity that 3G promised; they identified, protected, and auctioned off the spectrum required, garnering 150 billion Euro in the process and saddling "winners" with an equal amount of debt even as they are expected to spend at least that much building the necessary infrastructure.[34]

By contrast, an obstacle to 3G service rollout in the United States has been the difficulty to finding and freeing a sufficiently wide swath of spectrum to support its bandwidth requirements. This has two causes: a greater tendency to favour the proliferated emergence of new technologies, each with its own bandwidth requirements, and the relatively greater influence of the Department of Defence (relative to European Ministries of Defence) whose various information requirements (e.g., for space-based and land mobile communications, radar, telemetry) result in many bands being locked up. Congress had put pressure on federal agencies to cut back on their use of spectrum. The NTIA (National Telecommunications and Information Administration) that regulates federal bandwidth use has mandated that all federal spectrum users reduce by half the bandwidth used to transmit signals by 2005 for VHF and 2008 for UHF.

Most technology developers do not see either WCDMA or UMTS being commercially deployed for at least a year, possibly two. The reason for this has to do with settling standards, interoperability and backward compatibility issues rather than technology or end-user pricing. In any event, 3G is likely to come to the United States two to three years after it will roll out in Europe and Japan. Although there have been spectrum auctions in the United States and local auctions of 3G spectrum (e.g., in New York City) no nation-wide auction has taken place here. Spectrum auctions have not specified which standard to use, nor does the FCC intend to specify this in the future. However, given the impact of such auctions on the financial balance of European telephone companies (e.g., BT, KPN, British Telecom) and lingering doubts over whether the bandwidth promised can, in fact, be engineered, the cost to the United States of lagging are hard to judge.

Proponents of 3G promise that users on cars and trains can receive 384,000 bits per second while those standing and walking can receive as much as two megabits per second. The former approaches DSL and cable modem rates; the latter significantly exceeds it. Indeed, 2,000,000 bits per second may be more than ample for the most stringent feasible palmtop users – enough to handle CD-quality music (200,000 bits per second for stream MP3 files) plus a full-colour, full-motion MPEG video at 30 fps to a generously endowed palmtop (e.g., the Compaq iPAQ's 320 x 240 screen).

In the meantime, 2.5G services will include GPRS (general packet radio service), which introduced packet switching to European wireless consumers in late 2000 at 170,000 bps bandwidth, and EDGE (enchanced data rates for GSM evolution) which can reach 384,000 bps (the latter being introduced in the U.S. market first). 2.5G service (or at least GPRS) has the advantage of not needing new towers for transmission. Whether 2.5G or 3G service works as advertised under all loading and locational conditions, however, remains to be proven (wireless is far more sensitive to transient interruptions than is wireline service).

[33] Vendors such as Nortel do offer IP-based data bridges between GSM and CDMA (IS95) at the physical level but they cannot deal with voice traffic.

[34] *Economist*: 3 March 2001

2.5.3 The Singular Characteristics of Wireless Internet

Will people actually take to the wireless Internet? They do in Japan, home of the ultra-popular iMode service, and where surveys indicate that wireless is, in fact, the preferred way to surf.[35] As an always-on service, it promises far frequent periods of instant gratification. Since cell phones know where they are, it is possible to tailor service offerings to location (e.g., show me the closest source of cappuccino) in ways that E-commerce cannot. Conversely, data entry is much more difficult on handsets than on desktops.

Yet, the failure of the Wireless Application Protocol (WAP) as a way of introducing wireless customers to the Web, has to be at least somewhat daunting. WAP was promoted as a way of packaging the image-heavy and wide-screen Web for low-bandwidth small-screen phones (NB: WAP requires dial-in but iMode is always on). To do so, special web sites were established that offered reduced but nevertheless essential content packaged as a set of linked note cards (in some cases regular Web sites were encoded in such a way that intermediaries could intercept the page request, reformat the material for wireless handsets and send it on). Yet, Web hosts who maintained both full-scale and handset-scale sites have consistently reported hundreds and thousands times more traffic on the former.[36] This hardly spells doom for wireless access. It may take several attempts to understand how to create interesting content or repackage existing content for today's digital handsets. Although 3Com (from whence Palm) belatedly joined the WAP Consortium, the WAP standard is really made for smaller screens than palmtops routinely sport. Yet palmtop screens are better suited than today's cell phones for Web surfing even if the latter outsell the former by 60:1.

The policy implications of wireless rather than wireline access to the Web *et al* are significant, both for developmental and architectural differences. As noted, mobile small-screen access to the Internet is a different experience than immobile large-screen access (although wireless connectivity can also be associated with immobile workstations, mobile laptops, as well as easily portable phones). If both can co-exist, the choice of which is selected has little policy significance. Compare the rise of the home video market that was initially perceived as a severe threat to the movie theatre industry but which has instead involved into a symbiotic relationship with the latter. However, as is often the case with competing conventions, the triumph of one mode might come at the expense of another in ways that feed upon themselves (e.g., content providers break their pages into small, deeply nested quickly paged chunks and keyed to where the client is physically situated; these are adequately handled by mobile devices, thereby offering little extra value to large-screen users which depresses large-screen access which reinforces the format used by small-screen content providers). Those who initially sat out the contest find that the basic decisions had already been made about broad versus narrow content. Certain options are already off the table and thus societies are locked into particular technological development paths before the implications of such paths are fully understood. Some paths may be distinctly better for education, E-commerce, E-medicine, E-government, or entertainment. Media good for broad simultaneous discussions may not be good for interlinked one-to-one communications; those that support quickly jotted notes may not support considered essays as well. Conversely, there may be the risk that people hold off on pushing the wireline route to global access only to find out that, wideband wireless connectivity, once deployed in real-world settings, has technological limitations that, while tolerable for short bursty messages (e.g., G-mail) are unacceptable for the longer sessions that characterise Web access and other E-business transactions. *Will satisfaction with mobile service retard or promote applications that require write capabilities, larger screens, and higher bandwidth?*

In the United States, wireline service is horizontally divided between the phone company, the ISP, the favourite portal, the browser supplier, and the operating system provider being different (indeed, the amalgamation of browser and operating system lead to a celebrated antitrust case). Wireless small-screen service is likely to be far more consolidated: the phone company is likely to be the ISP and the first screen the viewer sees will be provided by the service provider and would, by default, become the favourite portal. Similarly, the browser and operating system are likely to become one and the same. In the case of DoCoMo (admittedly, a unique case), all five were initially provided as a complete package. Indeed the corporate merger of telephone companies, portals, and software houses has begun. One example is Terra Lycos, a

35 www.financialgatewaytoasia.com/articles/2000-04-11-internet.hmtl

36 One Chinese Internet portal, Sohu, reported that the 16 million hits on its regular Internet page contrasted with thirty thousand on its WAP-page; see "Waiting Game" in the *Far Eastern Economic Review*, 17 August 2000, p.40.

merger of the Spanish cellular telephone company, Telefonica, and the Lycos portal. Another example is the combination of Deutsche Telekom's T-Motion and Pal/debis Systemhaus software for mobile phones.

There are fears that just as channels are valuable real estate in the world of television real estate on the "first screen" will achieve great importance -- in ways absent from wireline service where literally millions of sites are twenty keystrokes away. This being so, how real estate is divvied up becomes important and the deals that put one or another site on the strip rather than out in the desert may be less than totally transparent -- a corporatist Internet as it were. As has been observed, "The special business tie-ups can make services frustratingly limited. Your operator may advertise access to movie schedules that turn out to be for only one chain of cinemas -- other chains may have cut deals with competitors overseas. Says Frank Yu: WAP is driven by a corporate mentality. It is not being user-driven."[37]

All this suggests the risk that wireless Internet is likely to come with rules, restrictions, and standards so far missing from the wide-open wireline Internet.

2.5.4 Identification Technologies

Wireless access to the Internet is likely to increase the use of identification and location information on the Internet. Through a combination of cell tower triangulation and GPS,[38] it is becoming increasing easier to determine the location of a cell phone to within a few meters (see Table 7). Although GPS is a necessary component for precision services via the Internet, additional investments for GPS services will be required for improving accuracy such as (1) enhanced cell global identity, (2) enhanced observed time difference, and (3) assisted global positioning system. The latter, is probably the only technology that provides enough accuracy for feasible deployment. Major commercial disadvantage of the technology is the additional costs for the handsets, which range from 19-25 Euro (mass market) to 51 Euro (niche market). In the mass market scenario variable costs (fee per request) are about 1-3 Euro cents[39]. Note that the - possible - introduction of (A)GPS is occurring against the backdrop of declining average revenues per user for both the operators and handset providers (market saturation and longer lead times for replacement of handsets).

Table 7: Alternative Location Technologies

	CellID (+TA)	ECGI[a]	EOTD[b]	AGPS[c]
main mechanism	CellID	signal strength	time of arrival	time of arrival
handsets	legacy	legacy	new	new
investment	low	low	high	high
time to market	Q1 2000	Q2 2002	Q2 2002	Q4 2001
coverage	very good	very good	rural poor	urban poor
accuracy	low (up to 35km)	medium (750m)	high (100m)	very high (10m)
speed	Fast	fast	fast	slow

Source: Hambeukers (2001)

[a] Enhanced cell global identity
[b] Enhanced observed time difference
[c] Assisted global positioning system

If the cell phone belongs to a subscriber (as opposed to a model that uses prepaid minutes) the identity of the caller can be ascertained as well. Location, in turn, permits wireless Internet service to be

37 See "Breaking down WAP's Walls" in *Far Eastern Economic Review*, 14 September 2000, p. 36.

38 GPS is a satellite system, operated by the U.S. Air Force, which broadcasts precisely timed signals that allow users worldwide to calculate their position. Combined with maps and other sources of information, GPS enables navigation of ships, cars, and aircraft, the remote control of machinery, surveying, and asset tracking. Since the signal is a one-way broadcast, there is no limit on the number of potential users and the service is free of direct user charges.

39 Dennis Hambeukers, Business Case AGPS, Msc-thesis Delft University of Technology/Libertel-Vodafone, July 2001.

geographically tailored. Someone using a cell-phone to access traffic conditions, for instance, can be informed of circumstances within say, a mile of the phone. Someone using the device to locate Chinese restaurants can see a listing prioritised by distance from the caller's location. The latter goes by the name of M-commerce. Users of wireless devices announce their location to the service provider, which, in turn, may provide it to third parties benign (e.g., M-commerce vendors) and otherwise (state security services). Unless encryption is automatically employed, the wireless Internet could be as easy to "wire"-tap as wireless phones are (and far easier than wireline communications are to tap). As it is, the Wireless Transport Layer Security for wireless Internet service looks insecure compared to the Secure Sockets Layer ubiquitously used for today's wireline E-commerce.[40] All this raises privacy and censorship concerns that exceed those already raised for the largely wireline Internet.

2.6 Drivers

What has driven the development of broadband technologies in general (and the Internet in particular) so far? What is likely to drive their development years to come?

In answering these questions, several initial caveats need to be kept in mind.

First, these are two separate questions. Factors that *drove* development in the past may be less relevant to *driving* further development. This is particularly true in the case of the Internet. Up until roughly 1992, the Internet was driven largely by requirements from the research community: academia, high-tech corporations, and selected (U.S.) military uses. The motivations of the academic community differ sharply from those of the commercial community. To give one important example, status in the research community comes from the amount of intellectual property one can make public -- that is, give away without direct recompense.[41] Such motivation is at odds with commercial norms, at least as understood today. Thus, if broadband is to make it as a commercial proposition, other motivations are required.

Second, many important drivers are not amenable to public policy treatment in any but the most indirect or broad ways. To wit, the two primary drivers in the adoption of *any* technology are the economics of supply and demand. The economics of supply are largely driven by production possibilities: the technical ability to convert inputs (e.g., high-purity silicon, investment capital for fabrication lines, skilled workers, intellectual capital) into outputs (e.g., semiconductors). Production possibilities, in turn, are determined, in large part through exogenous variables that are obtain globally: they are likely to be similar in Japan, California, and Germany. In the high-tech world they are strongly influenced by fundamental physical and (for software) cognitive constraints. Ultimately, it is up to Mother Nature to determine how many more years of life Moore's Law will enjoy. The economics of demand are usually even more straightforward. Demand depends on aggregate income adjusted for cultural factors (people of the same income have varying tastes). Most policy decisions are unlikely to change that in fundamental ways.

Yet, the supply of and the demand for broadband technologies may be uniquely sensitive to public policy. On the supply side, many of the inputs to broadband exhibit sharply declining cost curves. As an extreme but not atypical example, once the first copy of a piece of software has been written, the cost of producing a second copy is nearly free. A large share of the technological costs is dominated by the sunk costs of research and development. Even for hardware, learning curve effects for products such as semiconductors is so strong, that increasing volumes are associated with rapidly decreasing marginal production costs. The demand side of broadband is dominated by what are, not by coincidence, referred to as a "network effects." The more people are accessible via a network, the more valuable access to the network is for any given individual. People sought to join the Internet in order to connect to the millions that had gone before them, and to access material already posted. People posted information in order to place it before millions who already had access to the Internet. The combination of rapidly declining costs and network effects makes it possible for *intelligent* and *well-timed* public policy intervention to influence strongly the adoption of broadband technologies -- at least in its expression if not necessarily in its overall penetration. So, what would otherwise be incidental drivers for other sectors may be crucial for broadband.

Third, even some public policy drivers may be less than adequately affected by decisions made at a regional (much less national) level. Internet governance, the role of key corporations (e.g., Microsoft), the

40 As argued in *Far Eastern Economic Review*, 7 December 2000, p. 66.

41 Indeed, researchers usually have to *pay* academic publishers for every page of their papers printed.

relationship between media sectors (e.g., transmission versus production), the mores of computer hacking are all determined at a global level through the interaction of multiple governments, cross-cutting communities, and world scale corporations.

2.6.1 Drivers Past

Clearly, networks for research and education in Europe have been the vanguard of broadband networking since the early eighties. Researchers can never get enough bandwidth; this is still true and is likely to remain so. As such, Government funding was vital to what became the Internet even if the original goal of such funding (to share expensive mainframe computer cycles among a few research organisations) was overtaken by the original "killer application" of the Internet, e-mail and the subsequent killer app, the World Wide Web, was totally unforeseen (as was the transition from mainframe to personal computer "hosts"). Large international collaborative activities, such as high energy physics, space physics and molecular biology, put the first heavy requests on data communication. The need for large regular transfers drove the broadband requirement, first for 64,000 bps connections and then for far more. Technologies such as multimedia, advanced graphics, videoconferencing, and collaboration widened the requirement beyond those of large scientific endeavours.

Fortunately for the Internet, when it came to governance, the Internet was so new and "academic" that funding agencies were willing to "devolve" their leadership of these developments to independent, international organisations such as the IETF and, more recently, the Internet Corporation for Assigned Names and Numbers (ICANN). Also important was that the standards for the Internet became publicly published and available on the network itself (as Requests for Comments or RFCs). Funding agencies were also provident in encouraging commercial exploitation of networking researching and their shifting their funding mode from direct support to purchase of commercially-available networking services at the earliest practicable time.

A third driver, in a sense, was the fact that the evolution of the networking remains a fantastic subject of interest. From circuit to packet switching, from proprietary network protocols to open systems, from X.25 to IP to ATM to optical switching, the R&D in networking itself is an extremely attractive topic. Research in networking technology is therefore one of the main reasons why there is a constant demand for more advanced networks; and it remains a permanent problem to have advanced networks that must serve for the benefit of research in general, and which should be used for research in networking at the same time.

In the United States, as noted, the Internet flourished because there was little regulation (the Internet being defined as an enhanced service atop the still-regulated phone service) and because of a tradition of flat rate phone calls. It was not until the early 1990s that companies such as CISCO and PSINet arose specifically to serve the Internet market. Until then it was an add-on. In Europe, which was initially two years or so behind, Internet service was an adjunct for that much longer and, as such, flew beneath the regulatory radar.

Finally, the Internet's origin in academia meant that intellectual content was a non-issue. As noted, researchers give away their intellectual property for the sake of community-wide recognition, a tradition that lingers within the open software community.

2.6.2 Drivers Present

First, broadband is likely to be driven by the expanding range of advanced services that require either broadband service or a broadband infrastructure, e.g.:

- multimedia such as "private TV" (WebTV, video streaming),
- advanced graphics capabilities (virtual reality, high-quality rendering),
- advanced group communication (using multimedia as well as data-sharing capabilities),
- advanced tele-monitoring activities (such as in medicine: tele-diagnosis, tele-surgery),
- tele-training and tele-education,
- the widespread[42] connection of monitored and remotely controlled devices, and
- grid computing and data sharing (see the next section).

[42] Despite some exceptions (e.g., remote cameras) the bandwidth requirements of any one such device are likely to be modest, but the aggregate requirement for bandwidth and electronics and the associated revenue flow from accommodating this requirement may well be a driver for the overall build-out of broadband.

Second, the trend toward flat-rate pricing for local connections (today, via telephony; tomorrow, via DSL, cable, and satellite *et al*) is likely to encourage more intensive use of the Internet in general, and broadband in particular. Experience from the USA and New Zealand shows a doubling of capacity in 6 months following the introduction of flat rate access. The recent rapid take-up of DSL in The Netherlands, for instance, was also based on its being unmetered. Two caveats bear mentioning: (1) on a system of shared unmetered resources, the swift rise of an application that eats bandwidth, Napster being a case in point, cannot be discounted,[43] and (2) some high-value content, such as pay-per-view[44] television, may be successfully marketed as metered service.

Third, the availability of capital is likely to constrain (or encourage) broadband investment. As noted, the 150 billion Euro sunk into 3G licenses have lowered the credit rating of the "winning" bidders and thus hiked the cost of their raising money to build out their system.

Fourth, the specific patterns of service distribution (e.g., cybercafés, Internet booths, broadband to the home, at schools etc.) matter. Accessibility is becoming a major issue after the 'rediscovery' of regions and their potential. Lagging connections to the broadband backbone characterise remote regions in the EU, notably the "accession" countries in central and eastern Europe. In the long run, this may be a hurdle to genuine pan-European integration.

Fifth, new ways to squeeze bandwidth out of old infrastructure (e.g., copper wires) are continually being discovered. As an earlier example, pundits once thought that 14,400 bits per second was the most bandwidth available from the twisted pair that goes to most homes but today's modems routinely pull 50,000 bits per second. Similarly, tricks to extend the range of xDSL beyond the current 5000 meter limitation, or to raise the effective throughput of coaxial cable may permit more bandwidth without a wholesale reinvestment in local wiring.

Sixth, the migration of academic users into the overall population (e.g., as students graduate) is likely to juice the residential market for broadband. Such diffusion may rest on bandwagon and demonstration effects. In addition, when suppliers start to cater the needs of the residential broadband niche, broadband access becomes available on a larger scale and other user groups might step in.

Seventh, how governments use and deploy networks and networking technologies will invariably influence how citizens do so. Government use will encourage citizen use and thus leverage the market in creating an even bigger market; it can also serve as an example for other organisations.

Finally, although more regulators than drivers, government policy on content (e.g., censorship), intellectual property rights and antitrust measures will also affect broadband use.

2.6.3 The Special Role of Standards and Governance

Interoperability and Internet governance merit special attention as potential rocks against which an otherwise smooth-sailing journey to broadband could founder.

Until recently, for instance, Internet backbones were connected on the basis of seamless peering -- open access of one network to another. This is increasingly raising issues of equitable pricing, quality of service (QoS) and the use of bandwidth, particularly between smaller network operators and the larger backbone providers. If the latter decide to detach certain nets (e.g., because access has been "abused") such practice will cut into the value of the Internet as data and users become suddenly cut off.

Standards for micro-payment and must-carry regulation are also important in fostering the cross-fertilisation and convergence of narrowcast and broadcast services. As noted, how 3G standards resolve themselves will matter greatly; the growing tension between the global technology strategy of ETSI members and the limited geographical scope of ETSI, itself, does not help. An interim step may be to back

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[43] News.bbc.co.uk/hi/english/business/newsid_942000/942090.stm. Many U.S. universities and workplaces were struggling with how to limit the load on their systems when adverse judicial decisions squelched such traffic.

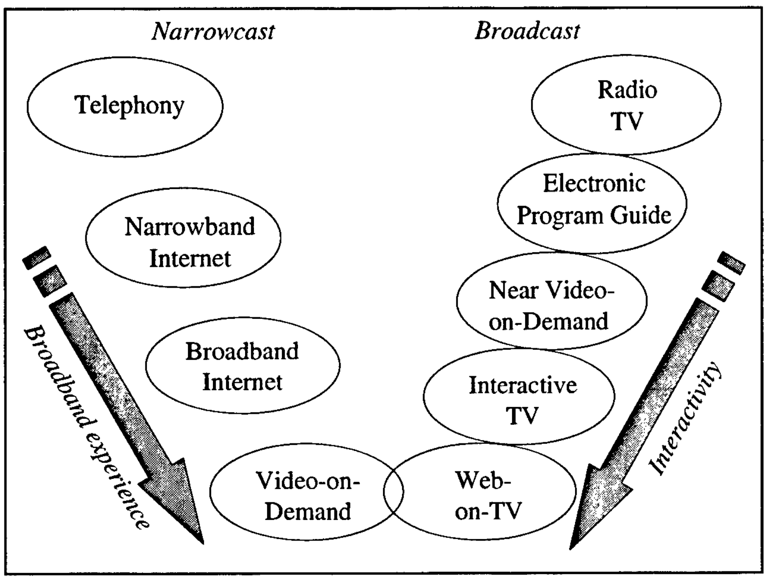
[44] In Spain, Madritel charges 6 Euro per football match (double the amount for Real Madrid vs. Barcelona matches).

away from focusing on communications protocols and concentrating on standards required for advanced applications.

Yet, the broader issue of standards formation for advanced applications is still unresolved. Ten years earlier, the rough-and-ready approach of the IETF trounced the more formal ISO-based approach to standards. Since then, however, as the Internet has grown, the IETF has slowed down considerably.[45] The rise of other institutions such as the World Wide Web Consortium as well as a raft of pick-up entities has met only part of the unfilled need.

Many such standards issues are bound to be raised in the process of telecommunications de- and re-regulation, especially in Europe. Choices between IP over Dense Wavelength-division Multiplexing and/or IP with new QoS features are likely to emerge as key determinants in broadband evolution. The ever-looming transition to IP version 6 (IPv6) also has to be taken into account.

Figure 5: Convergence of Narrowcast and Broadcast Services



At a minimum, fifteen years of history suggest: never bet against Ethernet. Inefficient as Ethernet may be, it has proven relatively simple to implement (e.g., compared to Token Ring LAN technologies). By now, its software base, programmer cohort, and economies of scale have proven more than a match for erstwhile competitors. Thus, FDDI (fibre data-distributed interface) never had a chance. The long-running contest between ATM (asynchronous transfer mode) favoured by the telephone companies and gigabit Ethernet has swung decisively to the latter. The most recent casualty appears to be Bluetooth, a standard (backed, in large part, by European vendors) for wireless local-area network connectivity; it is losing to the Ethernet-like 802.11b standard.

As for governance, there is essentially no background, no traditions in those areas: everything has to be invented as we go, and there is more and more money involved (e.g. in the registration of domain names – p.e. Networks Solutions Inc.), which makes all discussions ever more delicate.

Internet name allocation is a current flashpoint. The Internet, itself is divided in several general domains (e.g., ".com", ".edu") and country domains (e.g., ".de" for Germany). Yet, domain registration rules vary widely among countries. Norway, for instance, limits domain registrations to a company's official name -- and thus forbids registration under product names. Sweden only issues domains to domestic firms. Brazil cancels domains if left unused after six months. Israel strictly enforces distinctions between domain categories such as .net and .com. The Netherlands, on the other hand, no longer insists on prior registration

[45] For a general description of this issue see Libicki *et al*, *Scaffolding the New Web: Standards and Standards Policy for the Digital Economy*, Santa Monica, CA (RAND), 1999 at www.rand.org.

on the Chamber of Commerce list to win a ".nl" domain name. Registration fees also vary greatly, driving applicants to cheaper domains (e.g., the U.S.-based ".com" domain).

The lack of a uniform policy has bred litigation. ICANN's new Uniform Dispute Resolution Policy (UDRP) has been adopted by all accredited domain-name registrars. Some domain managers (e.g., ".nu," ".tv," ".ws") provide cheap fast dispute resolution by cancelling or transferring domains. Yet, the UDRP lacks a requirement for uniform rules or procedures.

3 Trends and input scenarios

The purpose of this chapter is to lay out some factors that span the present and the future.

The first three sections of this chapter discuss specific trends: (1) convergence amongst the telephone, networking, and data communications sectors, (2) advanced research networks, and (3) the evolution of the backbone. The last section lays out four potential scenarios for the evolution of broadband based on a mix of drivers, affected but not necessarily dominated by government policies.

3.1 Convergence

Traditionally, one could divide the communications industry into three segments: telephony, broadcasting, and data communications. The first two were analogue, the last was digital. Starting in the late 1970s, however, telephony became increasingly digitised, starting first in the central trunking architecture and slowly but surely moving out toward the handset. The digitisation of broadcasting has taken place more slowly, but avenues of convergence already exist in the area of direct broadcast television, Web-TV, digital cable service, and the entire debate over high-definition television.[46] Digitisation backed by standardisation is a driver of convergence. The existence of technical standards for physical connection points and the translation of pulses and waves into digital code creates a durable connection between infrastructures that can be produced by any manufacturer and used by any communications company. Generally accepted technical standards that are widely used create large interoperable networks.

3.1.1 Levels of Convergence

Convergence can take place on two levels:

- the technical infrastructure, consisting of physical elements and their protocols and standards;
- the organisational environment, consisting of the organisations that maintain, regulate or use the infrastructure.

The first manifestations of convergence as an industrial phenomenon date to the 1980s in the United States as IBM purchased the data communications company, SBS (Scientific Business Systems) and AT&T purchased the computer company NCR. Both investments turned out to be world-class flops and soured many on the proposition that convergence was likely to be simple and straightforward. The disasters made it clear that although the technologies of digitisation might give rise to eventual convergence, as *industries*, they each featured distinct modes of comparative advantage that did not transfer easily from one sector to another.

Convergence can be described as primary, secondary, or tertiary. Primary convergence brings together various parts of the consumer and business ICT value chains (e.g. Microsoft not only selling software, but also its X-box game console; Sun trying to influence Microsoft's hegemony by supplying office applications for Windows). Secondary convergence is more the complete fusion of IT, media and telecommunications to form a new convergent sector (e.g. AOL and TimeWarner; Bertelsmann and MyPlay; Vivendi and MP3.com; Telefonica and Endemol Entertainment), whilst tertiary convergence reflects the joining of the retail, travel and financial services sectors with the parties which have created secondary convergence.

The EC's Green Paper on Convergence chose to focus on mergers and acquisitions -- notably for vertical integration -- as the institutional source of convergence. Vertical integration meant that telephony, computing, and broadcasting firms extended their reach to other infrastructures. Many traditional telecom operators now double as ISPs and content providers while cable firms offer telephony services. Yet, organisational convergence is just that. A telephony provider in the ISP business is not offering a single network, or even a hybrid one, but simply common management that permits technologies to be applied to

[46] In 1993, the erstwhile front-runner for HDTV, Japan's analog MUSE system, was overtaken -- at least in the imagination of the industry -- by a competing set of digital proposals submitted to the U.S. FCC.

various services based on business considerations. Large telephony companies, being well-financed, ought to be able to reach mass markets, despite evidence that creating and maintaining a global size and presence is proving a challenge for even the largest operators. As a consequence of convergence, significant competition is predicted from Internet service providers, since increasing quantities of telecommunications data and voice traffic will be delivered over networks using Internet Protocols (IP), in a data communications market which is expected to reach a value of $60 billion in 2001 from $8 billion in 1996, and where growth is foreseen to continue at an even steeper level.

3.1.2 The Details of Convergence

In practice, however, will all forms of communications converge to the Internet? And, even if they did would such convergence be visible or would it just be in the backbone?

Technologies often undergo interleaved cycles of convergence and fragmentation. The personal computer, for instance, replaced a menagerie of high-end programmable calculators, word-processing machines, dedicated database terminals, scientific instruments, and numerical machine controls. Yet, palmtops have, in recent years, come to pick up some functions previously performed by personal computers[47] and newer specialised devices are forecast.

For instance, the inevitable progression from analogue to digital telephony in the form of ISDN came to a dead halt in the United States with fewer than one percent of all handsets having been converted. However, digitisation of *cellular* telephony is nearly complete in Europe and Japan, and proceeding apace in the United States.

As for convergence itself, start with something fairly simple, the potential merger of voice telephony with the Internet. Telephony in the last twenty years has evolved to include not only advanced services (e.g., call forwarding, conference calling) but data transfer in the form of facsimiles. Until recently, the primary distinction between the telephony and data communications was that the former was synchronous and the latter was effectively not. But Instant Messaging and (admittedly poor-quality) Internet telephony has eroded that distinction. Meanwhile data services such as NTT's iMode, GSM's Short Messaging Services, and sophisticated alphanumeric pagers have eroded distinctions on the other end. Yet to come (but when?) are wall-mounted Internet devices that one can talk to rather than type on–voice recognition has made great strides forward lately and in these troublesome times of RSI has already mustered a significant crowd of ardent keyboard-less followers.

In parallel, but not necessarily faster, is the substitution of the circuit-switched fabric for a packet-switched fabric (clearly, a switch from when data streams were ladled over voice circuits). Such a switch would be invisible to users, except insofar as it enabled new services such as stereo audio conferencing (a great help in distinguishing who is speaking at any one time). Such a switch could save up to ten times the bandwidth of trunk lines,[48] but with fibre so cheap and statistical multiplexing already in use, these economics are too modest to, by themselves, compel the premature retirement of circuit-switching hardware in favour of routers.

The convergence of the Internet and broadcasting is beset by similar issues. Simply put, broadcasting is easy, channel capacity is multiplying everywhere, generating clever programming is difficult, and new devices are reducing the effort needed to time-delay programs. The services offered by Web-TV *et al* are, almost by definition, niche ones; if the audience is large enough the networks will find some way of delivering it *en masse*. Direct broadcast television is already transmitted in compressed form to be decompressed in the receiver dish. People interact with computers and televisions in different fashions; they like being close to computers and use them individually while televisions are watched from further away and often in groups. As a general rule, old technologies backed by enough capital and managed by smart people can often create a stream of incremental improvements that can postpone the inevitable crossover to new technology for years and years.

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[47] 3 September 2001 *Business Week*, article on prep school requiring Palm IIIC's vice computers.

[48] Because two people rarely talk at once and they occasionally pause, a normal conversation is 60 percent dead time on a duplex circuit. Between that and voice compression, a five- to tenfold improvement in circuitry use over a full 64,000 bps duplex line is easily achievable.

Convergence is also likely to play out differently in different regions. Different countries have taken different paths to broadband: e.g. narrowcast in the Benelux and broadcast (digital TV, set-top boxes) in Spain and France.

Nevertheless, bits are bits, and for that reason the logic of convergence is compelling. It is more a question of when and how rather than one of whether. Until then the "information superhighway" will remain a patchwork of older infrastructures and technologies mixed with new ones rather than a seamless multifunctional network. At a technical level, companies offering multiple functions like traditional telecommunication and Internet or new functions like Voice over IP are translating information signals for the transmission over a variety of infrastructures. They operate across technical borders that still exist and are only bridged because of physical technical interconnections and inter-network standards, but that are physically clearly distinguishable.

3.1.3 Implications of Convergence

The problem with (or opportunity in?) convergence is that telephony, data communications, and broadcasting are all governed by different standards and regulatory regimes. Convergence, for all its logic, is likely to lead to a culture clash, which, if unresolved, may retard the diffusion of broadband.

Take standards. Originally created in the 19th century to co-ordinate standards for telegraph lines between France and Germany, the ITU is now a UN technical agency. Meanwhile, the IETF has been the arbiter of Internet standards. Their standards often clash (e.g., for video teleconferencing standards) with the IETF more than holding its own. Some administrations in an ITU study group are seeking to require cost-recovery mechanisms on Internet backbone providers similar to traditional half-circuit pricing mechanisms. But Internet usage is different than telephone usage (e.g., longer connection times) and packets may travel over a wide variety of lines in a single session. Bandwidth for data is more like a commodity is as such subject to greater price competition and smaller profit margins. Last year, bandwidth prices fell by half every six months by one account;[49] by another[50] it fell by a third in the first half of 2001. The main driver is the overcapacity at the transatlantic route (NY-London); intercontinental prices (USA, EU) are much more stable. Aside from their practical impossibility, such efforts represent a continuing sporadic effort to apply ITU norms to the Internet -- norms that may be incompatible with the kind of deregulatory free-for-all under which the Internet has thrived -- *so far*.

ITU's subsidiary, the WRC (World Radiotelecommunications Conference) allocates spectrum and geo-synchronous satellite slots internationally. Although each nation retains sovereign control over spectrum use in their territories, spectrum must be allocated broadly around the world lest global interoperability be confounded and global marketing of wireless and broadcast services stymied. Conflicts over spectrum affect not only competing technologies and commercial services, but also governments seeking to protect spectrum used for public safety and security (e.g., aviation communications) and commercial firms seeking access to that same spectrum. Wireless broadband usage must win its spectrum from other claimants.

In the EC, the clash of cultures is clearly visible in the diverged activities of the various DGs. DGXIII (Telecommunications, nowadays "Information Society") has favoured a strong relationship with big business in IT and telecommunications and has sponsored the RACE (Research and Development in Advanced Communications for Europe), the subsequent ACTS (Advanced Communications Technologies and Services) and today's IST (Information Society Technologies) programmes. By contrast, DGX (Media) has focussed on issues such as national cultural independence, the promotion of diversity and pluralism, and protection of ethical and moral standards.

As for the broadcast-Internet convergence, values such as public service and cultural pluralism principles, which have underpinned the development of the broadcasting sector, are under pressure as new audio-visual media have become viewed more and more as appropriate for consideration under the broader

49"Wrong Numbers," by Om Malik, *Red Herring*, January 16, 2001, p. 66

50Band-X World Composite Index based on E1/T1-prices prevalent on the one percent of all circuits traded publicly (the rest are traded via private peering arrangements).

Information Society banner. There technical and economic issues have often (certainly by DGXIII) been given greater attention than culture.

International and domestic regulations typically distinguish between "enhanced" services such as voicemail and Internet access and "basic" service such as a telephone line. Basic services are also typically treated as "common carriers" and regulated as natural monopolies - or at least required to provide equal access to all customers. Private networks are typically not regulated and may make whatever private arrangements they choose. At first, broadband would seem to clearly be an enhanced service and one most likely to be provided over private networks. However, it is possible to imagine, as a result of convergence, broadband access being as crucial to consumers as basic telephone service and thus subject to common carrier regulation.

In its 1997 Green Paper, the OECD argued:

> *Since it will become increasingly difficult to have technical or practical separation between broadcasting or telecommunications markets, and given the dynamics of the convergence of infrastructures and services, a review of the existing regulations, and the maintenance of distinct administrative bodies and procedures should be considered.*

It then presented three alternatives:

- Current structures in broadcasting, IT, publishing and telecommunications could evolve separately.
- Separate legislation could be written to cater to new convergent services whilst maintaining vertical separation between sectors in all other respects.
- An all-embracing new horizontal regulatory model could be developed for both existing and new services.

The EC generally regards the headlong rush into a bright new technological future offered by seamless digital information infrastructures as having settled the debate over policy choices. With its proposal for a directive on a common regulatory framework for electronic communications networks and services[51], the EC seeks a harmonised framework for regulating electronic communications networks and services. Its domain covers all satellite and terrestrial networks, both fixed and wireless -- but not services such as broadcast content, electronic commerce or terminal equipment.

On 12 July 2000, the EC proposed legislation to strengthen competition in the electronic communications markets in the EU. It not only established a common regulatory framework, but addressed harmonisation of authorisation rules for electronic communication services, access and interconnection agreements across the EU, rights of users on specific services, privacy, and the unbundling of the local loop[52]. This package aims to liberalise telecommunications markets by adapting regulation to the requirements of the Information Society and the digital revolution. It emphasises the stimulation of high-speed Internet access and providing a light-touch legal framework for market players.

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[51] European Commission, Proposal for a Directive of the European Parliament and of the Council on a common regulatory framework for electronic communications networks and services, COM(2000) 393 final, Brussels, 12 July 2000.

[52] See:

- Proposal for a Regulation of the European Parliament and of the Council on unbundled access to the local loop, adopted 12 July 2000, Com(2000)394,
- Amended proposal for a Directive of the European Parliament and of the Council on a common regulatory framework for electronic communications networks and services, Com(2001)380, 4 July 2001,
- Proposal for a Directive of the European Parliament and of the Council universal service and users' rights relating to electronic communications networks and services Com(2000)392,
- Amended proposal for a Directive of the European Parliament and of the Council on access to, and interconnection of, electronic communications networks and associated facilities, Com(2001)369, 4 July 2001,
- Proposal for a Directive of the European Parliament and of the Council the processing of personal data and the protection of privacy in the electronic communications sector Com(2000)385, and
- Amended proposal for a Directive of the European Parliament and of the Council on the authorisation of electronic communications networks and services, Com(2001)372, 4 July 2001.

Despite the prospect that pan-European level arrangements may transfer control of regulation from the national to the European level, the framework aims to set up unified NRA's throughout Europe. In this light the UK has prepared the formation of such a body, Ofcom[53], replacing five existing communications regulators: Oftel, the Independent Television Commission, the Radio Authority, the Broadcasting Standards Commission, and the Radiocommunications Agency. Technically complex legislation and the control of behaviour remains with dedicated regulatory offices, such as the Media Commission (broadcasting) in The Netherlands.

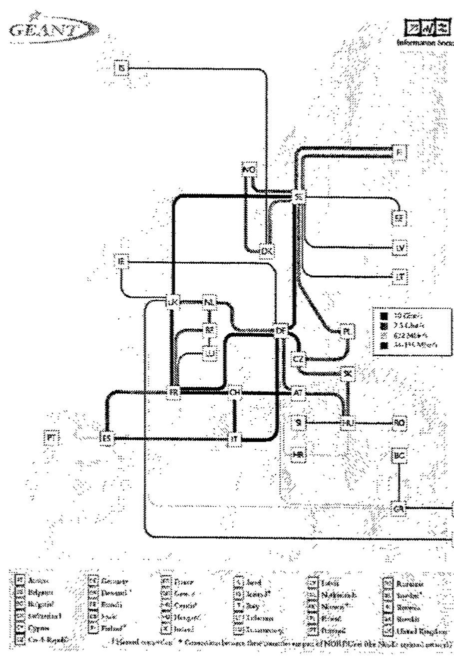
3.2 Advanced Networks

Despite all the commercial activity in broadband development, research networks are still expected to be leading-edge testbeds for new networking concepts. Some merit note: the U.S. Government-sponsored Next Generation Internet (NGI) program, the Internet2 consortium, and the nascent development of grid computing.

3.2.1 GEANT

GEANT is the successor to TEN-155, and, as such, a new research backbone built for gigabit speeds. It covers the EU and associated countries, with more then 3000 accessible institutions. The European Union support for GEANT is justified by its contribution to coherence across Europe and its support to bringing European researchers to work together. It is notable for several reasons.

- for the first time, a technical characteristic in the world of networking (the data rate of a given infrastructure) has become an important item on the political agenda;
- people who have nothing to do with research networks know about gigabit networking, and it is mentioned that 10 gigabits is better than 1, and 100 is better than 10;
- a vision of increased bandwidth for research networks as a plan for the future has been developed in political circles (from Commissioner Liikanen to national governments); this vision considers that building a gigabit infrastructure and striving for higher data rates in the future, will be good for Europe;
- 6th Framework Programme documents now include references to GRID computing (which implies very high bandwidth and quality networks) both in its "Integrating European Research" and "Structuring the European Research Area" chapters (i.e. two of its main three themes).



Multi-Gigabit pan-European Research Network Backbone topology February 2002 DANTE www.dante.net

Researchers of course are very happy with this new political attitude, and it is actually not difficult to conceive applications that will require ever more bandwidth in the future to justify using and developing these new infrastructures. It is interesting to see how GRID computing has emerged as a new agenda item (see comment on the 6th Framework Programme) although it is in fact only a very lightly defined research concept at this point in time. Only a very few years ago, the word "multimedia" was used just the same to justify the need for high-speed networking for future applications and services.

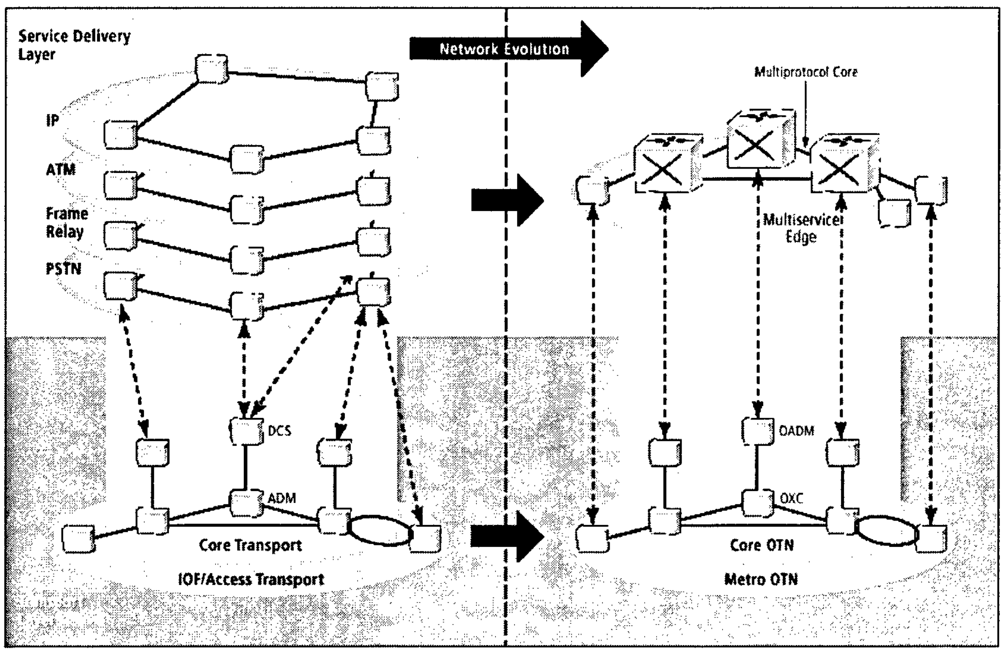
53 *Financial Times*, 13 July 2001, news.ft.com/ft/gx.cgi/ftc?pagename=View&c=Article&cid=FT3ORL7I4PC.

Nevertheless, an infrastructure such as GEANT has a positive global effect on the European scene, as it not only satisfies the permanent demand of researchers for more (and cheaper and more reliable) networking bandwidth, but it also creates an environment where new applications and services can be developed without having to first consider the questions of essential infrastructure. Typical in this context is the current European frenzy about "Next Generation Networks" (high on the agenda of EC and ETSI) and the associated "official" European support for the new IPv6 Internet protocol. While the technical debate about these concepts is far from over (or even complete), there is a general political support for those matters because of a strategic perception, for instance, that these new networking infrastructures will benefit Europe if they allow it to keep its lead in mobile applications and services.

3.2.2 The Next Generation Internet

The next generation Internet (NGI), as it were, ought to be simpler, more effective and reliable, and able to scale up to billions of users. To this end, the NGI (www.ngi.gov) effort has been launched under the auspices of the U.S. President's Information Technology Advisory Committee (PITAC). NGI specifications are largely complete[54], barring some insignificant loose ends, yet the large-scale deployment of many of the newer features over the current Internet is proving difficult. The implementation of advanced features is becoming available in research prototypes, but they still require much experimentation and refinement. Thus, the general commitment to large-scale commercial deployment, and the time-scales over which this could be achieved, are much more uncertain.

Figure 6: The Transition to New Networking Architectures



Source: *Next generation routing switches*, Alcatel, April 2000

Programmatic components of the NGI include:

- *Advanced networking research*, primarily funded by the NSF and DARPA, focuses on guaranteed ultra high-bandwidth on demand for national, regional, metropolitan, and local networks, as well as dynamically-controlled optical networks, multicasting, network management (including allocation and sharing of bandwidth), optical networking, QOS, service differentiation (e.g., among multicast and video) and advancements in reliability, robustness, and security.
- *Testbeds.* In FY2000, NSF, the Department of Energy (DOE), and National Air and Space Administration (NASA) connected more than 150 sites to a testbed providing 100-fold increase in performance over existing Internet speeds. DARPA is deploying a testbed with 1000-fold

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[54] See www.ietf.org/html.charters/ipngwg-charter.html.

increased performance at more than 15 sites. There is also work underway on a "Qbone" network to experiment with applications requiring QOS guarantees.

Applications. A fifth of the funding goes toward applications. Many are part of a "digital Earth" initiative, whose goal is making all US geo-referenced data available via point-and-click over a high-speed network. Other applications (see www.ngi.gov/apps/) deal with collaboration technologies, digital libraries, distributed computing, multi-megabit wireless, nomadic computing, privacy and security, and remote operation and simulation. They include:

- radiology consultation workstation,
- distributed positron emission tomography (PET) imaging,
- real-time and remote-control telemedicine,
- high resolution imaging telemedicine,
- remote control telemedicine,
- medical image reference libraries,
- tele-robotic operation of scanning tunnelling microscopes,
- characterisation, remote access, and simulation of hexapod machines,
- advanced weather forecasting,
- Chesapeake Bay virtual environment,
- distributed modelling laboratory for meso scale meteorological studies, and
- real-time environmental data access.

Such funding is meant to facilitate the transfer of technology to the private sector. In its April, 2000 review of the NGI program, the PITAC states that, "...a quick survey found about a dozen start-ups capitalised at nearly $30 billion that have sprung up from the NGI program" (a figure that no doubt deflated since the Internet bubble burst).

Networks associated with the NGI (www.ngi.gov/related/) include:

- *Advanced Technology Demonstration network (ATDnet)*, a testbed for possible future metropolitan area networks;
- *SUPERNET*, a DARPA program encompassing high speed technologies and testbeds that would permit researchers to collaborate and experiment with advanced networking technologies and applications;
- *Defense Research and Engineering Network (DREN)*, which links DoD scientists and engineers to DoD high performance computing (HPC) centres and to each other;
- *NASA Research and Education Network (NREN)*, which supports NASA missions such as Mission to Planet Earth, advanced aerospace design, telemedicine, astrobiology, astrophysics, remote operations, and simulations and deploys such advanced networking services as IPv6, multicast, QOS, security, and network management tools; and
- *Very high performance Backbone Network Service (vBNS)*, a networked backed by NSF and Worldcom/MCI to link approximately 100 research institutions, and run at 2.4 gigabits/second -- several steps ahead of commercially available networking.

In addition to the above networks, the following federal and university activities have ties to NGI:

- The *National Laboratory for Applied Networking Research* (NLANR: www.nlanr.net) is an NSF-supported, multi-site effort to provide U.S. research institutions with network engineering tools, services and training; user support; network traffic measurement and analysis; and research, testing and deployment of new network traffic measurement tools.
- The *University Corporation for Advanced Internet Development* (UCAID: www.ucaid.edu/ucaid/) is a non-profit consortium of universities and corporations to provide leadership and direction for advanced networking development within the university community.
- The *Science, Technology, And Research Transit Access Point* (Startap: www.startap.net) is an NSF-funded infrastructure designed to facilitate the long-term interconnection and interoperability of advanced international networking in order to support applications, performance measuring, and technology evaluations. Startap anchors the international vBNS connections program, connecting with the Ameritech Network Access Point (NAP) in Chicago. It enables traffic to flow to international collaborators from over 100 U.S. leading-edge research universities and supercomputer centres that are now, or will be, attached to the vBNS or other high-performance U.S. research networks.

Table 8's budget numbers, shown below, tend to understate total network funding inasmuch as other sources are scattered throughout a wide variety of U.S. government agencies. DARPA and NSF are clearly the dominant funding entities.

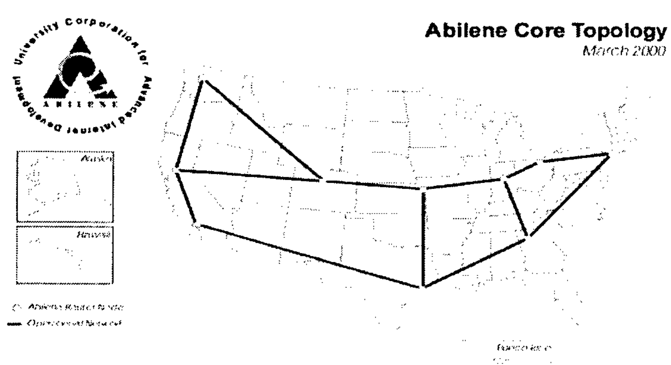
Table 8: NGI Funding

Agency	FY2000 estimate	FY2001 request
DARPA	$36	$30
NSF	$25	$25
NASA	$10	$10
NIST[a]	$5	$4
NIH/NLM[b]	$5	$5
Total	**$81**	**$74**

[a] National Institute for Standards and Technology (www.nist.gov)
[b] National Institutes of Health/National Library of Medicine (www.nih.gov and www.nlm.nih.gov).

3.2.3 Internet2

The most relevant of these developments may be the Internet2 and the Abilene initiatives. Internet2 (www.internet2.edu) is a collaboration of 120 universities working with government and industry[55] and government to develop advanced Internet technologies and applications to support research and education within higher education. Abilene (internet2.edu/abilene/), in turn, is the backbone that supports the development and deployment of Internet2 applications. It connects regional network aggregation points (gigaPoPs) with a topography shown in the following figure.[56]

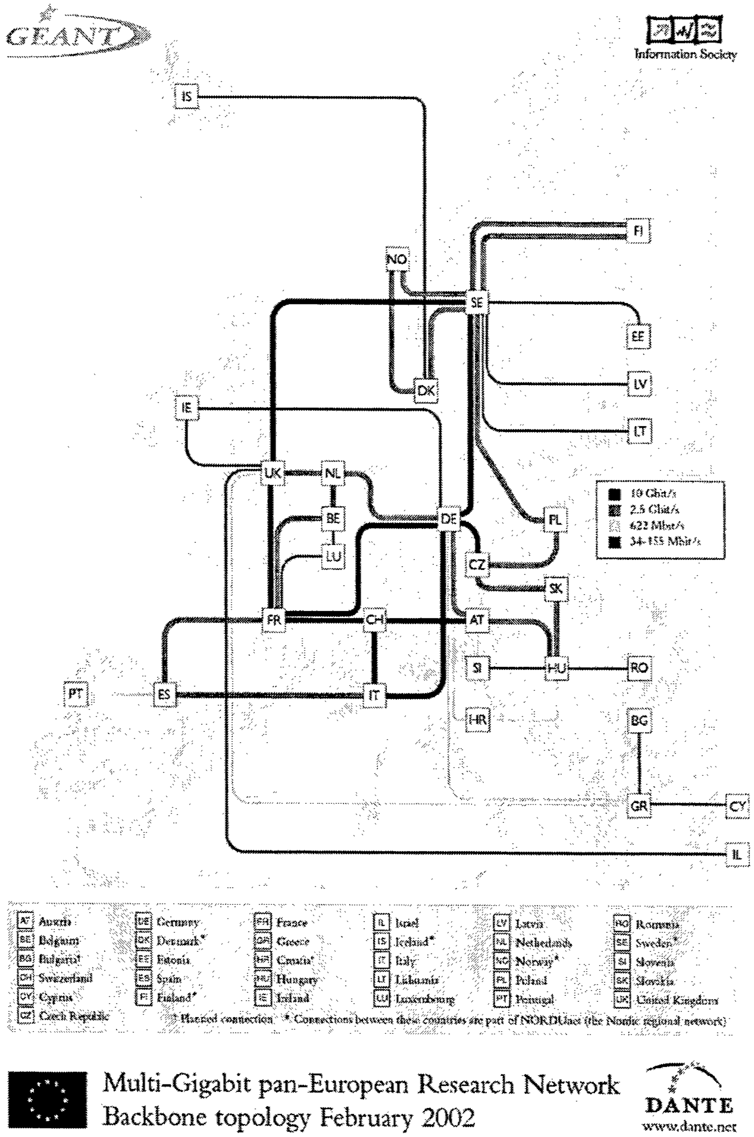


Internet2 has formed peer-level relationships with organisations outside the U.S. with projects similar to those of Internet2[57]. The European/Middle East members of Internet2 are combined in the Euro-link

[55] E.g., 3Com, Advanced Network & Services, Alcatel, AT&T, Cisco, IBM, ITC DeltaCom, Lucent Technologies, Marconi Communications, Microsoft, Nortel, Qwest, SBC Communications, Sprint, WCI Cable Inc., and WorldCom.

[56] Taken from www.ucaid.edu/abilene/html/maps.html, as of 1/31/01. For annual connection fees to Abilene per November 1, 2000, see www.internet2.edu/resources/abilene-update-fallmtg00.ppt.

57 See www.internet2.edu/international/ (accessed 31 January 2001). These networks include: ARNES (Slovenia), HEAnet (Ireland), RedIRIS (Spain),CESnet (Czech Republic), HUNGARNET (Hungary), RESTENA (Luxembourg), BELNET (Belgium), INFN-GARR (Italy), Stichting SURF (Netherlands), DANTE (Europe), Israel-IUCC (Israel), SWITCH (Switzerland),DFN-Verein (Germany), NORDUnet (Nordic, Countries), TERENA (Europe),GIP RENATER (France), POL-34 (Poland), JISC and UKERNA (UK), GRNET (Greece), and RCCN (Portugal).



consortium, an NSF-funded initiative (through 2003) to facilitate the connection of networks in Europe[58] and Israel[59] and thereby support international research collaboration.[60] Internet2's goals in pursuing these international relationships are to ensure global interoperability in the next generation of networking technologies and enable research and education through advanced applications on a global scale.
Abilene also links with European networks, such as TEN-155 (the "155" stands for 155 megabits/second or SONET-3 rates), and GEANT, whose topology and external links are noted in the picture[61]

The French government has unveiled plans to build high-speed Internet links to all regions within the next five years. The estimated costs of connecting the entire country are about 4.6 billion Euro - an amount that well exceeds the *total* IST budget. The funding split between the government and private parties remains to be determined. One option is to piggy-back a fibre optic backbone atop state-owned electricity networks as mooted by the U.S. Bonneville Power Utility and Grant County Utility.

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58 E.g., CERN (European Laboratory for Particle Physics), NORDUnet (Nordic Countries' National Networks for Research and Education), RENATER2 (the France Research and Education Network), and SURFnet (the Netherlands Research and Education Network).

59 IUCC: Israel Inter-University Computation Center.

60 See www.euro-link.org/ (accessed 23 July 2001).

61 Source: http://www.dante.net/geant/

3.2.4 Grid Computing

Supercomputing can be carried out by powerful machines or by networks of less powerful machines each working a part of the puzzle. This idea is over 35 years old, with Multics -a multi-tasking operating system for mainframes - as precursor[62]. Networking, in turn, makes it possible to take the problem pieces and have them run during the idle time experienced by any machine on a network, obviating the need to purchase dedicated machines. SETI@Home exemplifies this possibility; it is a screen saver program that exploits idle cycles on random computers to sift through (chunks of) signals recorded by the giant Arecibo radio telescope in Puerto Rico, in the search for extraterrestrial intelligence.

Serious Grid computing needs faster networks (which is anyway occurring), more powerful processors (ditto), and standards that permit programs to be negotiated and run in a transparent manner (a universal IPv6 fabric helps). Hence the concept of a World Wide Grid. Grids are appropriate for data-intensive problems. For instance, GriPhyN is being developed by a consortium of American physics laboratories to analyse the data acquired by digital surveys of the whole sky using large telescopes. The Earth System Grid, another American academic initiative, would run huge climate simulations spanning hundreds of years. Other initiatives include an Earthquake Engineering Simulation Grid, a Particle Physics Data Grid, and an Information Power Grid Project supported by NASA for massive engineering calculations.

Europe's sally into Grids is its DATAGRID[63] framework to help and co-ordinate national Grid projects. Not surprisingly, CERN is a potential user. Similar European initiatives include Damien (Distributed Applications and Middleware for Industrial use of European Networks) and Eurogrid (www.eurogrid.org/) that tries to establish testbeds for grid applications.

3.3 Backbone Deployment

Work by Coffman and Odlyzko suggests that backbone capacity is unlikely to be a major driver (or more to the point, inhibitor) of broadband diffusion.

Table 9: WDM Deployment and Worldwide Hard Disk Storage Capacity, 1995-2007

	Fibre capacity (Gb/s)	Storage capacity (TB)
1995		76
1996	20	147
1997	40	335
1998	40	695
1999	80	1,463
2000	400	3,222
2001	800	7,240
2002	800	15,425
2003	3,200	30,340
2004	3,200	56,559
2005	4,000	126,767[a]
2006	4,000	266,211[a]
2007	6,400	559,043[a]

[a] Estimates based on extrapolation. However, conventional storage technologies are likely to run into physical limits somewhere in the first period 2000-2010.

Source: *Coffman & Odlyzko* (2001), IDC (2000)

62 www.economist.com/science/tq/displayStory.cfm?Story_id=662301.

63 See www.eu-datagrid.org/.

They have found that the average growth rate in data traffic has close to doubled every year since 1970[64] and that U.S. data traffic will exceed voice traffic in 2001/2002 with Europe only a year or two behind. They conclude that supply and demand of bandwidth will be growing at comparable rates and that pricing is thus likely to play a major role in the evolution of traffic. Data transmission prices have been increasing through most of the 1990s, and have only recently showed signs of decrease. Once they start declining rapidly, many of the constraints on usage that exist nowadays are likely to be relaxed.

Figure 7: Growth Rates for Various Traffic Types at the U.S. Long-Distance Backbone, 1997-2005 (in terabytes per month)

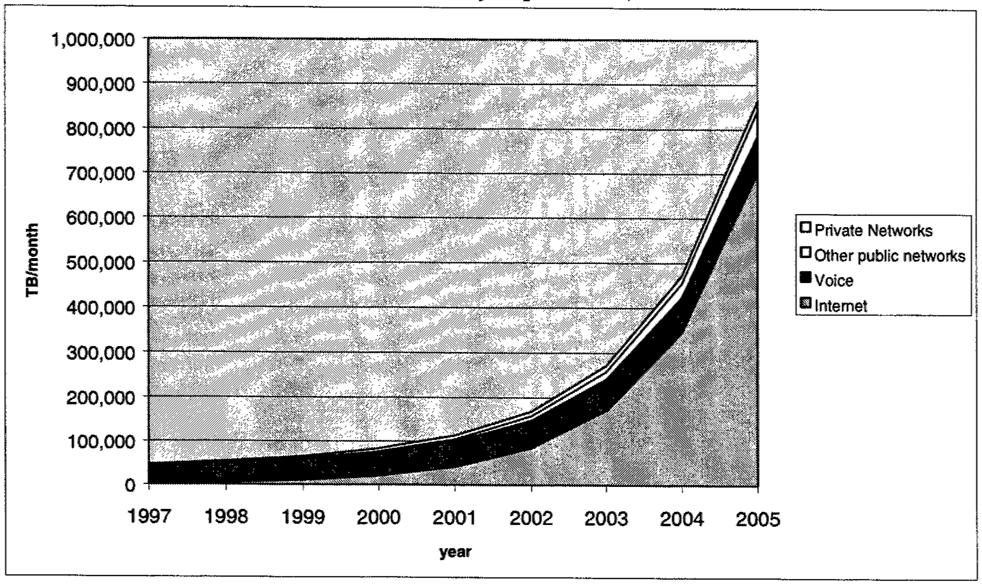


Table 10 - Traffic Growth for Various Major Networks (GB/month), 1997-2001

	Library of Congress		JANET[a]		SWITCH[a]	
	total	growth	total	growth	total	growth
1995	14.0					
1996	31.2	123%				
1997	109.4	251%	6.7		2.2	
1998	282.0	158%	13.2	98%	3.2	45%
1999	535.0	90%	29.0	119%	6.2	94%
2000	741.1	39%	63.7	119%	13.3	115%
2001	1,202.6	62%	104.1	64%	28.4	114%

[a] JANET is the UK academic network, and SWITCH is the Swiss academic network.

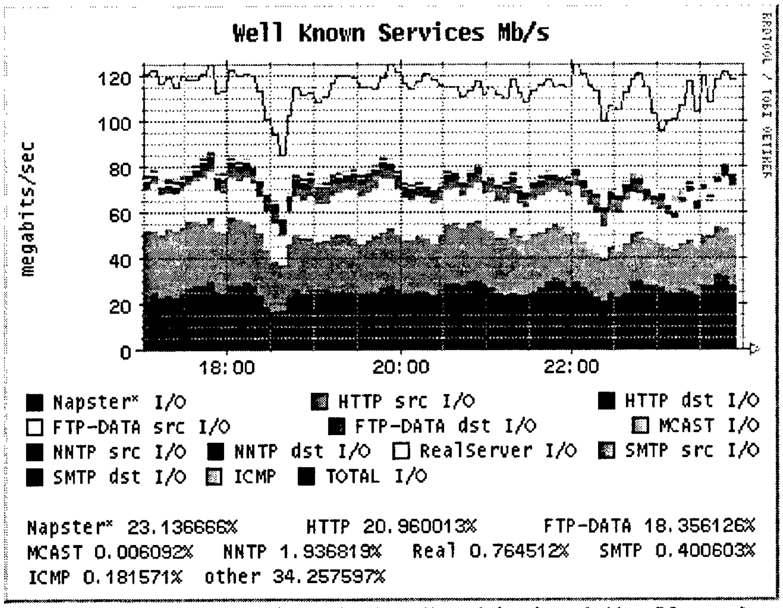
Table 11: Aggregate Growth Rates

	Annual Growth Rate
Library of Congress	87%
JANET	100%
SWITCH	92%
NORDUNet	130%
DFN	70-90%

Because new 'killer applications' can rise very quickly, estimates at the medium term range (say, 6-36 months) are subject to variation. Napster, at one time, accounted for more than 20% of all traffic at some US university networks, similar to what FTP and HTTP traffic accounted for. But then Napster was crippled in the courts and usage declined by 65% (from 6,300 million minutes in February to 2,200 million minutes in June). Alternative sites are not nearly as big as Napster once was.

64 See also, for a critical review of current and alarmingly flaky sources of statistical data on Internet traffic: Hendrik Rood. 2001. Indicators for bandwidth demand. *Telecommunications Policy 24* (2000), 263-270.

Figure 8: Traffic at the University of Wisconsin, March 9, 2000



Source: University of Wisconsin (http://net.doit.wisc.edu/data/Napster/)

All this supports the conclusion that *there will be enough redundant capacity to cope with a 100% annual growth for at least the coming five years.*

Table 12: Unique Users for Top 3 Peer-to-peer Audio Sites (millions)

	Winter 2001	Summer 2001
Napster	57.0 (February)	19.9 (June, est.)
Bodetella	1.2 (January)	1.05 (May)
AudioGalaxy	0.4 (April)	0.98 (May)

Source: Jupiter Media Metrix (2001)

3.4 Input scenarios

Scenarios are stories through which the future can be glimpsed. The purpose of a scenario is not to predict the certain or even the likely but to limn the plausible. They are ways of testing the coherence of a story, and their test is internal consistency and some conformance with the boundaries of the possible. As the scenarios in this study are not the purpose, but a means for testing plausibility of policy options, they are referred to as "input scenarios".

The four scenarios to follow -- roses, tulips, bromeliads, and snowdrops -- are meant to illustrate two broad thematic areas. The first, as alluded to in chapter one, is between the untrammelled development of broadband applications irrespective of their effect on society and a willingness to risk slowing the leading edge of development to ensure that what results is consistent with broad societal values. The second is the choice among three broad vectors of broadband development: depth-first, breadth-first, and wireless.

Normally, the cross-multiplication of two policy vectors and three development vectors would yield six scenarios (without considering other underlying vectors such as good times versus bad times, or policy success versus policy failure), but only four are contemplated. The reduction was predicated on the notion that market forces -- particularly if one assumes a continually more uneven distribution of income -- are likely to favour depth-first development while the insertion of policy options based on democratic principles is likely to favour breadth-first development and special arrangements to bring broadband to underdeveloped areas. In practice, of course, the correlation is much less simple than that: a history of public policy intervention in favour of research networks has, effectively, nurtured depth-first development. Nevertheless, tractability requires simplification.

The scenarios are named after flowers that inspired their individual spirits and also underlines the fact that there is not just one "flower" (i.e. "future"), but many.

- The *roses* scenario features the "magic" of the market and a depth-first development path. Innovations in the use of broadband are plenty. They arise in the well-wired and well-watered environments of global (and largely urban) commerce. They are driven by, on the one hand, sophisticated business needs, and, on the other hand, by sophisticated entertainment wants (of those who have succeeded in business).

- The *tulips* scenario is like roses with ropes -- meant not to constrain but to guide development. Innovations are plenty but they are as likely to be driven by social purposes and for communitarian objectives. This is a breadth-first development path that consciously trades off some leading-edge applications for public security and well being.

- *Bromeliads* are plants that sit on tree branches with their roots exposed to the wind. This scenario emphasises the delivery of broadband services through wireless means. European decisions favours this path, both for social reasons, and for reasons of industrial policy: not only do its industries lead the world in digital wireless but its telephone companies need the market to recover their investment in spectrum.

- *Snowdrops* are harbingers of spring in the dead of winter -- the bright promise of broadband tomorrow but not today. This scenario starts off in the roses but unfettered developments quickly leads to opposition from the bottom. They echo the flak that genetically modified foods received. Policy ultimately becomes important but it plays catch-up to grassroots politics.

Table 13 portrays three characteristics of each of these four scenarios:

Table 13: Scenarios

	Driver	**Path**	**Success?**
Roses	Free Markets	Depth-first	On its own terms
Tulips	Social policy	Breadth-first	On its own terms
Bromeliads	Industrial policy	Wireless-first	On its own terms
Snowdrops	Free Politics	Depth-first	No

3.4.1 Scenario 1 – Roses

2012 brought good news and then the hangover. The good news was that communication and networking technologies created wonderful opportunities for rich, effective communication. Bandwidth on demand was everywhere capable of supporting even three-dimensional video over IP. Interoperability among various providers' networks was high, and networks were interoperable, ready to be used by any application across networks.

The hangover was social. Roses was a depth-first approach; one that created (ostensibly oxymoronic) global islands -- physically disparate, virtually conjoined. Those on the outside, homeless with cellphones as it were, were even further outside than ten years earlier; they might as well speak another language. The backwaters of Europe seem even more remote, and Continental integration fell farther into the future than anyone would have dared predict in

2002. Worst, in the global village, village mores prevailed and Gresham's Law found its way into the cultural domain.

Europeans wished for this, but is this what Europe really wanted?

Background: Economy, Technology, and Policy

The economy, overall, was rosy (what else did you expect?). The general laissez-faire attitude towards the Internet fostered two distinctive trends: a significant increase in the number of price/QoS combinations and the vertical integration of traditional telecommunications operators and multimedia companies (i.e., Colt-Bertelsmann). Market, having shuddered ten years earlier, recovered quite nicely. True, the dot-com mania was dead and buried, but larger institutions were able to cherry-pick on their bones, harvest (and lock up) some very interesting intellectual properties, and hence grow smartly; this lead to great concentrations of power and influence. American exceptionalism, that, for a while was to have been nicely tempered by the slump of 2002, came roaring back. With it followed the mantra of salvation-through-unfettered-technology. As for the Euro, its best days were still to come.

Well, at least the scientists were right. During the past decade, optical communication breakthroughs rolled to where a terabit per second (tbps) could be pushed through one fibre, or 96 tbps through a bundle of 96 fibres within one cable. This was made possible through use of up to 160 separate wavelengths transmitted together without interference within each fibre. Furthermore, within the past several years pure optical packet switches became widely commercially available, allowing switching of data packets without time-consuming translation into and back out of electronic circuitry. Rights-of-way to lay fibre optic cables were obtained along the many railroad tracks traversing Europe. The oceans were criss-crossed with cabling. All this created a rich fabric for high-bandwidth communication linking all major cities, and most secondary ones. Widespread standardisation on the Internet Protocol (IPv6) for packet-switched communication meant interoperability across individual networks. There was also a "convergence" of media, in that video, voice, movies, imagery, and digital documents all shared the same network data transmission lines.

Wireless technologies proved stubborn, as they are sometimes wont to do. It was difficult to transmit more than 144,000 bits per second to a handheld device outside the laboratory. 3G spectrum owners managed to sell back most of their spectrum and recovered enough financial solvency to participate in the boom in wire line assets. But no one wanted to touch broadband wireless again. Anyway, iMode's success put paid to the notion that broadband wireless was necessary; narrowband plus "always-on" sufficed.

Research networks -- now heavily subsidised by corporations, who, in turn, harvested a rich bounty of patents for their troubles -- made good use of the available bandwidth. The most demanding usage was for research in advanced networking such as lambda switching and sophisticated QoS models, but also in advanced applications such as GRID computing for high energy physics, molecular biology, meteorology, seismology and others.

The effect of all this bandwidth and interoperability was, in retrospect, entirely predictable. If any one location on the backbone were as good as any other, economies of scale would lead to concentration, especially of routers, servers and their maintenance specialists. Inexorably, if unexpectedly, the hub of the networking universe migrated to the Pine Barrens of New Jersey, the last pristine (but otherwise unremarkable) terrain on the U.S. East Coast.

These technology developments were greatly stimulated by two policies: (1) a low degree of intervention, so private enterprise could explore options, commit resources, and pursue developments without regulatory restrictions; and (2) stimulus via government purchasing power. The EU decided back in 2002 to make major purchases of bandwidth from communication providers to induce sector growth, strongly supporting large computing facilities in the European Research Area and the health system's need for the transmission of 3D images.

Results

The benefits of technology were very unequally shared. Those with money could buy unparalleled bandwidth, with three-dimensional VTC/WB (video teleconferencing with whiteboarding) approaching fidelity levels previously associated with virtual reality. Indeed, it was considered *de rigeur* for smart offices in urban high-rise towers to be so equipped, leading to business meetings around the globe as easily as around the corner (this, incidentally, fostered a standard workday in the global corporate economy that ran from noon to nine, GMT -- in every time zone).

Depth was purchased at the expense of breadth, a trade-off manifest, in large part, by a transfer of costs from long-distance and high-bandwidth services to local narrowband voice. Deregulation made it difficult for erstwhile state monopolies to cross-subsidise service from their own account; attempts to do the same with taxes foundered after the first few giant telecommunications providers and users decamped to Luxembourg, hired some very fancy accountants, and invested in untraceable electronic payments systems that all but made taxes unenforceable. So, narrowband uses were still charged by the minute and at even higher rates in some cases. Ironically, broadband uses, although sporting higher monthly charges, had no per-minute fees. Thus, heavy broadband usage cost less then heavy narrowband usage (a largely unnoticed anomaly because those who could not afford broadband could not afford to linger on narrowband calls, either).

Box 1 (Roses): "Killer application"

A rather unexpected service that changed the use of network bandwidth are the so-called 'virtual playgrounds'. This new hype that led to massive immersion into on-line adventures with 100-200 participants per game, was pushed by several game-computer manufacturers. The applications are, however, only possible with very high bandwidth. The success pushed for more use of the technology and therefore even more need for capacity.

All this fructification had three unfortunate side effects.

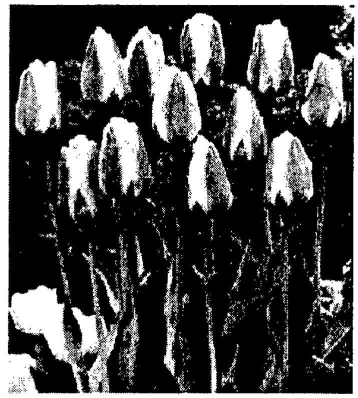
First, business-to-consumer and government-to-citizen electronic applications never took off because no critical mass was ever developed to support such applications. Business-to-business E-commerce, bulwarked by plentiful bandwidth, did quite nicely, and, as a result, productivity in the larger corporations improved at smart rates through the decade. But small businesses were left "out of it" and grew decreasingly competitive -- leading to a round of consolidations throughout all industrial sectors. Most of the productivity among the larger corporations resulted, not in lower prices (at least not immediately) but in higher profits and American-style salaries and bonuses for management.

Second, the data rights and security regimes painstakingly built up in the 1990s simply eroded due to America's refusal to co-operate and the curious fact that every transaction wound up in the aforementioned Pine Barrens where it became untraceable. In any event, the Internet was busily bifurcating into the signed and unsigned sectors. In the signed sectors, all communications were encrypted and signed (with the global digital signature repository located in -- guess where). There, security was very, very good. In the unsigned sector communications were open but unsigned and almost impossible to attribute -- an increasing percentage of all traffic in that sector emanated from cybercafés or cell phones financed with prepaid cards. There security was very, very bad; outages were common, interception was the norm, and identity theft became a plague.

Third, corporate broadband became a vehicle for corporate "culture". The original promise of the Web was of many-to-many cultural exchange. In many ways this promise became a victim of its own success; there was so much out there it was impossible to find and thus market to the uncommitted. Most people got their cultural content from cable and direct broadcast television, and a thick web of cross-financing and hidden rebates made it difficult for independent (and non-mainstream language) content to get an airing. The lowest common denominator of mass entertainment proved to be very low indeed.

3.4.2 Scenario 2 – Tulips

Intellectual trends followed the Gulf Stream. With Wall Street moribund, U.S. electricity deregulation a failure, and telecommunications deregulation a bad joke, Europe shook off the Washington consensus and formed a new consensus that held technology to be a service to the social order and not the other way around.



The world of tulips was one where integration of networks, and thus the interoperability of networks, is stimulated. In the fields of convergence, government enacted rules and guidelines on the use of networks to direct activities on the basis of competition regulation. Government stimulated the use of broadband by making heavy and robust use of it – but it did to broaden access to the Internet and have it reach everyone regardless of social station or address.

Europe enjoyed high economic growth, partly due to the active but discerning embrace of the information society. The last few years, European countries and governments had strongly and actively pushed Information and Communication Technologies (ICT), so that Europe was able to keep up with US growth in this field. The Euro finally came into its own.

Background: Technology, Economy, and Policy

The Internet came to run under the IPv6 protocol. Worldwide standards on privacy and security matters were implemented; they greatly boosted E-commerce (esp. business-to-consumer but also government-to-citizen). The number of Internet clients doubled every year, based in large part on the rapid growth of non-human users: always-on devices in households dedicated to specific services (entertainment, information retrieval, communication) and applications (data, audio, video). Active government intervention effectively unbundled the local loop. Satellites competed well against terrestrial broadband, but had problems due to government purchasing preferences for terrestrial broadband.

Very strong growth in the content industry boosted co-operation between traditional telecommunications and content companies. This led both national and EU telecommunications regulation to separate facilities and services strictly and block mergers between traditional PTTs and multimedia industries permitting at least modest competition in both realms. In the service layer, most firms offered a full range of multimedia products and services stretching from traditional telephony and video broadcasting through Internet provision of (small-screen) video-on-demand and distributed game rooms. Broadband connections were hobbled, however, by the persistent growth in demand beyond what supply could catch up to.

In contrast to the roses scenario, narrowband service continued to be subsidised in order to promote the kind of universal connectivity that let service providers assume that everyone could "dial" in (and thereby retire facilities dedicated to the few who hitherto could not). Broadband service made up the difference. But per-minute usage charges vanished. This offered a wide palette of options to consumers, who pay for what they get: cheap narrowband connectivity and more pricey broadband connectivity.

European integration moved forward successfully, both politically and economically. The economic crisis following the implosion of the dot.com bubble and the continuous epidemics in the agricultural sector were followed by intervention on the part of the EU, which (1) promoted eCommerce, Intelligent Transport Information Systems, health applications, (2) stimulated research and technological development and (3) supported the development of open source software. Europe continued to take a strong role in intergovernmental steering- and policy groups to develop network technologies and infrastructures.

Social policies were neo-Keynesian - activating the economy by stimulating demand. Thus a "guaranteed" market existed for telecommunications services and application, making it easier for suppliers to invest. The government frequently functioned as a launching customer. Fibre lines fanned out to remote regions financed using long-term low-interest loans; many were directly subsidised via generous payments from school systems. Networks that link research facilities in universities and institutes were also heavily backed. Scientists agitated for more interconnected facilities (see textbox 2). Small enterprises that operate on a local level were also promoted, to push the last few computer illiterates into using networked applications.

Europe also took an active stance in making "virtual worlds" (Internet-like applications) safe domains. Policies were adopted to permit effective control of the use of multimedia: e.g., by requiring that pornography not be easily accessible to children. Also, guidelines were set up to control the flows of unwanted multimedia advertisements (spam) and the collection and use of personal profiles of network application users. Europe hired a large and active net-policing force to track of cyber crime and -criminals.

Great effort went into supporting transactions via electronic networks. Not only were digital signatures accepted as legally binding (which was already achieved in 2001), but participants in a transaction were required to identify themselves with the help of biometric ID (a chipcard with embedded fingertip sensor that worked across Europe). Thus, not only the computer but its user could identified.

Results

European policy, having spent the first few years of the 21st century getting the network architecture it wanted, spent the years through 2012 working on getting the content right.

Box 2 (Tulips): Research networks

Every new physics and astronomy research facility in Europe seemed to be more expensive than the last – up to several billion Euros each. Due to the high costs associated with building and maintaining these facilities, they are funded by several countries, which, in return, demanded access to raw data (the historical case is CERN, which boosted network connections between Europe and the US).

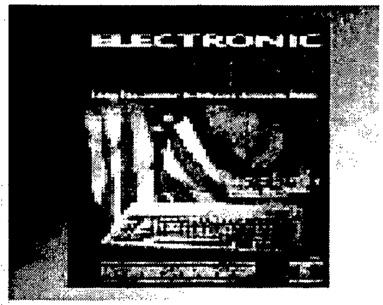
An example of a project that was set up in the years 2001-2006 is JIVE. This Joint Institute will attempt to interlink radio telescopes in Europe to a central processing facility thereby creating a virtual telescope with a diameter of several hundred kilometres. The current practice of distributing data via tapes is envisioned to transition to on that would provide real-time data from approximately. 12 radio telescopes, each producing 1-8 Gbps of continuous data flow and would eventually combine US, South American and Chinese data from telescopes. Unfortunately, most observatories are in remote areas, to which no optic fibre connections yet exist.

A major initiative was undertaken to develop educational material for all grade levels (and in all major languages) that built on decades of research on how to use computers in education most effectively. This yielded a wealth of curricula, for all types of schools, available for free on the Web, offering advanced interactive audio-visual facilities, group or individual teaching in virtual classes. This was conducted in parallel with traditional school attendance where students go physically to school for the benefit of human contact, psychological quality of the direct interaction between teachers and pupils, and also for physical interaction among pupils themselves who would otherwise see each other less and less because of the vastly available virtual communication means.

Beneath this education R&D was a major development to link all of Europe's history and culture into a single accessible master narrative that would be continuously upgraded from text to add, successively, graphics, imagery, passive video, and interactive video. Governments financed some of the content; but what the greatest minds of the continent threw their energies into was a coherent and intuitive conceptual infrastructure -- what one might call a "directory" were the word otherwise not so inadequate. With this in place, it was far easier for others to see where content -- officially blessed and officially cursed alike -- fit in and could be found. This master narrative has deliberately engineered to give minority cultures and disadvantaged regions a place of their own and, ironically, permitted them to be integrated more completely into Europe now that fears of cultural assimilation could be assuaged.

Supporting the explosion of free content was a drastic change in intellectual property rights regimes under which inalienable rights were assigned to individual content producers and commercial rights were limited to the seventeen years that patents enjoyed. In parallel, legal norms began to recognise that data about an individual was, in fact, owned by that individual -- who could not sell it but could only lease it for use. These norms were swiftly injected into the World Intellectual Property Organisation (WIPO) and, despite initial U.S. objections, won world-wide adherence.

Box 3 (Tulips): Public network applications



The Technology for Public Responsiveness (TPR) Network seeks to enhance the usage of modern technologies for the benefit of modern, democratic societies. The existence of the networks shows that co-operation in R&D across regions and network can be successful.

Some projects focus at the introduction of modes of electronic democracy. One of the central research questions concerns the balance between maximising popular consultation and optimising the effectiveness of public policies.

Another issue concerns the access to public information databases. Citizens should be able to find multiple (types of) data-sources easily so that they could choose among policy alternatives. Problems that are touched upon deal with safeguarding privacy and the availability of bandwidth.

The early success of this master narrative in the cultural realm led to parallel efforts in the commercial realm: an attempt to categorise and catalogue all manners of goods and services so that they could be easily found. This gave considerable fillip to small and medium-sized enterprises whose products hitherto suffered by being unknown except to cognoscenti. Europe led a global economic shift from the (never-quite-realised) goal of mass-production-to-individual-tastes to a return to craftsmanship, cleverness, and culture as the basis of manufacturing of many goods and services.

All this intervention came with costs. Technological trends that assumed widespread use of personal data or boundaryless computing had to find a market other than in Europe. Some did, and, as a result, many promising enterprises were started only elsewhere. Many otherwise promising ideas had to undergo vetting against this or that social norm and many were inhibited as a result. So productivity was slower than it could have been -- and there was the nagging sense that the next new thing would not be coming out of Europe.

3.4.3 Scenario 3 – Bromeliads

It would seem ironic that Europe, a continent whose history has emphasised a sense of place, should be leading the world in the development of wireless applications, but it was indeed so. This came about thanks to the initially botched 3G spectrum, and the energy price hike that took place early in the decade. This hike made some old industrial sites uncompetitive forever whilst new energy-producing places had far more work than workers.

As a result, Europe made an unambiguous and vigorous commitment to wireless technologies in order to promote its industries, save energy, and support the new generation of mobile workers. This required that it revisit its earlier policies on spectrum and satellite use, which it did with alacrity.

Background: Technology, Market, and Policy

As the recession of 2002 dragged on, many former technology powerhouses faced the brink. Orders were drying up at Nokia and Ericsson while cell-phone providers were drowning in an ocean of debt. A large and apparently persistent hike in the price of oil and natural gas two years later signalled to Europe that it was not going to enjoy economic recovery or the recovery of its global economic status without some serious policy work.

The first place to start was with the struggling market for (relatively) high-bandwidth wireless connectivity to the Internet. Telecommunications companies were flat-out broke, unable to build out their system nor get more than a pittance in reselling spectrum. European governments agreed collectively to buy back the spectrum they had offered under the proviso that they build out what they had left. Slowly at first, but accelerating throughout, always-on wireless service came to Europe -- at rates that varied between 200 - 500,000 bps. This was not quite what 3G had promised but since the universal "techno-tool" (See Box 4) had a limited screen, it was more than adequate for almost any purpose. Earlier 3G proponents swallowed their pride, relabelled what they got (essentially souped-up GPRS) as 3G and went on with making money.

Wireless networking technologies became the new focus of government-funded research. One goal, achieved in part by 2012, was to permit handheld receivers to predict where its signal was coming from and thereby electronically point (using phased-array technologies, and very fast signal correlation processors) to source of such transmissions. This permitted space-division multiple access techniques to reuse capacity. Implementing such a technology, incidentally, required a very detailed three-dimensional map of the European urban and rural terrain, the accomplishment (and, more importantly, maintenance of which) boosted Europe's GIS capabilities severalfold.

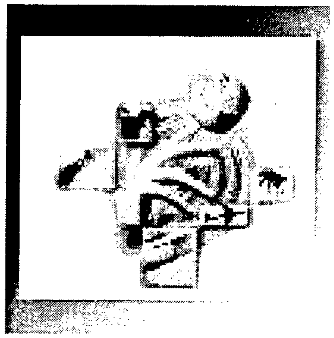
As for Europe's energy usage, wireline service (especially when used to feed CRT monitors) turned out to be an energy hog and server farms planned as hosts for video-on-demand had to be located near hydroelectric plants. Under the influence of very high energy prices, the average dwelling unit per person started to shrink and even less room was available to house immobile high-technology toys. Techno-tools (especially those that used flexible thin-film screens) were energy-misers, by contrast. Incidentally, Grid computing, which relied on exploiting the off-duty cycles of networked computers was doomed once energy-conscious computers, which entered sleep mode if not used for a few minutes, proliferated.

Workers were encouraged to leave distressed regions in search of work, either in Europe's cities, or increasingly as talented and well-paid expatriates in once-again rich energy-intensive regions. Here, too, was the need for mobile connectivity, free, at least in a *sub rosa* sense, from the cultural restrictions often imposed on networks by third world countries.

Finally, a vigorous program was undertaken to extend connectivity into underserved regions. This was largely accomplished through programs that favourably leased VSAT terminals to local centres, promoted a local base of users and applications, and, as demand grew from that point, profited from the privately funded (and only somewhat-subsidised) extension of the terrestrial wireless network – allowing VSAT terminals to go elsewhere. Again, the side effects were important. To exploit VSATs for broadband, Europe was forced to learn how to use, first, Ka-band, and then the V-band region of the spectrum. With U.S. satellite manufacturers still reeling under export controls, European companies quickly grabbed the lead in advanced space-based wireless capabilities as well as well over half of the global satellite market.

Box 4 (Bromeliads): "Killer application"

The development of the so-called techno-tool dramatically changed the appearance and use of technology applications and services. Audio, communication, IT and credit card were integrated in a single device with the appearance and size of a traditional cell-phone circa 2000. Catalysing use of the device was its low energy use as opposed to the array of devices it replaces. Usage of the techno-tool (privacy and theft-prevention assured by hand palm recognition) accelerated the need for bandwidth.



With the proliferation of broadband wireless and technotools of roughly similar capabilities came a regional substrate on which to build a variety of M-commerce applications. Usage rates surged in Europe where "peer-to-peer" computing, GPS-based technotools communicating with geographic database servers (e.g., "where's the nearest Thai restaurant"), electronic games with 10,000 simultaneous participants battling it out together in cyberspace - all created continuing strong demand. What telecom companies lost from low, fixed telecomm rates they made up for in advertising revenue and volume. Policy intervention even extended to a gentle and sometimes not-so-gentle push on European standards bodies to develop a common continent-wide nomenclature for M-commerce terms built upon XML.

Results

Europe enjoyed success -- on its own terms.

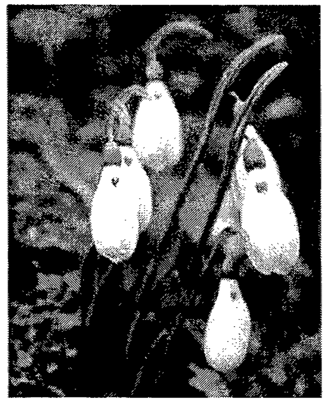
It achieved a widespread broadband wireless infrastructure, with roughly two-thirds of all cell phone users making the leap to Internet service. As a result, Europe regained the lead in manufacturing devices and switches. M-commerce was well established and European applications providers were acknowledged to be the world's leaders. Thanks to the near-uniformity of techno-tools, applications providers had a good sense of what the user experience was across the board (in great contrast to the Web of 2000 where access rates varied between 10,000 and 1,000,000 bps) and their applications benefited accordingly.

Nevertheless there were drawbacks to this approach. Europe missed out on the development of applications that did not make sense at speeds as low as 500,000 kbps. The provision of global interconnectivity -- albeit on a modest scale -- had to be taken over by hobbyists with a cosmopolitan outlook. Several academic research groups were forced to take up the challenge of low transnational bandwidth and lack of interoperability and while maintaining world-wide user communities. Funding for such efforts was, however, very limited and these virtual communities resorted to low-tech solutions to meet their communication needs.

Security and identity authentication provided other problems. Because cell phones are normally easy to tap, demand for them prompted a corresponding demand for hard encryption. Regulators originally went along (in order to strengthen demand) only to find that hard encryption was a cover for considerable mischief. Wireless communications using prepaid cards also do not afford much in the way of identity. Law enforcement officials tried to compensate by attempting to correlate cell-phone location (provided by GPS and triangulation technologies), usage patterns (including unique keystroke and speech-pause attributes), handset electronic signatures, and urban face recognition to recover some basic capability to indicate identity in cyberspace. This was only partially successful in its own terms and but fully objectionable to privacy advocates.

But at least the Euro's value rose well beyond that of the dollar as strengths in wireless communications and ancillary applications (e.g., GIS) pulled the rest of its economy upwards.

3.4.4 Scenario 4 – Snowdrops



Sometimes things go bad. Circa 2000, the future had looked so bright. The Internet had grown at an incredible rate. With the removal of the bottleneck of the local loop and the solution of the domain name space at hand (IPv6), soon hundreds of millions of users would be connected at high speeds to the Internet and the supply of broadband applications would be burgeoning.

But nothing exceeds like success.

Background: Technology, Policy, and Economics

At least everything started smelling like roses. After having shaken off -- permanently it first appeared -- the dot-com bust, high-technology firms reasserted their place in the industrial firmament. Stock prices recovered and so did personal wealth, at least among those who lived large on the basis of their investments. Corporations were again flush with cash.

And, technology, of course had yet to slow down. Vast server farms established themselves on both sides of the Atlantic, the better to discern the various motivations and expectations of potential consumers by correlating a vast supply of data, collected either openly, or surreptitiously through its acquisition by sites in less-than-fussy places. Personalised services through the Web finally succeeded through the exploitation of a few surviving and useful business models. "We know you," claimed many sites, even those run by petrol vendors, and, indeed, they did. So they could tailor clothing, media selections, and even medical protocols to the individual. Such services demanded an ever more intrusive menu of data requirements, but most users were happy to comply, counting on adequate security, and oblivious to the mosaic effect of ceaseless collection. Not all collection was above-board. Increasingly realistic virtual reality technologies seduced users into more and more intimate conversations with complete strangers (who were busy mining such insights into further marketing tops). On the Internet, they rationalised, no one knows you are a dog -- but most users were unaware (or incredulous when told) that, for ten years, they had been purchasing software that identified its provenance and thus its owner with almost every packet one's computer (or personal digital assistant, or cell phone) sent out.

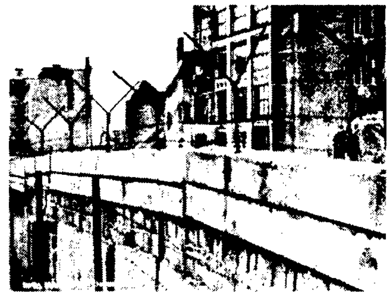
The parallel development in wireless telephony exacerbated this trend. At first, with technical difficulties in 3G worked out, the little devices were must-have items. They were always on, and one was always accessible. Oddly enough (or at least oddly enough for those naive on how these things worked), the software in most cell phone devices defaulted to the habit of relaying someone's location (derived by a combination of GPS and triangulation) whenever queried. Something like this was, of course, *sine qua non* for M-commerce (otherwise how could anyone know the nearest Thai restaurant to *you* -- before you knew you were hungry) but as these were unmediated requests, not everyone who asked had legitimate commercial interests (or at least not at that time).

But, by and large, most users perceived their broadband service -- via by wire or without -- as prescient, knowledgeable, clever, and accommodating. Initially, only a few thought it a little *too* good at these things.

These conditions obtained globally -- or at least where there was enough money to indulge in broadband. Some European policymakers were initially uncomfortable with the implications of such trends, but concluded, after a while, that they were powerless to alter technology's trajectory and accepted not only the general beneficence of technology but embraced faith-based deregulation. Hence the universally held dictum that technology grew best where tended to least.

Box 5 (Snowdrops): "Killer application"

The combination of massive databases, sophisticated security tools and so-called 'smart tracking systems' proved to be an extremely successful commercial formula. The gatekeeper market had long been synonymous with No Pasaran™ but the powerful Teeth of Hercules™ suite from Netscape acquired a reputation as superior in terms of selectivity and lock-out. Access profiles can be fine-tuned on numerous variables (income, education, gender, nationality, ethnicity, religion) and are sealed with an unbreakable 256-bit key.



Results

All that success, unfortunately, led to two problems. The first was that the technology started getting in its own way -- a problem that was, at least in theory, amenable to better engineering in the long run. The second problem was more serious; fundamentally, there was a reaction to technological excess -- for which no engineering could make much difference.

Take the first. Feeling its oats, and struggling against the reins of regulation, the major telecommunications firms, in 2003, collectively formed the Rotterdam Pact with what was, in effect, the rest of the world. Leave us alone, they pleaded, and we will, among ourselves, ensure that we can keep out of each other's way. This promise held two prongs. The first was in the use of spectrum; technology promised that spectrum could be almost indefinitely reused by employing Ethernet-like methods (carrier sense media access with collision detection.). In practice it did not work; worse, the abdication of regulators from spectrum control mean that far less savvy generators of RF energy were constantly getting in the way of signals needed not only for 3G but also for the GPS component of all high-bandwidth applications.

But spectrum problems paled besides those of cyber security. Again, industry leaders pleaded "trust us," and, indeed, no one knew how to secure a computer network half as well as those who had to run it for a living. But competence was only half of the coin, correct incentives was another. So-called zombies who let their personal computer host denial-of-service viruses did not, themselves, suffer harm and thus had little incentive to take care; the Web site pinged by such an attack, however, would suffer a great deal. The theft of personal information for the purposes of identity theft posed little threat to the owners of the information who, one would have thought, might have taken pains to protect it. But to those whose personal information was now in play, the potential harm was grievous. Intrinsic to computer security should have been cryptography for both confidentiality and, more important, identity and authenticity. But public-key/private-key arrangements needed a trusted repository and the lack of governmental leadership or even oversight led to a profusion of incompatible and mutually suspicious systems. And so it happened that cyberspace, as a general proposition was becoming increasingly polluted with mischievous pings, great quantities of spam using ever more devious tricks to gain the users' attention, and identity theft -- the latter linked to several large crimes and even the occasional murder.

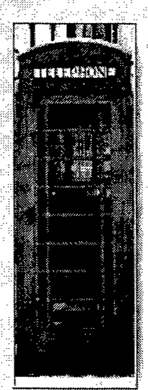
Some of the troubling aspects of information technology turned on changing mores. At first, users enjoyed being connected anytime anywhere. After a few years, the expectation that everyone should be locatable -- not only in the sense of taking cell phone calls but being traceable to a physical location -- started becoming the expectation and, *sotto voce*, a condition of employment in many multinational corporations. Worse, by correlating locations it would be possible for third parties to know who was talking to (or at least within a few meters) of whom.

What finally sparked user ire at technology run amok, however, was the talking bus bench. This was a clever hack wherein a combination of remote camera, face recognition software, a detailed consumer database, and more than a dollop of *chutzpah* meant that transit passengers were being constantly annoyed by advertisements directed at them personally. This was push technology with a vengeance.

The revolt started in the toniest districts. All of a sudden, first one and then several glitterati turn on its head the axiom that (the ability to command) human attention was the world's scarcest resource. No – peace, quiet, and anonymity was. The acme of status was to be unwired, unreachable, and untraceable -- at least electronically. The highest skilled workers started to demand that, in the face of management trends, freedom from having to wear a cell phone was to be a non-negotiable contract demand. Within months, this became a common demand of white-collar employment in Europe; unions injected as much into subsequent bargaining cycles.

Box 6 (Snowdrops): 'Killer application'

The return of the public telephone booth was one of the most remarkable trends in the recent years. According to TeleCabinas, the Danish market leader with pan-European coverage, the success was based on a mix of economic and socio-psychological factors. An increasing number of people viewed a permanent home connection as ostentation. By aggregating demand and levelling off traffic peaks, operators of public access points could operate at much lower costs, and charge much lower prices, than conventional telecom operators. The growing fear of sniffing and other breeches of privacy also furthered the demand for guaranteed anonymous public access. Public access became a niche market for young urban professionals who took pride in not being permanently connected to the telecommunications system any more.



Before too long, technical gadgets such as sophisticated handheld devices fell into bad odour with Mr. Average Income. Not only had they become the symbol of the dotcomania that is widely regarded as the trigger to the current social problems, they also do not fit at all in the present-day culture.

Pervasive computer insecurity also led to the return of paper; nothing else could be trusted to be authentic and stable from one minute to the next. Nascent government attempts to foster E-government simply collapsed in the face of growing body of judicial decisions that held electronic evidence of anything at all to be practically worthless.

By 2012, the counter-reaction had start to set in. European governments, propelled from below started to get tough with data merchants, a return to the trajectory abandoned ten years earlier. Open source software, which could be inspected for trap doors, dangerous defaults, and general gotchas, became a requirement, not only for government purchases, but for any device used over the common infrastructure (e.g., cell phones) or which was critical to safety (e.g., hospital monitors). Since this demand did not sit well with U.S. and Japanese manufacturers, trade in high-tech goods essentially came to a standstill while issues were being sorted out – which meant that very few people actually cared what the Euro was worth.

4 Policies and policy options

Does Europe have any choice but to embrace information technology and make the revolution its own?

At first glance, the answer is no: information technology -- manifest as broadband telecommunications in its current phasing -- is what is primarily propelling the world into the 21st century. Insofar as one is to be an optimist about this century, with its prospects for greater freedom and prosperity, one must therefore be a proponent of broadband.

At second glance, the answer is yes. There are good grounds for holding back, for letting others take the chances, learn from their mistakes, and then shape Europe's use of such technologies in ways consistent with Europe's values and not necessarily the values of those regions loudest in proclaiming their devotion to the future.

A synthesis of the two approaches suggests that the choice is not "either/or" but "both/and". Only by embracing broadband can Europe hope to shape it consistent with European values: social cohesion, solidarity, identity, and privacy. Any other policy risks having it grow up under other parents. When it arrives, as it inevitably will, the creature will be fully formed and far less capable of instruction. Conversely, any policy to promote broadband that does not respect such values must inevitably face so much resistance as to ensure that broadband enters without the scale required to make any network prosper.

Fine notions, but do they have substance? This report argues that, in fact, Europe can have a broadband policy that both promotes rapid positive evolution in the Continent's material basis and stays consistent with Europe's values -- by paying attention to three key policy drivers of broadband development: regulatory policy, research and development, and services and content.

The search for policy proceeds in two steps. First is a review of the prevailing programmes in the policy discussion, eEurope, TEN, and IST. Second, building on these programmes, are considerations on policy options to help move Europe ahead on the right path to the information age. This analyses was presented as input for the expert workshop.

4.1 Prevailing programmes in the policy discussion

The EU has several policy programmes that contribute to the evolution of networks in Europe. In the following text the contribution of 'eEurope' towards this development will be described. In the light of the 'Network Evolutions' project, the policies of the eEurope programme will be compared to the theoretical framework of policy options as described before, i.e. a depth-first, breadth-first or mobile strategy.

4.1.1 The eEurope Initiative

In December 1999 the eEurope initiative was launched by the European Commission to bring the benefits of the Information Society to all Europeans[65] and make Europe the most competitive and dynamic economy in the world. The eEurope report identified three key objectives:

- Bringing every citizen, home, school, every business and administration, into the digital age and online.
- Creating a digitally literate Europe, supported by an entrepreneurial culture ready to finance and develop new ideas.
- Ensuring the whole process is socially inclusive, builds consumer trust and strengthens social cohesion.

[65] *eEurope: An Information Society for all, Communication on a Commission Initiative for the Special European Council of Lisbon*, 23 and 14 March 2000.

Hampering the rapid uptake of digital technologies were several factors: expensive, insecure and slow access to the Internet, digital illiteracy, indifference on the part of public sector to the potential of electronic applications, and a business culture not attuned to dynamic services. Some of the barriers are cultural (and may change, but only at their own pace). Others, though, are infrastructural and can be remedied with the right economic policies.

Ten actions, each with ambitious completion dates, were identified by eEurope and then linked (in June 2000) with these three objectives in the eEurope 2002 action plan'.[66] The ten combined and reinforced existing initiatives and added a few.[67] Although the effect of the eEurope action will take time to play out it is seen by European governments, the European Commission and the involved industry that the plan has accelerated policy and has permitted initiatives to be prioritised.[68]

4.1.2 Actions, Targets, and Priority Areas for eEurope

In the fundamental eEurope document, several actions are identified and, connected to them, targets to fulfil these actions. In the action plan they are, as already mentioned, grouped, ranging from actively changing and stimulating networks ("a cheaper, faster, secure internet") to a more indirect influence ("stimulate the use of the internet" or "investing in people and skills"). The eEurope action plan also identified the supporting framework ("methods") in which these targets are to be achieved: setting up an appropriate legal environment (regulatory framework), supporting new infrastructure and services (depending mainly on private funding) and applying open co-ordination and benchmarking. This new framework for electronic communication services is seen as a priority area.

The various target areas can be analysed in turn.

Cheaper and Faster Internet Access

Eight methods are: (1) inducing more competition, benchmarking, (2) adopting five frameworks (one for overall access, and then one each for subsidiary goals: access/interconnection, authorisation/licenses, universal service, and data protection), (3) inducing more local competition, (4) co-ordinating European frequency policy framework, (5) co-ordinating frequency allocations, (6) financing the extension of infrastructure to less-favoured regions, (7) adopting IPv6 faster, and (8) using competition and the implementation of EC recommendations to reduce leased line prices.

Comments: This target area emphasises breadth, mobility, and depth in roughly that order by emphasising competition, and more rational frequency allocation but with a nod toward public financing and indicative planning (for IPv6). Competition is laudable, but not always easy to achieve, and harder to maintain.[69] The local loop still has characteristics of a natural monopoly. Furthermore, to the extent that the lack of competition permits higher-than-normal profits, it provides the capital for investing in telecommunications. Nevertheless, in any series of policy options, this has to be the most heavily analysed.

Spectrum policy is another rich policy issue, in part because of the 150 billion Euro paid out for spectrum licenses and the light such auctions threw on the fact that too many valuable spectral ranges are grand fathered to the wrong uses. Yet, overly generous spectrum allocation to one usage necessarily takes place at the expense of others – what are such tradeoffs and are they worthwhile?

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[66] eEurope action plan 2002, Prepared by the Council and the European Commission for the Feira European Council, 19-20 June 2000. Note; these objectives were slightly reformulated as to comply with other communications on Job Strategies and Broad Economic Policy Guidelines.

[67] European Commission, *eEurope 2002 Update*, for the European Council in Nice, 7th and 8th December 2000.

[68] European Commission, *eEurope 2002 Impacts and Priorities*: a communication to the Spring European Council in Stockholm, 23-24 March 2001.

[69] To use U.S. airline deregulation as an example: over its twenty year life, many new companies entered the market, but only one, America West, has survived for any length of time, while incumbents grew larger through consolidation.

As for public financing, to the extent that regions are disadvantaged because they are poor as well as remote, accelerating infrastructure deployment may lead to only modest gains in broadband (or even narrowband) usage because the inability to afford terminals (e.g., PCs) or monthly subscriptions.

Finally, IPv6 was motivated by the (now ten-year old search) for new address spaces, and by some of its security features. Several tricks such as the expanded use of C-level classes, and dynamic IP address allocation pushed back the threatened exhaustion date. IPv6 also helps with some security problems (e.g., IP-spoofing) but not others (DDOS, chain-mail viruses). Conversion to IPv6 is also likely to be expensive. Is it worth it? How should it be motivated? Can the few major cell phone companies who appear poised to become major ISPs as soon as Web-to-cellphone takes off be anchor tenants for such change?

Faster Internet for Research and Students

Four methods are: (1) funding networks in order to build out a fully optical backbone and make Europe a global connectivity leader, (2) supporting national research networks, (3) improving high-speed internet access for universities, and (4) advancing Grid technologies.

Comment: This is clearly (and inevitably) a depth-first initiative with thirty years of history behind it. Supercomputing-cum-supernetworking is a well-established foundation for science problems, notably in biotechnology (e.g., IBM's Blue Gene). Europe can and should be doing as much scientific work as the United States. So, it all seems well-grounded. But how much is the right amount? Proposed spending figures can be compared to historical experience as well as to counterpart per-capita numbers in the United States and Japan. Apart from a few grand challenges, at what point is capacity no longer a constraint in terms of serious (e.g., non-Napster) uses? If IT costs are factored in, are the Grand Challenges still worthwhile? Should the EU be setting how-to-do (e.g., all-optical) as well as what-to-do goals?

Secure Networks and Smart Cards

Six methods are: (1) improving online transaction security by promoting greater product availability, industry-led security certification, privacy-enhancing technologies, public/private co-operation, and inter-CERT co-ordination, (2) promoting the development and deployment of open source security platforms, (3) co-ordinating actions against cybercrime, (4) fostering smart card standards, (5) improving human interfaces for security devices, with special needs and multi-lingual support, and (6) improving the availability of smart card solutions

Comments: Although it is empirically unclear whether resolving security issues will necessarily lead to more Internet usage (i.e., how many people refuse to use the Internet over security worries?), improving security remains a legitimate public policy role.

These methods emphasise increasing product availability and accelerating standards development. But will availability come from more product introductions (apart from targeted acquisitions, there is little that can be done) or more R&D (where public funding is more straightforward)? Because governments are such large buyers of security products, a more active policy role is plausible (e.g., U.S. NIST's Advanced Encryption Standard) than in other standards arenas where government influence is fading.

Smart cards can, with some care, be used as access-control devices as long as there is some public key infrastructure behind it (using an open algorithm but a private key). Yet, any smart card *system* that can be cracked by someone who gets hold of a smart card and starts playing with it is probably unreliable -- and the goal of establishing a European PKI is conspicuous by its absence.

European Youth into the Digital Age

Six methods are: (1) getting Internet into the schools, (2) connecting them to research network, (3) developing materials, (4) training teachers, (5) altering curricula accordingly and (6) disseminating best practices.

Comments: These seem like good common sense and similar policies have been pursued in the United States for most of the 1990s. The primary criticism is that people buy the hard infrastructure and neglect the materials, curricula and training. Results so far suggest that computers help but that putting the ingredients together for a breakthrough is more difficult than thought. Overall, education is clearly a breadth-first thrust. However, if done right, the primary effect of these policies is and ought to be improving education; stimulating a richer broadband (or even a richer narrowband) environment is secondary.

Working in a Knowledge-based Economy

Six methods are: (1) promoting lifelong learning, (2) encouraging more IT training places and courses (with gender equality), (3) creating a European diploma for basic IT skills,[70] (4) increasing teleworking, (5) creating a network of learning and training centres for demand-driven information, and (6) creating more telecenters.

Comments: Unfortunately, while these are worthy goals, there is scant discussion of what policies would bring them about. Three of the six appear to entail more facilities. Putting Internet terminals in public libraries makes sense.[71] But it is unclear by how much Internet usage is held back because of inadequate facilities -- so it is not clear what more facilities will do to create a broadband environment.

Widening Internet Access

Five methods are: (1) encouraging performance benchmarking, (2) publishing "design for all" standards, (3) reviewing relevant legislation and standards, (4) adopting the Web Accessibility Initiative, and (5) ensuring the establishment of networked centres-of-excellence for design.

Comments: This is a special case of a breadth-first policy. Because special needs populations are many, various, and small, markets usually have less interest in going out of their way to serve them (except perhaps at high cost) -- hence a *prima facie* case for government intervention. Benchmarking and standards are meant to nudge people into serving special needs markets largely by drawing invidious comparisons between those that cater to such markets and those that do not. Conversely, justifying help for specialised "centres of excellence" must presume that ignorance of design alternatives keeps this market from being served -- a questionable assumption.

By way of comparison, special needs in the United States are addressed through the ADA (Americans with Disabilities Act). The ADA requires public authorities and businesses to make "reasonable accommodations" for people with handicaps (frequently the wheelchair-bound) without using stigmatising methods (e.g., a door in the back of the building). Because special needs markets are, by definition, small, there may be economies of scale in promoting trans-Atlantic research and design initiatives to spread the cost.

Accelerating E-Commerce

Nine methods are: (1) adopting outstanding EU legislation on copyright, financial services, E-money, and jurisdiction, (2) promoting alternative dispute resolution norms, trust marks, and codes of conduct through private means, (3) co-operating with the Global Business Dialogue, (4) improving legal assurance through online information service and awareness, (5) promulgating best practices, (6) establishing an ".eu" domain, (7) removing legal obstacles to e-procurement, (8) establishing an e-marketplace for public procurement, and (9) harmonising VAT for bricks and clicks

Comments: Although e-commerce would drive breadth, depth, and mobility, it is primarily a breadth-first thrust, especially for business-to-business applications.

Four of these methods (1,7,8, and 9) entail changes in existing legislation. Some of these changes appear obvious, a necessary overhaul to make pencil-and-paper practices conform to new technological

70 Incidentally, the only people at the RAND Corporation that must pass computer certification tests are secretaries -- and their relative pay has not advanced over the last ten years.

71 Affluent Montgomery County, in the suburbs of Washington D.C., has roughly one library-sited Internet terminal per 5,000 residents.

possibilities. Others, such as VAT harmonisation, are not so simple. E-commerce companies in the United States have vociferously fought the imposition of sales taxes on their business on two largely specious grounds: local taxes are too complex (well, that's what computers are for), and that E-commerce is an infant industry worth subsidising.

The other five are relatively low cost; they would work by stimulating private activity (2, and 3) by providing information (4, and 5"), or by applying for a domain (".eu") just as new ones are being handed out. All of them fall in the "it cannot hurt" category.

Government on-line

Seven methods are: (1) putting data (2) public services, (3) EU transactions, and (4) administrative procedures all online as well as (5) harmonising online data and its access, (6) promoting open source software, and (7) promoting electronic signatures within the public sector

Comments: Such measures are hard to argue with in the abstract and cannot help but stimulate Internet access although their specific impact on broadband or mobile Internet use is indiscernible. They all have to be adopted one way or the other -- but how soon? Going online costs money, and money is finite. Therefore, it makes sense to prioritise: e.g., put already-computerised data online but not necessarily data still in analogue form; don't make public services for the indigent contingent on their owning a computer.

As for open source software, feelings about the Microsoft Goliath and the Linux David notwithstanding, government online services seems an inappropriate venue to make the necessary discriminations.

Health Online

Four methods are: (1) ensuring healthcare providers have a telematics infrastructure, (2) disseminating best practices, (3) establishing quality criteria for health-related websites, and (4) establishing health technology and data assessment networks

Comment: The health care sector is primed to be a broadband driver if only because passing around imagery (e.g., X-rays, cat scans) is such a bandwidth hog. However, a good deal of medical information can be transmitted in narrowband (as long as it is typed and not hand-written).

Unfortunately, these four methods miss the mark. The real issues are (1) privacy, (2) data standards for conveying medical information, (3) investments in internal networking equipment (notably wireless LAN infrastructures to support ever-popular handhelds), and (4) the over-cautious attitude the medical profession has toward technology. The first two are the subject of the U.S. Health Insurance Portability and Accountability Act of 1996; Europe may be able to take advantage of U.S. successes and mistakes to do the same thing more cost-effectively in a few years.

European digital content

Two methods are: (1) stimulating European content, especially in the public sector, and (2) co-ordinating digitisation programs across EU member states.

Comments: Better content would accelerate Internet usage, and more interesting imagery would stimulate middle band (100-400 kbps) use (video content is better matched with broadband uses). The first method appears more related to museums *et al*; the second, to libraries. European tastes may differ (and thus more apt to be motivated by material from museums and libraries) from American tastes. Nevertheless, such policies are expensive (and their effect on tourism needs to be carefully assessed). They ought to be justified not on the basis of their effect on Internet use, but on their more direct contributions to educational and cultural awareness and development. There is, of course, a world of content beyond museums and libraries -- newly created literature, imagery, audio, video, and other lively arts. Here, the Internet is a double-edged sword, reducing distribution costs but also making copyright infringement easier. Thus, it raises issues related to intellectual property protection (or overprotection) as well as fair usage.

Intelligent Transport Systems

Seven methods are: (1) making emergency (112) services widespread, (2) creating a Single European Sky, (3) implementing traveller information services, (4) realising the Deployment plan for ITS, (5) instituting wireless communications for high-speed trains, (6) setting up a maritime and inland shipping reporting system, and (7) adopting the Galileo precision location satellite system.

Comments: This a mixed bag; most of these take advantage of Internet technology rather than promote its use (or the use of broadband). No one will adopt broadband, or even narrowband for that matter for the express purpose of accessing emergency services, rationalising air traffic control, or facilitating maritime reporting. The relevance of ITS depends, in large part, on what aspects of ITS are being employed (cars, for their part, hardly need broadband, and drivers have enough distraction already without giving them broadband or even narrowband connections whilst driving, unless done as a substitute for, say, car radio). Traveller information services are yet another category of Web content (and the travel industry is already a heavy contributor of Web content). Only setting up wireless on trains creates infrastructure but the method, in its specifics, refers only to standards.

4.1.3 Afterthoughts

The eEurope plan has the benefits of (1) official imprimatur, and (2) a reasonably high level of comprehensiveness and completeness (perhaps overly so). Very little is missing and the exceptions are noteworthy in and of themselves. Most of its recommendations are widely seen as worthwhile investing in, or will at least not lose much money if they prove useless. By and large, these are policies specific to the goals of fostering a global information society in Europe. The most conspicuous overall gap in this analysis is a failure to address problems in capital markets that inhibit the use of venture capital to build up a supporting Internet sector. Other general policies (e.g., better education, more efficient capital markets) could also promote an information society -- and a good deal more besides -- but they are not part of the action plan.

4.2 TEN Telecom

The 1992 Maastricht Treaty of the European Community calls for the creation of a Trans-European Networks (TENs) programme, in Transport, Telecommunications, and Energy.[72] The TENs program, with a 2000-2006 budget of 4.6 billion Euro supports projects of common interest whose immediate commercial prospects and benefits are uncertain but which promote the interconnection and interoperability of and universal access to national transport, telecommunications, and energy networks.

The European Commission Whitebook on Growth, Competitiveness and Employment in 1993 saw TENs as a way for Europe to achieve its socio-economic goals. In telecommunications; it also called for the development of services and applications that would yield a critical mass for further infrastructure investments and for attracting new users. True, the Whitebook did not reflect the Internet, but the Internet only validated its logic.

Under the TENs program is the TEN Telecom Action program, managed by the EC's DG InfoSoc and funded to a level of 275 million Euro (2000-2006). It supports projects that could offer social and economic benefits across Europe but are not privately financed because financial returns are too uncertain and because those who want to commercialise the results of research and development often have limited access to venture capital in Europe.

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[72] See RAND Europe and IDC Benelux, *TEN Telecom Guidelines Status Review*, April 2001 (draft final report); PLS Ramboll Management, *Intermediate Evaluation of the TEN-Telecom Action*, November 2000 (Final Report Executive Summary); and European Commission and Directorate Information Society, *TEN-Telecom Work Programme*, March 2001.

In conformance with the TEN Telecom Guidelines,[73] projects are supported if they are expected to be (1) of interest across Europe, (2) based on mature technologies, (3) backed by committed sponsors[74] (4) and capable of producing strong socio-economic effects (job creation, education, health care are important desiderata). TEN-Telecom concentrates on funding the validation (up to fifty percent of all costs) and roll-out of an operational service (up to ten percent of all costs). Validation includes feasibility studies, commercial and financial validation activities, business plans, and even revenue-generating pilot applications to prove the concept and evaluate user acceptance. As a result, project sponsors will know whether they have a convincing business case, allowing them to rollout the operational service with their own financial resources or by seeking additional external private or public funding. But TEN-Telecom, in turn, requires that such projects be sustainable in the long run through private funding or public funding justified by rates of return.

By overcoming initial investment and launch hurdles, TEN-Telecom helps to reduce commercial risks and overcomes some transnational implementation cost barriers. It also helps with any organisational problems related to public/private partnerships, which TEN-Telecom emphasises in order to broaden access to, and use of information and communication technologies.

TEN-Telecom is also open to proposals from single entities -- if they meet the "general interest" requirement outlined above, and seek to serve several Member States.

TEN Telecom Action appears to be successful in supporting projects that would otherwise not have started, without duplicating private or other investment sources. Experience from the TEN-ISDN preparatory action confirms that TEN-Telecom can promote follow-on ventures to successful Telematics projects. The TEN Telecom Action can leverage its vision by expressing its clear focus on its exact role within the telecommunication sector, and its links to overall European policy, with emphasis on those embodied in the eEurope initiative.

4.3 IST

IST is a single, integrated research programme within the European Union's Fifth RTD Framework Programme (1998-2002) that builds on the convergence of information processing, communications and media technologies. IST has an indicative budget of 3,600 Million Euro.

The strategic objective of the Information Society Technologies (IST) Programme is to realise the benefits of the information society for Europe both by accelerating its emergence and by ensuring that the needs of individuals and enterprises are met. This includes enabling technologies[75] which are the foundations of the information society, for which the programme objective is to drive their

[73] The Guidelines call on the EC to support the interconnection of networks in the sphere of telecommunications infrastructure, the establishment and development of interoperable services and applications as well as access to them. This should lead to:

- Facilitating the transition towards the information society, as well as providing experience on the effects of the deployment of new networks and applications on social activities and promoting the satisfaction of social and cultural needs and improving the quality of life,
- Improving the competitiveness of Community firms, in particular SMEs, and strengthening the internal market,
- Strengthening economic, social and regional cohesion, taking account in particular of the need to link island, land-locked and peripheral regions to the central regions of the Community, [and]
- Accelerating the development of new growth-area activities leading to job creation.

[74] A TEN-Telecom consortium must include a public entity (a local, regional, or national authority), or an entity which represents the public interest of the intended service. This can be a provider of content in areas of public interest (museums, educational content providers, health information providers), users or users organisations (schools, training centres, hospitals, SMEs organizations) or telecommunications licence-holders. It is important that consortium partners have a well-defined role and a credible commitment to success.

[75] Essential technologies and infrastructures– to further the development of these technologies and infrastructures common to more than one application, enhance their applicability and accelerate their take-up in Europe. RTD will cover areas such as the convergence of information technology and communications; mobile and personal communications; microelectronics; technologies and engineering for software, systems and services; simulation and visualisation technologies; novel multisensory interfaces; and the development of peripherals, subsystems and microsystems. In particular, the priority will be on realising a ubiquitous computing and communications landscape with embedded, networked (wired or wireless) information systems and on developing open technology frameworks for personalised services irrespective of time, location and context.

development, enhance their applicability and accelerate their take-up in Europe, as well as specific support for research networks[76]. IST is building on the work done by ESPRIT, ACTS and Telematics Applications Programmes under the 4th Framework Programme. Total budget foreseen is 3.6 billion Euro, from which 1.36 billion Euro is dedicated to enabling technologies, and 160 million Euro to research networks. The Programme, taking into account the policy objectives of the Union, has identified a set of focal directions for the work in 2000 and beyond. These place the needs of the user, i.e. the citizen, at home, at work, in leisure or commuting, at the centre of future development of IST. It is based on a vision that: "Our surrounding is the interface" to a universe of integrated services.

Pursuing this vision is to enable citizens to access IST services wherever they are, whenever they want, and in the form that is most "natural" for them. While directly targeting the improvement of quality of life and work, the vision is expected to catalyse an expanse of business opportunities arising from the aggregation of added-value services and products.

The Programme orientations can be summarised by the following vision statement:

"Start creating the ambient intelligence landscape for seamless delivery of services and applications in Europe relying also upon test-beds and open source software, develop user-friendliness, and develop and converge the networking infrastructure in Europe to world-class".

European added value: Realising the full potential of the information society requires technologies, infrastructures, applications and services, accessible and usable by anyone, anywhere, anytime, whether it be for business or individual use. Collaborative research and technological development is needed to create both the critical efforts and the interoperability necessary to ensure this in Europe. Pan-European research is also needed to ensure that content, together with its creation and use, properly reflects and exploits the EU's cultural diversity and many languages.

European competitiveness: Information society technologies are integrated in, or support products and processes in all sectors of the economy. To be competitive in the global marketplace, Europe needs to master both the supply and use of information society technologies. To this end, the Programme integrates a wide range of actions to stimulate the development and take-up of information society technologies and to ensure that the conditions and requirements for their use can be met.

Socio-economic needs and EU policies: The IST Programme supports EU policies, notably in employment, social cohesion and competitiveness; in fostering the convergence of information processing, communications and media, and in ensuring interoperability and coherence at a global level. The Programme therefore foresees "close articulation between research and policies needed for a coherent and inclusive Information Society".

The IST Programme is very much linked in with the eEurope initiative, and helps to focus and boost research and development of technologies enabling broadband networking, as well as creating applications that will be needing these facilities, based on a society focus and within a policy framework defined in the eEurope action.

4.4 Prolegomena to Policy

Before discussing policy recommendations in chapter 5 that would accelerate the deployment of broadband, two points are worth making. One, the primary drivers of broadband are fundamental to national or regional economies, leaving policy to influence the secondary drivers. Two, government policies that would influence the flow and direction of investment must pay attention to risk factors that inhibit otherwise good ones from being made.

4.4.1 Primary Drivers and their relation to Policy Choices

National (or regional) income is a first primary driver in determining the extent of broadband. The more income, the more discretionary spending and thus the greater the potential demand for consumer broadband. In addition, higher incomes are also correlated with higher levels of business cash flow, a

[76] The programme will support activities involving the broadband interconnection of existing national research and education networks, and also the integration of leading-edge European experimental testbeds.

more complex economy (and thus a denser information exchange), and greater pressure to substitute capital for labour. All this increases the motivation for business to purchase broadband. Needless to add, national income is influenced by an extremely wide array of national endowments and long-run policies, and only modestly by IT policies as such.

Education levels are another broad indicator of a society's propensity to invest in telecommunications, but up to a point. The more people are educated, the more literate they are and thus more likely to consume words and pictures. An educated labour force will also be more technically literate and thus capable of making wiser investment choices, and, more importantly, in maintaining and using hardware and software intelligently. Conversely, to the extent that broadband usage is related to television watching, demand for it may, if anything, fall with higher education levels. Education is, likewise, only modestly affected by IT policies as such.

Broadband deployment is also correlated with the *costs and performance of the underlying technology*. Buying more bits for fewer Euro means more interest in them. Underlying technology is nearly completely exogenous for three reasons. First, technology, can only explore up to the boundaries of what physical law provides; it cannot cross them. Second, most information technology is developed by the private sector, for reasons that relate more to opportunities influenced by market structure and corporate strategy and only secondarily to policy. Third, technology development is a world-wide enterprise, and Europe is only a fraction of this world.

All that noted, policy decisions *can* influence the translation between technology and cost. IT investments are subject to significant economies of scale, for instance, and thus an initial leg up may lead to faster ascents up the learning curve. Costs are also affected by competition (which can spur innovation and lower prices, but may also retard the accumulation of capital for subsequent investment), cross-subsidies, decisions to allocate costs per subscriber rather than per minute, and forward pricing (e.g., going for market share in the hopes that profits will follow) among other factors.

The point of noting these primary factors is to temper expectations about what policy can do. That noted, broadband networks themselves are subject to network effects.[77] DoCoMo's iMode service grew successful in Japan (and, so far, nowhere else), not simply because of an inherent and uniquely Japanese fondness for the service, but because bets were placed on its future, investments were made, and early success attracted customers and service providers, which attracted even more of each other, building a large market in the process. In any system characterised by path-dependency, adroit judiciously timed policy initiatives can have a disproportionate effect. So, secondary drivers can, nevertheless, be important in their own right.

4.4.2 Policies to Reduce Investment Risks

To oversimplify, the decision to invest is predicated on expected rates of return modified by risks. Typical categories of risk[78] are technical ("will it work"), financial ("can we get funding"), and market ("will anyone buy it "). A less common category of importance to the network externalities of information technologies is the question of picking the right standard ("standards risk") or "if we use this standard will others do so as well?"

Among the roles that government may play in encouraging investment are those that reduce or at least absorb such risks. The government may play a variety of roles with respect to new technology. It may fund basic or applied R&D, subsidise or otherwise support operational uses, buy the products of technology itself (e.g., buying intellectual property, goods, or enabled services), regulate the technology and its uses (e.g., licensing, export controls), and finally, compete with private firms in exploiting technology. These roles in turn affect the level and scope of risk in the introduction of new technologies, especially as they move beyond government markets.

Government roles may be compared across these categories of risk as shown in Table 13 (where 1 stands for "high impact" and 3 stands for "low impact")

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[77] Robert Metcalfe, Ethernet's inventor, has famously observed that the value of any one network is proportional to the square of the number of users.

[78] Another category of risk, but one that only applies to certain types of broadband investment (notably, satellites) is physical risk (e.g., will the rocket blow up on the launch pad).

Table 13. Government Roles and Risk

Gov. Roles \ Risks	Technical Risk	Financial Risk	Market Risk	Standards Risk
R&D Patron	1	3	3	3
Supports/Subsidies	2	1	2	2
Customer	3	1	1	2
Regulator	2	2	1	1
Competitor	3	1	1	2

Government-sponsored R&D is crucial to reducing or managing technical risks, but may afterward play less of a role in commercial acceptance. Supports and subsidies, especially early in a technology's life may be crucial to reducing and managing financial risk, but may only moderately affect what others do in the market or in choosing a standard. As an anchor customer, government can greatly reduce initial financial and market risks – it limits the downside risk of acceptance – but this may not reduce technical risk if the wrong technology is supported.

Government can also alter the entire risk map; regulating technology can harm or help depending on the details of the regulations, themselves. The choice of technologies to back (e.g., GSM and IMT-2000) clearly affects standards and market risk. But Government's choice does not necessarily assure private financing or assure technical success. Finally, the government may choose intentionally or unintentionally to compete with private enterprises such as broadcasting, telephony, or broadband networks.

In one case, however, generic policies ought to be noted as of special relevance to broadband development. Attracting private venture capital for the development of broadband-technologies is critical for the deployment of these technologies in the market. Available public funds generally are small compared to total market investment, but they can contribute to reducing risk, and thus leverage investments in certain areas. Favourable tax-regulations, setting up a system of loan-guarantees, co-financing risky initiatives are examples of financial instruments. 'Intelligent' deregulation is the most important legislative instrument. The high risks that are involved in investing in new communication technologies call for a regulative environment that stimulates instead of hinders new venture capital, and an environment that does not punish failure (in Europe, regulations make it hard to restart a business after bankruptcy) but highly rewards success. A core role of the government is to establish a policy environment that fosters stable, long-term firm strategies. Legislation, regulation and policy actions should decrease, not increase uncertainty about the future.

4.5 Policy Options

The strategic menu of policy options to follow are specifically those which are consequential and, hence, potentially controversial. They are considered in three categories:

- Regulation,
- Technology Development, and
- Services and Content.

Excluded from the analyses below are all the measures related to information sharing, best practice examples and stimulation activities that are for a large part contained in the eEurope plan already. These policies are not under discussion here but assumed to remain active.

4.5.1 Regulation

Several distinct questions fall under the rubric of regulation. One is whether the price and parameters of broadband are to be regulated at all -- that is, will or should be treated as basic or enhanced services based either on their nature or ownership. Content is no longer a good guide to regulation; a private broadband could carry IP telephony; while a public network carries video on demand. With IP data stream, precisely monitoring different applications is likely to be difficult to impossible.

Another is the question of anti-trust enforcement to ensure competition. Today, there is no one dominant Internet backbone provider. Were a publicly-funded broadband network deployed for consumers, to what extent should the government price to recover fees as opposed to cover marginal costs and encourage use? What effect would these choices have on the global competitiveness of European suppliers?

Third are conflicts between public and private interests in allocating RF spectrum. In general, consumer expectations of mobile access to communications and the Internet have lead to increasing commercial demand for bandwidth (notably for 3G wireless), which, in turn, has put pressure on all forms of globally allocated, "clean" spectrum currently allocated to public safety or national security functions (e.g., aeronautical communications). This factor merits consideration in any choice between wireless and wireline solutions to similar problems.

Fourth is standards policy. Standards bring stability to markets, strengthen confidence of both producers and consumers and in so doing create a better environment for technological innovation. Co-ordination on standards among market players and between them and regulators is best done as an open process, one that does not hinge on how formal the underlying rule structure has been. Layering and technology-neutrality (e.g., protocols such as TCP/IP that are independent of the underlying physical layer) is usually the course of wisdom, since over-specified systems tend to be hard to engineer and cause multiply sources of incompatibility among versions. Governments can stimulate or regulate standards formation.

Overall, there are at least five areas that require careful attention by regulatory authorities:

- safeguarding sufficient competition at the access level (unbundling of the local loops),
- stimulating efficient use of the backbone infrastructure (network sharing),
- establishing wholesale competition in the market for flat rate retail services,
- regulating the supply of content (media, must carry obligations) in such a way that use of broadband channels is stimulated. Legislation of narrowcast and broadcast services should be harmonised, and
- ensuring, throughout, that new entry (especially by entrepreneurs with disruptive concepts) is *never* discouraged.

Using these precepts as foundations, this leads to the following series of policy options:

Flat-rate pricing of local telephone calls[79] is important in encouraging extensive narrowband or broadband usage. Only with such pricing will always-on service be available, and only with only-on service will people come to rely on such service for instant access to information. Widening the range of what may be considered a local call (and thus toll-free) may also be useful (consistent with fibre optic pricing). Experience with U.S. ISPs suggests that competition can yield flat rate pricing absent countervailing regulation or established practice.

A general approach could be as follows: *anything that encourages competition is good.* The problem is that oftentimes, competition is based on investment and not the arbitrage of existing facilities. Preventing this is often a matter of establishing correct incentives (e.g., for cross-payment). But if the result of having no unfair competition is to have no competition, then policy may have to be rethought. Local provision of telephony or cable television, unfortunately, would appear to be a natural monopoly. That said, long-distance and cellular telephony proved capable of supporting vigorous competition even though they, too, had similar natural monopoly characteristics. At very least, deregulation of entry and, ultimately, of price, should be coupled with vigorous enforcement of some fairness regimes so that incumbents cannot tilt the playing field away from competitors. One approach may be to lock incumbents out of new service areas pending demonstrated good behaviour on their part.

[79] Such pricing has to be consistent across the service; a combination of flat-rate pricing and time-dependent settlement fees between telecommunications providers may create perverse incentives for some competitive local exchange carriers who specialize in signing up high-load users, profit from arbitrage, but add no value to the process.

Another approach is *to concede the monopoly aspects of the industry but rigorously pare back those functions that are, in fact, monopolies, and (re)create a corporation that does that and nothing else.* Unfortunately, experience with California electric power deregulation suggest this be done carefully. It is also important to maintain an incentive structure for broadband throughout. Cable companies, for instance, may argue that they will not invest in broadband unless they are allowed to establish a superior market position in terms of content (e.g., customers may only use ISPs owned by cable providers). This argument may be specious but the underlying point that incentives must not be regulated away persists.

Given such difficulties, a vigorous second-best approach is to permit and *encourage competition among the various broadband competitors*: telephony/DSL, cable, 2.5/3G wireless, satellite-to-the-home, and fixed wireless. At very least this will require regulators to keep their hands off newer technologies: the President of SES has publicly decried the fact that inconsistent European regulations prevent a continent-wide Internet-via-satellite system from getting off the ground.[80] Imaginative policies may also be needed to support inter-media competition in parts of Europe (notably in the Mediterranean area) that lack a strong cable sector.

For reasons of industrial policy and competition, some way must be found to *get the broadband wireless sector out from its debt load.*

Finally, governments can finance infrastructure directly and devise a method of distributing or selling bandwidth. Active involvement from local (municipalities) or regional (public utilities) authorities might in fact be the only way to deploy fibre optics in the local loop. The Stockholm municipality decided to lay out a ring of dark fibre, and makes this infrastructure available to all service providers that ask for it, with no discrimination. The government of the Netherlands is planning to subsidise fibre in newly built houses. In the United States some energy utilities in the north-west (Bonneville, Grant County) supply dark fibre as a side activity next to their core service of providing energy transmission. Alternatively, subsidising mobile satellite terminals (VSATs) in underserved regions may be a way of supporting the build-up of local demand, which past some point will attract long land-line investment without subsidy (at which point the VSATs move on)

4.5.2 Technology Development

The use of broadband can be stimulated indirectly by *stimulating activities that make heavy use of bandwidth.* A number of fields that could potentially use large amounts of data transfer are:

- Research (super computing), for sharing or collecting huge streams of data (e.g. of nuclear research, distributed radio-telescopy, distributed data-processing) so that more researchers can benefit the findings of activities at one institute, and;
- Healthcare, for the transmission of live video (telemedicine) or electronic patient dossiers (EPDs) with images of x-ray and other scans;
- Education, for the transmission of (live) video of lectures by experts on specific topics;
- Public administration, facilitating interaction with government as an extra incentive for citizens to participate in the electronic community.

These strategies can benefit from *public financing*, deep deployment directly via the support of specialised user niches, and wide deployment indirectly via trickle down effects. One of the potential effects of the use by public administration of broadband(services) is enhancing the involvement and integration of remote areas and regions in the national economy and in national politics. If the needed bandwidth exceeds an amount of roughly four million bps, the mobile strategy is unlikely to be an option.

An important but often overlooked aspect of technology development is to *make broadband a more secure place than it is today.* The Information Society will simply not progress unless it is built on secure foundations[81]. This means more secure technologies but also a greater climate of trust as

[80] *Space News*, 16 July 2001, p.8.

[81] See Minitrack Security and Cyber Crime, IST Conference 2000 and European Commission, Communication on

perceived by users. The policy of 'stimulating trust' assumes that trust lags real security. It would be naïve to think that stimulation of trust beyond reliability will lead to long term positive effects. Although it is in the commercial interest to stimulate the trust of likely users, there are several public instruments that may help. Providing for a reliable infrastructure is a function that many still see as one of the main premises of governmental activities. Since the new infrastructures are global and very much driven by the private sector government needs to work closely with the private sector. The private sector, in return, recognises the need for government involvement for creating a level playing field and for prosecuting violators. Instruments that can facilitate this policy are in the fields of stimulation mainly, backed by regulation.

Other research thrusts may be able to simultaneously promote the use of broadband and advance the competitiveness of European companies in global markets.

- Europe should lead the way in developing security and privacy solutions that encourage customers to look at a European site (e.g., perhaps as designated with a ".eu" domain name) as a mark of quality in terms of security and privacy.

- Real-time speech translation is a big European requirement where R&D money would be well spent if it could be done without displacing commercial expenditures.

Conversely, it may be time to re-examine the tenet that heavy expenditures of taxpayer resources to build up university networks is worthwhile (except insofar as it has scientific rationale). In the United States, bulking up such university networks only led to their being filled up with pirated music (and the broader relevance of P2P architectures has yet to be validated). Were Grid computing a wave of the future, there might be some argument for using universities as a testbed for technologies with a user use, but apart from solving scientific problems, the applicability of Grid computing needs to be demonstrated.

4.5.3 Services and Content

The application of information technology to improve the delivery of government services, besides making them more cost-effective, may encourage the uptake of broadband in order to access such services. It also creates a market for the development of innovation that Europeans would logically be the first to bid for.

- Hospitals and long-term care centres are prime candidates for such investments. Broadband would help modernise the sector and the ability to pass hospital records back and forth could help the efficacy of non-hospital medical practices and the delivery of services to people out of town

- Education is an obvious category if done right (there are enough accumulated failures to learn from); more fundamental research and development is required in order to match the capabilities of information technologies with what is known about how people learn.

- Although most applications of intelligent transportation systems are narrowband, the ability to download map (and transit line) data and layer obstructions (e.g., construction) data atop it, and then traffic reports (and perhaps inferences drawn from there) would be a powerful application that would permit people to plan their traffic patterns, and, incidentally, spur the demand for broadband powerful enough to pull in such data.

- Applications may be set up that help regional and local government carry out their tasks. Information databases (content) about policies and policy aims, applications for regional and local governments to directly interact with citizens (individual regional and local authorities may be expected to lack to necessary resources to set up applications like these) are examples of services and applications using broadband technology.

Another policy option would be for the EU to set up a fund which would provide matching investments (hardware, software, and the first year or two of operations and maintenance) so as to encourage a competition for developing innovative uses of broadband to improve government services.

Impact and Priorities for eEurope 2002 to the European Council in Stockholm, COM (2001) 140, Brussels, 13 March 2001.

Encouraging the provision of content is another way to interest consumers in creating a demand for broadband infrastructure.

With content, however, Intellectual Property Rights (IPR) become a tricky issue. The provision of video, high-quality text, graphics, and audio may lead to erosion of IPR and disincentives to create new content. Alternatively, burdensome restrictions on the access and use of intellectual property can dampen market growth -- as when copy protections were installed and then removed on many computer games and software in response to consumer resistance. Similarly, current U.S. court decisions over the exchange of music files in the Napster case demonstrate the tensions between evolving consumer expectations and traditional media.

However, in Europe cultural content has long been state-subsidised (also, Europe has moral rights conventions lacking in the United States). This leads to the following issues:

- More could be done to put material over twenty years old (cf. 17 year patents) into the public domain. Although syndication rights on old material are a lucrative form of cash flow for some companies (e.g., Time-Warner), it is unclear whether the prospect of losing commercial rights twenty years after a product is copyrighted would have any dampening effect at all on production – nor should the presence of twenty-year old material drive newer material out of production.

- Artistic subsidies, where Europe invests far more than the United States or Japan do, can be reallocated to favour projects that may take unique advantage of broadband (unless government money has a stifling effect on such creativity).

- More aggressive efforts are needed to convert government intellectual property into the public domain. Examples include museum archives (if the Louvre is typical, there is much progress yet to be made), geospatial data, and school teaching materials.

5 Observations and policy recommendations

On October 8-9, 2001, a distinguished group of experts in networking and telecommunications from research, industry, and government[82] met at Chateau de Limelette, Brussels[83]. They considered approaches toward achieving high-bandwidth, ambient, ubiquitous networking throughout Europe, with special attention to recommending needed initiatives. The discussion was based on the analyses presented above in Chapters 2 to 4: the historical development of communication networks, identification of its drivers and exploration of policy options. In this chapter we first present the outcome of the workshop, formulated as a set of observations and recommendations on which policy options could best be pursued, aimed at providing state of the art networks in Europe.

The next section (5.2 Explanations and analyses) goes deeper into the background and rationale of the issues raised, and develops more concrete policy and research proposals, as needed.

The synthesis in the final section (5.3 Syntheses) puts all policy recommendations and research needs in perspective. This section also highlights areas where the outcome of the workshop emphasised or neglected the outcomes of the analyses based on the desk work.

5.1 Observations and recommendations from the Workshop

1. The primary carrier for broadband in the EU will be fibre optic cable to businesses, institutions and homes.

2. Broadband, ubiquitous networking infrastructures should be based on open, non-proprietary standards. Governments should be active stakeholders in the development of these standards, but not assume sole responsibility.

3. Public sector bodies can act as 'launching customers', using procurement to encourage and support appropriate and sustainable broadband development.

4. Municipalities should have a primary role in creating environments that use and nurture the deployment of fibre optics. Their actions should include the development of plans for establishing a network of conduits and points of aggregation to complete existing networks and, crucially, to allow multiple service providers easy access to a common infrastructure. Further research should be done on appropriate architectures for open networks, useable by multiple service providers including different modalities (e.g., cable, telecom) and protocols (e.g. in addition to the Internet Protocol). Special attention should be paid to the appropriate design and role of "points of presence" (PoPs) in municipal networks, where service and application providers interface with the local network itself.

5. There are questions to be resolved regarding the appropriate role of competition and economic stimulus in providing the necessary conduits, fibre and services.

   a. Study is needed on appropriate models for investment and operation.

   b. The principle is to use competition wherever appropriate. However, for some aspects of these networks, unfettered or ill-regulated competition may lead to redundancy, lack of investment money, prices that inhibit uptake, gaps in network coverage or structural changes in the industry that destroy co-ordination advantages or create too much market power. To prevent this, additional measures may be needed.

   c. Allocation of public resources should be co-ordinated at the right level of authority. For example, allocation of scarce electromagnetic spectrum should be harmonised at the European level, while siting of local conduits and poles and allocation of scarce PoP space should be undertaken at the municipal level.

[82] List of participants in presented in Annex 1

[83] This meeting was facilitated by RAND Europe, and sponsored by the Information Society Directorate General of the European Commission.

6. IPv6 is necessary for effective broadband scaling and security and is a precondition for effective 3G mobile access to broadband networks. For that reason government should consider facilitating this transition. Research topics requiring attention include:
   a. Policy and technology solutions to overcome gaps with trading partners that lead or lag in the migration towards an IPv6 environment.
   b. Analyses of financial impacts on European businesses and institutions that must convert extensive private IPv4 networks to IPv6.
   c. Policy incentives and technology solutions to reduce transition costs and stimulate migration towards IPv6.
7. Co-ordination of research and technology development among trading blocks is crucial in the area of global technologies.
8. Security is vital for trust and confidence within the emerging broadband network and must be considered at all layers.
   a. Identification of online individuals and institutions should be the norm, but with anonymity an available option. For security purposes, and with appropriate legal authorisation, tracing should be possible under all circumstances.
   b. Individuals should have access to and control over information gathered about them.
9. It is vital for broadband services to provide access to increasing amounts and types of content, including public information. Limiting copyright to a period comparable to patent protection should be strongly considered.
10. Universal Service entitlements should be upgraded to include a minimum level of broadband access.
    a. Completion of the network, assuring that broadband is available in rural areas as well, may require government subsidies.
    b. For some rural or remote regions, satellite-based access to broadband services may be the most effective means of providing universal service.
11. To ensure that 3G networks develop in a way that provides an appropriate complement to fixed broadband networks, research is needed to identify policies that address dangers to competition and innovation arising from fragmented spectrum allocation and licensing procedures.
12. While it seems inappropriate to forgive or buy back debts incurred as a result of 3G licence allocation procedures, consideration should be given to measures designed to minimise their impact on equitable, efficient and rapid development of wireless broadband, such as making licences transferable, securitising debt and providing complementary public support or tax incentives for necessary investments.

5.2 Explanations and analyses

As the above-mentioned recommendations result directly from the workshop, a further analysis and explanation is given in the light of the findings of the desk study which provided the input for the workshop discussions.

Whereas the observations and recommendations mentioned above reflect the direct outcome from the workshop, as has been confirmed by workshop participants, the analyses and explanation in the section below are the responsibility of the research team and do not necessarily reflect the opinion of the participants of the workshop.

5.2.1 Fibre optic future

While fibre will be the primary broadband carrier, it will be combined with other technologies (e.g., 3G and future generations beyond 3G of mobile access) in a trans-European network offering mobile and fixed-line access modes with different levels of price and performance. The group highlighted the importance of fibre connections to the home, stressing that user orientation meant that this part of the network should be regarded as the "first" rather than the "last" mile, and drawing attention to current investment initiatives to develop this essential connectivity, either as commercial private initiatives (e.g. the fibre roll-out scheme by the Swedish company *Bredbandsbolage*[84]*t*), or via public subsidy (e.g. new neighbourhoods in the Netherlands).

Looking forward to a more "perfect world" of affordable, easy to use, high quality, ubiquitous communication networks, it is clear that technological neutrality is an important (if hard to implement) principle. One approach is to base competition on performance rather than technology. For example, allocating Universal Service contracts by competitive bidding (with the contract awarded to the bidder offering to provide the necessary bundle of services and tariffs for the lowest subsidy) would encourage development and adoption of the most appropriate technologies (if fair, transparent and non-discriminatory interconnect is guaranteed via regulation). The rate of introduction could be managed by the time-scale of the contract. This could be extended to other areas by granting spectrum access (e.g. when terrestrial TV networks are shut down) in service-specific terms. Another possibility is to kick-start development by underwriting certain risks, providing there is assurance that the supported technology will function, even if it turns out not to be the most cost-efficient.

5.2.2 Open, non propriëtary standards and the role of government

The public role in standard-setting and enforcement will include making sure that standards do not create distorted competition, making sure that social objectives are well-served and that incentives to develop and invest in infrastructure, services and applications are not diminished (i.e. serve the public interest). The group also noted that the endorsement of open standards has predominantly positive implications on security.

5.2.3 Procurement as tool for sustainable development

The use of government procurement to stimulate and focus deployment of innovative technologies and solutions has been a policy tool for some time. In the broadband context, it will assume extra significance as e-government initiatives develop.

A fair amount is known about the use of government procurement to encourage innovation at a general level, but there is a definite need to interpret and adapt this research to the specifics of the broadband context and recent changes in the public procurement environment.

Existing experience and research classified opportunities in the following terms, which influence the extent, timing and nature of strategic procurement policy.

a) the extent to which public sector preferences (as a consumer of the procured goods and services) differ from, parallel or foreshadow private sector demands.

b) the nature of long-term economic viability: whether the eventual market will be dominated by public- or private-sector clients (or neither), whether diversity is important, whether there is a danger of monopoly, etc.

c) the extent to which the necessary innovation is basic, applied or application-oriented in order to establish the proximity to the market.

d) the extent and appropriate allocation of risks (the public sector may be sold non-viable services, public procurement may displace private demand or investment, the public sector may be offered options that are 'too speculative' or where the risks are not borne by those best able to deal with them. The specific issue here is the extent to which Broadband services require adjustment on both seller and buyer sides and changes at various market levels - not just those where the procurement contract is written.

[84] www.bredbandsbolaget.com

These considerations have implications for how goods and services to be procured are chosen, how the procurement contract interacts with other forms of support, how the contract should be allocated (tendering, evaluation, negotiation) and structured (conditions, payment structures, and - critically - intellectual property right ownership).

In this specific context, it is necessary to use research to identify the type of innovation needed, to establish measures of performance and effectiveness, to identify and understand the relevant innovation and supply infrastructure and to understand the way the market will likely evolve with and without strategic procurement. This suggests the following specific research topics (in rough priority order).

- How lessons from existing strategic use of government procurement apply to the broadband context.
- How existing 'near-market' support modalities (e.g. TEN Telecom and related Member State programmes) can benefit from/complement demand-side stimuli. The hypothesis here is that guaranteed demand may focus people's minds on deployment.
- How government procurement can affect development (including feedback and business-as-usual effects, and the influence of assured demand in stimulating investment and deployment)in the relevant market layers.
- How existing procurement reforms affect or focus policy choices (this includes identifying internal barriers to strategic procurement, developing appropriately joined-up strategies, etc.)
- What competition considerations are raised by this use of public procurement?
- How do existing public procurement regulations (esp. at EC level) affect the possibilities for using the launching customer tool, and are any adjustments needed?
- [related to 12] - how does the fragmented debt and licensing inheritance of the UMTS allocation affect the potential for the use of strategic procurement? On one side, it can reduce the potential for simple applications of the launching customer idea. On the other, it can help to level the playing field.

5.2.4 A primary role for municipalities and higher layers of government

The group recognised the importance of multi-layered European governance. The principle of subsidiarity recognises that each layer has its own specific role and responsibilities. With regard to fibre deployment, for instance, frameworks and support modalities are defined via EC directives, adopted in national law by member-states, and implemented by municipalities, here understood to include regional or other sub national layers of government.

The group also noted that network completion involves creation of bridges, support for incremental investment, etc. Due to shared public and private interests and competencies, modalities can include public-private partnerships, equity participation and other forms of risk capital engagement. The scope of deployment plans should include rights-of-way, financial incentives, specifications, compliance with standards and specifications, and competition models governing a fibre-based infrastructure capable of delivering customer-driven broadband services.

The environments created by municipalities must have several important components.

- Conduits (or poles) to customer-premises suitable for deploying multiple transmission technologies, including fibre optics and poles for repeaters in the wireless complement to the fixed-line network. Location and ownership of these assets balances the needs of the system and legitimate land-use, environmental and health concerns of local communities. These issues should be resolved at the local level but a sound EU-wide framework is essential to ensure equity and prevent fragmentation.
- Fibre-based transmission facilities deployed in those conduits (or poles).
- Points of aggregation that terminate conduits from customer-premises and provide interconnection with other networks and service providers. This also includes the need for space for technical equipment of all service providers in "joint" facilities (nowadays still mostly owned by the former state monopolists).

- Network operation centres and back office functions (e.g., e-commerce with subscribers, network operators, and service providers requiring functions such as provisioning, maintenance, and settlements).
- Network maintenance.
- Competitive provision of generic services and applications, delivered via open interfaces to fibre and other transmission technologies deployed in conduits.

This "first mile" infrastructure architecture is intended to achieve several goals.

- Deployment of fibre optics in a "first mile" broadband network.
- "Markets" of residential and commercial customers that will attract network and service providers and sustain competition among them.
- Support for multiple generations of transmission and aggregation technologies, deployable in a common conduit and exchange, as technology inevitably evolves.
- Adoption of an appropriately harmonised public-private model that permits adequate access for other providers (e.g. co-location requirements, etc.) whilst preserving incentive and operational incentives.

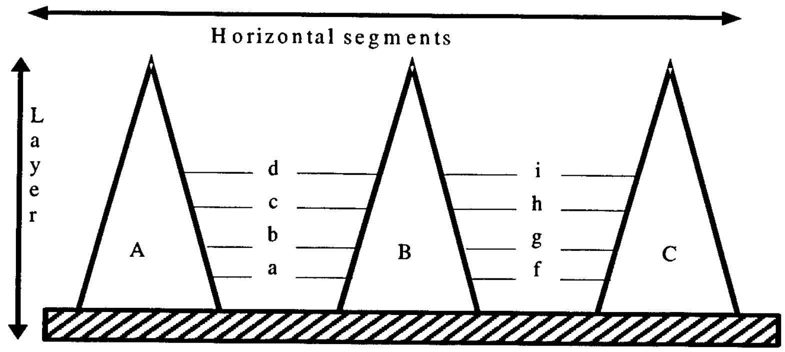
To achieve these goals, several possible approaches should be considered. Basic network installation and operation possibilities include a franchise auction with publicly owned, franchisee-operated facilities and adequate access regulation, or privately financed provision of "dark fibre" to public bodies along the lines of the STOKAB model[85].

Municipalities will also require access to educational materials, technical expertise, standards, and compliance testing to help them define and implement successful environments. The European Commission has a vital role in creating these resources: sponsoring research in such areas as interconnection standards, low-cost civil engineering techniques, network protocols, system architectures, transmission technologies, switching and routing technologies, customer premises distribution networks (e.g., home LANs), and competition policies. In this connection, the Commission can do four things:

1. support and guide research to fill in gaps or correct bias in private, other public and not-for-profit RTD.
2. facilitate appropriately interconnected, harmonised and localised deployment of generic services, applications and fully extended basic networks.
3. provide a regulatory framework giving overall coherence to national regulatory authorities, providing a forum and clearly-delimited set of rules for EU-wide regulation and negotiating on a world stage for interconnection, standardisation, licensing, pricing, competition, etc.
4. act as a user, content provider and even supplier in various parts of the network to ensure its viability and consistency with broad policy objectives like e-Europe. While the first activity is explicitly and solely research orientated, the other three also require a combination of research, investment and co-ordination.

The most challenging components of this research agenda are competition policies and the system architectures suitable for exchanges. Competition is a means to an end rather than an end in itself. As the diagram below indicates, the broadband sector is structured vertically (by layer) and horizontally (by firm and product).

[85] The City of Stockholm owns a dark fiber network and makes this available indiscriminately to any service provider. STOKAB is the city owned company that exploits this network.



The upper-case letters represent vertically integrated firms and the lower-case letters are layer-specific competitors. Economies of scope and scale, network and social externalities, widespread and rapidly changing risk and delivery of information/knowledge goods challenge conventional regulatory paradigms. The appropriate degree of vertical or horizontal integration (structure) or co-ordination (conduct) must reflect technological, economic and social considerations affecting supply and demand sides of the market. In some parts of the broadband market competition may be undesirable[86] or difficult to sustain[87]: this is represented by the solid horizontal bar at the bottom, which should therefore be explicitly excluded from vertical integration.

The foreseeable future will involve some degree of industry-specific regulation at a variety of levels. In view of the co-evolution of policy and business activity, the tools and goals of this regulation and the roles of local, national and EC parties must be clearly spelled out. This requires support from the EC at a number of levels – one of which is research, which must develop policy alternatives that create and sustain customer choices for broadband services. Such competition requires "first mile" facilities of a municipality that can interconnect with multiple network and service providers who offer the consumer choices.

Policy alternatives that are likely to create and sustain a "first mile" municipal network (comprising conduits and/or poles, transmission facilities, exchanges, etc.) are equally important. They may well include a model of regulated monopoly with common carrier obligations.

The latter component of the research agenda is to define the technical alternatives and requirements for connecting multiple, competitive networks and services to a municipality's "first mile" network. This work must (re) produce the "first mile" network equivalent of the general specifications and requirements developed over decades for the Public Switched Telephone Network.

Much of what is needed can probably be adapted from existing specifications for building construction, fire suppression, (backup) power, floor loading, heat dissipation, redundancy, etc. in the telephone system. The EU can estimate the magnitude of this undertaking by considering the size of organisations that have traditionally constructed and maintained such documentation (e.g., Telcordia in the U.S.). Although implementation of these requirements needs to be guided at municipal level, the requirements need to be formulated at the higher aggregate level.

This research must consider and improve upon the experience of incumbents and competitors with local loop unbundling and co-location. Research results must identify open interfaces that accommodate the inevitable evolution of technologies used in the physical layer, communications protocols, and services. Such interfaces must be standards-based. The services must include multiple modalities such as data, video and voice. Research results must assure that this open architecture is consistent with candidate competition policies, designed to sustain customer choices among constantly evolving services accessed through a municipality's "first mile" network. Ultimately, the EU will need to create and sustain a compliance testing service that municipalities can draw upon to assure that requirements are satisfied.

[86] E.g. due to duplication of facilities or spurious and costly product or market segmentation.

[87] E.g. due to vertical restraints, collective dominance and other barriers to entry or competition

Technological research should seek more than 'accommodating' interfaces. Interfaces can actually shape the evolution of technologies, and create (or destroy) a 'level playing field' that permits public and private costs and benefits to guide future RTD and deployment – for example, via support for scalability. This should emphasise interconnection and interoperability, recognise network externalities, and stress full stakeholder consultation as well as technological aspects.

In particular the following research is recommended:
I. Desk research a. the structure of open-access multi-layered markets and the options for design intervention. b. The legal and procedural aspects of funding the developments mentioned need clarification. c. the impact of different structures of diffused (local/regional/national/EU) governance on standards development, infrastructure (poles & pipes) creation and open access. This could look at the prospects for reallocating responsibility along the 'hollow middle' lines discussed at Limelette. d. What supplementary actions are needed to attain the stated objectives, and what are the roles of different stakeholders in carrying them out?

II. Pilot studies a. Following the results of Ib above, a set of clear pilot studies can be implemented to gain shareable case knowledge and identify good practice. b. Pilots for different approaches to studying designing and implementing local strategies for standards, infrastructure and open access, including different business models, different types of stakeholder consultative groups, etc. c. Pilots using a variety of the three options listed for network installation and operation. This can identify good strategies and practices, but critically it can also provide a common set of experiences on which future strategies can be constructed. One powerful lesson of the UMTS fiasco is that expectations are at least as important as design or market conditions in determining how a scheme works out in practice. If the expectations are well-formed on the basis of a common set of data and a clear framework, things will go much better. This is definitely a role that can only be filled by EC-sponsored research.

5.2.5 Appropriate role of competition

In order to identify and develop appropriate models it is important to look at current practice, and learn from experience with the different models handled within the Union or in other industrialised countries with a high penetration of communication networks.

With respect to the above remarks on the general role of competition, public activity should recognise that competitive provision is both feasible and desirable at specific layers – especially services – but may be endangered by foreclosure unless steps are taken to ensure transparent, fair and non-discriminatory access – including requirements for network providers to provide an adequate set of connection nodes, allow co-location, etc. A focus should be on those specific layers where there are big economies of scale, or where positive network externalities can lead to under-provision (compared to the social optimum). Also, where there are bottlenecks, the 'owners' may have too much market power - the relevant example is the UMTS license (ownership of fibre cable, switches, etc. are others) - the point made by most analysts was that UMTS didn't make sense in terms of WAP but made a lot of sense in terms of owning the licenses for 'true' 3G - the eventual network providers and content merchants would have to come to the licensees in order to gain market access. This means that access conditions and prices must be carefully regulated (or self-regulated) to balance investment incentives (i.e. fair return) with reasonable diversity, utility and affordability. This will be critical for uptake.

Closely related to this is the current wave of restructuring of major UMTS 'winners' in an attempt to deal with the huge debt load. Within those firms, this means spinning off mobile divisions, sacrificing some internal economies of integration in order to manage corporate finances and risk. The customer will pay for this - or will decide not to, in which case the 'network externalities' may be lost, or the broadband network will be lost to new players that buy the remainders of bankrupt European network operators. Across the industry, the issue is whether future mergers will be affected by UMTS or conduit ownership in ways that result in too much or too little market power, taking the need to develop and market applications, services and content into account. Specific policy analyses should be done towards measures like cross-ownership restrictions, more forward-looking merger/acquisition policy, regulation and universal service policies – and possibly reconsideration of licensing policy.

5.2.6 IPv6

The appropriate role for the EU is research that fosters the adoption of IPv6 and assures that it can be effectively deployed for use with non-European trading blocks that may lag or lead the EU in adoption of IPv6. As IPv6 unfolds, it may be that communications among the devices carrying ambient intelligence will require substantially greater bandwidth than at present. For example, a repair facility interacting with a complex device may be better able to diagnose faults with a comprehensive data download. Alternatively, as devices become more complex the need for frequent automated backup may create a demand for high-bandwidth transfers among a large number of addresses.

With regard to the deployment of IPv6, it seems evident that some sort of deployment will take place under private initiative. Without some coordinated research, this may be haphazard, delayed or inefficient.

Clearly, this area calls for pilots as opposed to desk research, and seems ideal for a conscious experiment, in which a by a stakeholder identified set of likely candidate technologies, financial models and deployment strategies are pursued in a framework that allows benchmarking and identification of good practices. Perhaps the biggest threats to identification and exploitation of a productive common standard is the risk of delayed or inappropriate investment; those who might otherwise be inclined to develop innovative solutions may feel constrained to wait until a clear candidate emerges or to imitate the first solution to hit the market. To overcome these bottlenecks and encourage participation and submission of good ideas, the experiment could be constructed in such a way that surpluses generated by successful approaches are used to ease the re-investment costs of participants who invested in less-successful technologies. In addition, access to EC support for initial investment (by modalities that minimise EC risk and encourage successful deployment) and the common reinvestment fund should be made contingent on information-sharing among participants. This experiment would have the character of a pre-competitive consortium, in view of the infrastructural character of IPv6 and the wide range of channels and market layers represented by participants.

The EU role is reinforced by the observation that open and competitive provision of these enhanced diagnosis, backup and repair facilities must be based on an open unfolding of this protocol.

5.2.7 Global co-ordination

Global co-ordination is more than just an open door. The network and associated markets are inherently global and some aspects can only be addressed on a global scale. We have already observed the problems that arise when different standards frustrate interoperability, or when different rates of adoption delay or even distort technological development. There is a policy counterpart that seeks to establish a common understanding of regulatory issues as a precondition to effective and non-inhibiting regimes that neither impose excessive burdens nor produce a 'race to the bottom.' The global approach can also assist in moving competition away from the basic networks towards the services. Starting at EU/EFTA activities would include collective reinforcement of standards development, joint foresight exercises, joint R&D funding, etc. Since the issues are global, taking these initiatives towards WTO level may be appropriate. In order to determine this, a combination of research towards expected impact and stakeholder consultation is recommended.

5.2.8 Security for trust and confidence

Public support for trustworthy mechanisms for identification and authentication of on-line individuals and institutions should be considered. In any case, research should be undertaken to clarify the social, legal and economic implications of identification (including trust, integrity, security and accountability) on one side and privacy (including optional anonymity and the rights to ensure that information collected is appropriate to the purpose for which it is collected and to control re-use of information for other purposes or dissemination to third parties) on the other.

In addition, it is essential that on-line individuals and institutions have knowledge of and access to information held concerning them and the right to insist on correction of inaccurate information – subject to appropriate legally defined limits reflecting national security and law enforcement concerns.

Implications of fragmentation of information from different data sets need to be considered. On the one hand, combining data sources may infringe privacy or otherwise harm individuals even when the separate data are OK for the purpose. On the other hand, fragmented data may harm individuals by giving a partial, distorted or inaccurate picture of them to others, or by 'chilling' their interaction with service providers who collect such information. Research towards a code of practice involving the stakeholders and based on an exploration of current practice is recommended.

5.2.9 Stimulate (access to) content

The recommendation regarding content is not limited to providing access to existing publicly owned content. It encourages appropriate support for creation and Internet dissemination activities aimed at cultural and artistic content. Clear delineation of the appropriate scope of intellectual property (e.g. copyright and patent) protection as related to broadband technologies, practices and content is essential, as is a framework for resolving issues with other jurisdictions and either strong mutual recognition provisions or European-wide IPR protection regimes. This has particular relevance to broadband as this market has a cross sector impact, and a potential for proliferation of a range of 'neighbouring rights' that may need separate treatment. Since this impacts business on a global market it is important that these issues are considered in a global context, by bringing in a position paper and proposal in the WIPO / WTO process.

5.2.10 Universal broadband service

It is important to note that universal services are related to Services of General Interest as defined in the Treaty and the allocation of universal obligations (and entitlement to associated subsidies or regulatory relief) should follow the same principles of transparency, accountability and competitiveness used to allocate spectrum and other licences. Current Universal Service definitions do not include Internet access as part of the 'bundle' to which individuals are entitled, and are not definitive as regards the status of Internet Service Providers and other participants in the broadband market as 'payers' or 'players' (providers) of these expanded services.

5.2.11 3G network development enabling

3G spectrum allocation and licensing procedures varied widely from country to country, leaving many 'winners' with high levels of debt and/or restrictive conditions. This can lead to a variety of undesirable consequences. For instance, some firms may have to sell off their wireless divisions, losing the advantages of vertical or horizontal integration. Others may go bankrupt, resulting in too few players for healthy competition. Finally, since this may lead to a situation in which the costs of delivering content to customers differ widely across national markets, the unfolding of a truly trans-European mobile network is inhibited. Measures need to be taken to prevent that. However, it is crucial that these measures do not lead to further distortions, and a delicate balance needs to be found. The call for a study on a *Comparative Assessment Of The Licensing Regimes For Third Generation Mobile Communications In The EU And Their Impact On The Mobile Communications Sector* by the European Commission which mentions end of March 2002 as date for delivery of its final report is therefore a timely and necessary one.

5.2.12 3G debt burden consequences

The securitisation of debt is a mechanism to provide support for necessary further investment by licence holders without distorting competition. In principle, content providers seeking market access via debt-laden licence holders could assist them by purchasing corporate debt, which would then be available for repurchase by competitors in the content market if economically efficient. This offers more transparency and freedom to licence holders and prevents undue control of 3G providers by network service or content providers.

5.3 Conclusions and recommendations

Looking about 10 years into the future taught us that new policies are needed in a wide range of areas ranging from market governance to social security etc. It has also become abundantly clear that there is not one most effective and cost effective way of moving ahead: what the best way is, depends on the policy aims (what does policy want to achieve), policy means (which policy instruments is the appropriate government able and willing to use), and local situation (installed base, usage patterns, culture). In order to be able to exert influence it is important to understand the drivers that are relevant for the evolution of broadband networking.

Primary macro drivers such as economic development, supply and demand, and global developments are not always (directly) amenable to policy intervention, or involve balancing of a wider range of cross cutting policy objectives. However, in the information age network effects may leverage intelligent and well-timed policy intervention into influencing *speed* and *direction* of these macro elements.

Important past drivers, such as use of networks by the research community, or specific military applications, are becoming less important as mass access shifts the balance of (return on) investment towards users and commercial markets. Moreover, while these pathfinder uses shaped the initial development of communications networks, mass-market uses play an increasing role, even providing solutions to research and military users.

The identification of opportunities for public policy to exert a necessary and sustainable influence rests on the role of the following *direct* drivers of broadband development:

- The emergence of advanced services requiring more bandwidth will drive demand
- Flat rate pricing of access to communication networks will encourage more intensive use
- Capital for innovations and investments in infrastructure is needed to build out the networks and services
- A range of different modes of service distribution - from home based broadband to Internet cafes etc. – will extend both the scope and utility of network access
- New technologies can improve the efficiency of capacity utilisation by squeezing more effective bandwidth out of existing infrastructures
- As the 'Internet generation' becomes a bigger part of the demographic pyramid, the number and proportion of people expecting to use PC's and the Internet – and the opportunity to deliver enhanced public and private services - are growing
- Champions leading the way reduce scepticism towards expanding offices and markets beyond their traditional barriers
- Availability of content – stimulates use of information networks

The direct, micro drivers distinguished above create "broadband evolution-specific" opportunities for policy intervention. The experts and stakeholders workshop resulted in the observations and policy recommendations listed in paragraph 5.1. The policy recommendations of the workshop emphasised the following.

- Getting the right infrastructure in place:
    - Open, non-proprietary and user-led standards;
    - Standards co-ordination across trading blocks;
    - A dependable information infrastructure built for massive participation, mobile access and built-in security (NB: IPv6 is an important step in this direction!); and
    - Reaching out to "everybody" through ubiquity and inclusiveness.

- Support by the right regulation::
    - Appropriate use of competition and economic stimuli in providing infrastructure and services (including revision of licensing regimes);
    - "Upgraded" universal service bundles, obligations and payment mechanisms; and
    - Identity, privacy and security protection in context.

- The role of government as actor in the market:
  - Establishment of network of conduits and poles (or even fibre) in the local community;
  - Leading by example; and
  - Supporting the standardisation process, in order to protect the interests of society at large.

- Research and development:
  - R&D collaboration across trading blocks;
  - Technologies for cheaper and faster access to information and communications
  - Technologies to enable "remote regions" to participate in the broadband network against affordable costs

Although the *areas* of necessary policy activity were well established by overwhelming consensus of the workshop participants, it is clear that in many areas more socio economic research and policy analyses are needed to pin down *what* can be done and how to ensure its (cost) effectiveness. In this a balance needs to be sought between regulatory reform and development assistance in order to create the right environment for a self-sustaining state-of-the-art network environment in Europe, against the lowest societal costs. Public networks and research networks can play a distinguished role in ensuring the long-term success of European telecommunication networks in two ways: acting as leading customer, or temporary assistance to overcome barriers to commercial sustainable network development stemming from (perceived) financial risks or excessive short-sightedness on the part of investors. More detailed recommendations on this point were presented in paragraph 5.2.

For many of the issues raised for *implementation* research, it is important to understand the nature of the global transition towards information societies. This is very much a transition at different speeds and with different priorities set by local circumstances, ranging from cultural factors to the life cycles of markets and the installed base of networks and equipment. The starting point is an understanding of where we are: this requires *mapping* of the current state-of-the-art.

There is *no single path ahead* for every region or country. Different roadmaps, however, can build on experiences already gained somewhere in this world – both in the sense of learning lessons and because those experiences define the global context for future changes. A framework for development should be made available at European level, as it brings together common needs with a portfolio of ways to address them. It is therefore considered well justified for the European Commission to call for *benchmarking* and "*best practice*" research input to the policy debate, at strategic and more practical levels. For new approaches and new technologies for which such experience does not exist, facilitating *pilots* of interest complements this.

Broadband is useless without content and services. The public sector can play two vital roles: (1) as a provider of –more– information and services and (2) as a stimulus to increased availability of cultural and artistic content through subsidies for creation and dissemination and –possibly– by reconsidering the appropriate scope and extent of intellectual property rights protection to balance availability and incentives.

Competition is one of the key drivers to the development of broadband. However, there are limits to the extent to which competition can be relied upon, particularly in areas in which investments or other scarcities tend to inhibit entry, or where economies of scale would lead to economic inefficiency associated with an excess of competition. The guiding principle is to recognise the advantages (diversity, efficiency, transparency) associated with competition in traditional markets, and to adjust public policies in such a way as to reap those advantages in the broadband networked environment.

Direct involvement of public actors in the *provision of infrastructure* is considered. In particular, in areas where the market may not be able to develop inclusive information infrastructures, government may consider playing a more direct role. Public funds to help matching investments in (broadband) infrastructure for remote areas are already available under the European Structural Funds.

Networks in general, and broadband networks in particular, present a unique opportunity to public authorities. Because they are open, common resources where market and regulatory decisions are likely to affect a wide range of participants, they challenge existing conceptions of governance. In the wake of recent (positive and negative) developments in the unfolding of the 'New Economy,' expectations are heightened and volatile. Novel technological possibilities combined with European leadership in 2G mobile telephony put European government institutions squarely on the 'hot spot' - there is abundant evidence that private (and civil society) entities are looking to public bodies to provide leadership in shaping the unfolding of the network and realising its enormous potential social and economic benefits. This public leadership must recognise both the need to act in certain areas and the equally pressing need to refrain from acting in areas where self-governance will be sufficient or where critical technological and market uncertainties must be resolved before appropriate policies can be identified.

The upheavals of the past few years, from widely-varying costs associated with 3G licence allocation to 'corrections' in overheated new technology company stock markets predictably lead to calls for support, if not outright subsidy. Many of these have merit, and clear identification of the appropriate roles of government, market (and civil society) forces is an essential prerequisite to sorting out those areas where intervention is warranted from those areas best left to market forces or other forms of self-regulation. This is not a call for laissez-faire inaction: government cannot avoid its responsibilities in this area without missing vital opportunities and taking on unnecessary risk. Rather, it is a clear recommendation for a transparent, unbiased and determined policy response to this challenge. It is patently obvious that government will make a difference in the evolution of this vital underpinning of the Information Society evolving. The framework developed in this study and the perspectives and recommendations developed in the study and the workshop represent a sound basis for facing up to this challenge.

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Annex 3 – List of abbreviations

3G	Third generation mobile telephony
ADSL	Asymmetric digital subscriber lines
AMPS	Advanced mobile phone system
ATM	Asynchronous Transfer Mode
CDMA	Code-division multiple access
CLEC	Competitive local exchange carrier
DANTE	Delivery of Advanced Networking Technologies in Europe
DBS	Digital Broadcast Systems
DSL	Digital subscriber lines
EARN	European Academic and Research Network
EU	European Union
ETSI	European Telecommunications Standard Institute
FCC	Federal Commission on Communications
FDDI	Fibre data-distributed interface
FRIACO	Flat Rate Internet Access Call Origination
GEANT	network providing pan-European interconnection between National Research and Education Networks in Europe at Gigabit speeds
GPRS	General Packet Radio Services
GPS	Global Positioning System
GSM	Global System for Mobile communications
HTML	Hypertext mark-up language
ICANN	Internet Corporation for Assigned Names and Numbers
ICT	Information and Communications Technology
IES	Information Exchange Services
IETF	Internet Engineering Task Force
ILEC	Incumbent local exchange carrier
IMT	International Mobile Telephone
IP	Internet Protocol
IPR	Intellectual Property Rights
IS	Information Society
ISDN	Integrated Services Digital Network
ISP	Internet Service Provider
IST	Information Society Technologies (programme of the EU)
IT	Information Technology

ITU	International Telecommunications Union
Janet	Joint Academic Network (UK)
LEC	Local exchange carrier
LMDS	Local multipoint distribution systems
MMDS	Multi-channel multipoint distribution systems
NGI	Next Generation Internet
NGN	Next Generation Networks
NRA	National Regulatory Authority
NREN	National research and education networks
NSF	National Science Foundation (U.S.A.)
NTIA	National Telecommunications and Information Administration
ONA	Open Network Architecture
ONP	Open Network Provision
OPTA	Onafhankelijke Post en Telecommunicatie Authoriteit (Dutch NRA)
OSI	Open Systems Interconnect
P2P	Point to point
PT&T	Post, Telephone and Telegraph
QoS	Quality of Service
R&D	Research and Development
RARE	Réseaux Associés pour la Recherche Européenne
RBOC	Regional Bell Operating Company
RTD	Research and Technology Development
SME	Small and Medium Enterprise
SMP	Significant Market Power
TCP	Transmission Control Protocol
TDMA	Time-division multiple-access
TEN	Trans European Networks (program of the EU)
TERENA	Trans European Research and Education Networking Association
UDRP	Uniform Dispute Resolution Policy
UMTS	Universal Mobile Telecommunications System
VSAT	very small aperture terminals
W3C	World Wide Web Consortium
WAP	Wireless Application Protocol
WIPO	World Intellectual Property Organisation
WRC	World Radiotelecommunications Conference