Shaping Cyberspace—interpreting and transforming the Internet

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Abstract

This paper explores the development of the Internet, from its earliest incarnation as an experimental site for wide-area networking of computers to its present transformation into an international commercial network. We outline the stages it has gone through, highlighting how patterns of stabilisation and closure in design and use have been undone. Using the concept of 'closure' from the sociology of scientific knowledge, we suggest these stages were not inevitable. There were alternative ways to distribute information globally which have been forgotten or abandoned. We argue that closure is never final and that its provisionality is necessary for socio-technical change. The closure achieved at the end of the 1980s has been blown open, but now new actors are trying to close the Internet in different, and perhaps incompatible, ways. We explore what this means for the future of the Internet through an examination of both the metaphors currently being used by different actors and the areas where different interpretations are contested. © 1999 Elsevier Science B.V. All rights reserved.

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1. Introduction

The Internet is rarely out of the news: major fashion retailers announce the possibility of buying clothes online, after trying outfits on virtual models with one's own measurements and colouring; Microsoft continues its battle with the US anti-trust authorities over whether its attempts to integrate its World Wide Web browser with its Windows operating systems are anti-competitive; the former head of a major German online service provider is convicted by a Bavarian court of distributing pornography because his service, along with most others around the world, carries Internet newsgroups with unsavoury content. Furthermore, the Internet has taken over

from the concept of the 'information superhighway' as the means by which the transition from an industrial society to some kind of information society might be driven forward.

This paper explores the development of the Internet, from its earliest incarnation as an experimental site for wide-area networking of computers to its present transformation into an international commercial network. We outline the stages it has gone through, highlighting how patterns of stabilisation and closure in design and use have been undone and reconfigured. We suggest these stages were not inevitable; there were alternatives which have been forgotten or abandoned. We argue that closure is never final and that its provisionality is necessary for socio-technical change. We are wary of some of the more extravagant extrapolations made by some commentators, but we are confident that the closure

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achieved by the end of the 1980s has been blown open. New actors, though, are attempting to redefine the Internet and to effect new, and perhaps incompatible, kinds of closure. We highlight this by pointing both to the range of metaphors currently used to describe the Internet and to the areas of greatest significance for contested interpretations.

2. From there to here: stages of Internet development

The Internet is both very new and not new at all. By all the common measures—number of connected computers, number of users, number of separate networks—it is growing extremely rapidly, and it is mutating quickly in terms of the services carried on it, the tools used to build and access it and the composition of the Internet industry. Commentators have been known to speak of 'Internet years'—units of time much shorter than actual years but which contain enough changes to fill an actual year in many other industries. So, at any point in time during this decade, a large proportion of Internet users have only recently begun interacting with it. People who have been using it for longer than a few months often find they have to come to terms with new software, new access methods, content delivered by new media, etc.—and if anything the changes are greater for the suppliers of Internet-based services, who have to cope with new languages, protocols and standards which are proliferating at an alarming rate.

On the other hand, as any reader of Internet histories knows (the Internet Society maintains a collection at **www.isoc.org**), the Internet has been around a long time. Exactly how long is open to interpretation, but the latest plausible date is the start of 1982, when the current Internet protocols were formally introduced. Earlier candidates for the birthday of the Internet might include 1972, when the first connection between ARPANET and another network (ALOHAnet in Hawaii) was opened, or 1969 when the first four nodes of ARPANET were connected to each other, or the meeting of the ACM (Association of Computing Machinery) in 1967 when Larry Roberts read the first public paper describing the ARPANET design. It is possible to go back even

further, e.g., to Paul Baran's work on robust networks for RAND in the mid-1960s, or—less convincingly—to the launch of Sputnik in 1957 which led to the creation of the Advanced Research Projects Agency, the original sponsors; but the point is clear that the Internet, from today's perspective, is not entirely a new phenomenon. (For a detailed account of the early history, see Hafner and Lyon, 1996.)

It is possible to trace stages of Internet development even before the explosive growth and commercialisation of the 1990s. A useful broad classification has been provided by Lorcan Dempsey (Dempsey, 1993; pp. 13–14). He identifies four main stages of development. In modified form, and with our own approximate dates, these are: (1) the Internet as *testbed* or 'scientists' playground', where the technical problems of creating a wide area computer network were being ironed out (most of the 1970s); (2) the emergence of an Internet *community*, chiefly consisting of computing science professionals and students, when new services and new forms of communication such as Usenet newsgroups began to develop (from the end of the 1970s to around 1987); (3) the broadening of the Internet into a general *academic resource*, across the globe, when the information and services on the Internet became more important than the addresses of the connected computers (from around 1987 to around 1993); and (4) the transformation of the Internet into a *general, commercial information infrastructure* (the current period, since the development of the World Wide Web).

Other classifications are of course possible, and the exact demarcation dates between periods are open to interpretation. What is clear, though, is that the last change—from an academic infrastructure to a general commercial infrastructure—has been extremely significant. Beginning (perhaps) with the decision of the US National Science Foundation in 1991 to allow commercial traffic across its network backbone, and given great impetus by the popularisation of the World Wide Web which followed the introduction of the first graphical browser—Mosaic—in 1993, the commercialisation of the Internet has been the principal driver of growth and change. It has dramatically increased the variety of actors involved with the Internet's development and has

opened up a set of possible, sometimes conflicting, paths to the Internet's future definition.

The use of the phrase 'stages of development' may be unhelpful, however. It implies an ordered, even inevitable progression. This would be inappropriate, because there was no inevitability about the Internet's success or its current structure. Before analysing the state of the Internet today, it is worth stepping back to examine some alternatives to the Internet, alternatives which had once looked far more promising as components of a commercial information infrastructure.

3. The road less travelled: early models for online services

The potential for using computers and communications networks to provide a broad spectrum of information and related services was recognised early on in the development of information technology. The inventor of videotex, Sam Fedida, expressed this potential in a series of articles written in the early 1970s. In one of them (Fedida, 1975) he expounded his vision of a system which would make use of user-friendly interfaces and the public telecommunications network to provide cheap, mass market information and communication services. Indeed, the list of potential services which he enumerated in this paper, e.g., a 'point of entry to a wide diversity of information requirements', messaging, business and government services, education at home—contains remarkable similarities to the list of services which pundits have more recently seen as forming the basis of possible 'information superhighway' offerings in the next millennium. [1]

Videotex, of course, suffered mixed fortunes, becoming somewhat less than successful in its native land and achieving the hoped-for levels of mass-market penetration in only one country, France, on the back of concerted state intervention and subsidy. Even there, certain aspects of the French Teletel architecture—notably the use of a packet-switched network environment and the encouragement of large numbers of independent organisations to provide self-hosted services—are more similar to the Internet design than to the original viewdata vision. In other countries, the development of the videotex 'large technical system' stalled because of poor coordination between actors, tariff complexity and the inflexibility of the centralised database concept and the videotex interface (see Bouwman and Christoffersen, 1992).

Other information and communications services were being built upon the public X.25 packet-switched data networks which were emerging in North America, Europe and elsewhere from the beginning of the 1980s. These networks, like videotex (in Europe at least), were innovated mainly by telephone service providers. They allowed the delivery of information from database hosts, which could be accessed internationally at volume-based rates that were generally far cheaper than normal international telephone tariffs. They also carried traffic for some of the first commercial electronic mail services, which again were mainly offered by telephone providers, for instance MCIMail, AT&T Mail and Telemail (Sprint) in the USA; Telecom Gold and MercuryLink 7500 in the UK.

The nascent electronic information industry needed to create its own business models and tariffs. Information services were mostly targeted at businesses, educational and government organisations, on a subscription basis and for use by information intermediaries. Competing providers tried to 'lock in' their customers by insisting on long-term subscriptions and/or by forcing customers to use special terminals. Access to information was often limited by time, volume or access speed in order to prevent customers from 'draining' the databases and perhaps reselling information thus obtained. Various distribution strategies were adopted, including the use of large database 'hosts' as intermediaries between providers and users (for more detail, see Thomas and Miles, 1989; Chap. 4).

There were undoubtedly several successful online information enterprises, e.g.—Reuters news and financial information services, the ISI citation indices,

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[1] There are of course also some differences: e.g., the 'advanced calculator' service remained for the most part on standalone machines; but Fedida's 'failed' prediction of using the viewdata service for storage of personal information has been given renewed currency via the notion of the 'network computer' with its server-based storage.

the LEXIS legal database, etc.—mainly catering to business or scientific customers and often specialising in niche markets. But the models used in the 1980s did not provide the springboard to mass market diffusion. In the online communications field, the telecommunications companies—despite huge financial and technical resources—proved strangely unable to move e-mail beyond a small customer base and launch widespread electronic mail services.

Why, then, did the Internet succeed in transcending its military/academic origins to become a general, commercial information and communications infrastructure? Certainly, a robust and flexible underlying technology was an essential ingredient of its success. However, another part of the answer lies in the origin of the Internet as a publicly funded resource and the effect of this on the attitudes of the Internet's creators and shapers towards issues such as interconnection. The commercial providers of e-mail had the *technical* ability to interconnect each others' systems, on the basis of emerging international standards such as X.400. However, despite the obvious network externality benefits to their customers, the telcos (and other commercial e-mail providers) did not have a powerful *commercial* incentive to push for universal interconnection. In particular, larger service providers saw little benefit for themselves in allowing smaller service providers access to all of their users. This was a situation which was later mirrored in the attitude of dominant telcos to interconnection of competing telephone systems after liberalisation, but in this area powerful regulators were able to force interconnection whether the incumbents liked it or not. Such enforcement of interconnection was not carried over into the 'value-added services' area of electronic mail, because this was considered to be an emerging service, not yet ready for such detailed and coercive regulation.

At a time when more and more organisations wanted to connect their internal (mainframe or LAN-based) electronic mail systems to the outside world, the Internet had the advantages of already covering a wide geographical area and allowing interconnection without many restrictions (the notable exception being the exclusion of commercial traffic), using freely available and inexpensive software. While commercial providers were placing restrictions on connectivity and worrying about how to protect their existing markets in voice communications, the Internet had been developing rapidly on the basis of shared access to intellectual resources and a culture which was committed to free exchange of ideas and innovations (at least in the area of software—hardware always had to be paid for, but this was often done at a distance, out of 'topsliced' budgets).

Even so, the progress of the Internet before the 1990s should not be seen as straightforward. The Internet protocols were looked upon with suspicion even within the academic world, especially in countries outside the USA, where they suffered from the 'not invented here' syndrome and from suspicions about the willingness of the US military to share access to, and governance of, this outgrowth from ARPANET (see Abbate, 1994). This was shown particularly clearly in the UK, where the creators of the JANET network which linked higher education sites from 1984 explicitly ruled out using TCP/IP as the basis of their network. Although some of the 'Coloured Book' standards they chose or created were quite similar to those used within the Internet (there were similarities between the JANET 'Grey Book' mail standard and the Internet's RFC-822, for instance), the underlying network protocol was X.25, and the stated intention was to migrate to the slowly emerging Open Systems Interconnection protocols. Older UK academics still have fond memories of having to explain to the rest of the world that their e-mail addresses were just like Internet addresses, only written backwards! It was not until 1991 (and even then not finally until July 1997, when support for X.25 was discontinued) that the UK academic network stopped 'driving on the wrong side of the road' in network terms. Revealingly, the committee which investigated the feasibility of migrating from Coloured Book to Internet protocols was called DoDAG (for 'Department of Defense Advisory Group'), a name ironically highlighting European mistrust of the Internet's origins in US DoD funding. While OSI boasted significant government support worldwide, it was eclipsed by the Internet protocols because it was developed too slowly and was too complicated, while TCP/IP already existed, worked well and was bundled free with the most popular computers used for academic and scientific computing.

4. A theoretical detour: using closure to understand change and stability

The preceding sections illustrate that the development of the Internet has not been a straightforward linear process. Alternative means for providing some of the same services currently available, such as videotex, have subsequently become overgrown and underused tracks running alongside the superhighway. The path to the superhighway has taken some unexpected turns: crossing national boundaries, incorporating new applications and experimenting with different forms of governance and ownership. The development of the World Wide Web and the merging of academic, government and commercial networks have, in recent years, opened up what had appeared to be a closed system.

'Closure' is a concept with its roots in the sociology of scientific knowledge, where it is used to denote the resolution of a scientific controversy. 'Closure is achieved when debate and controversy about the form of an artifact is effectively terminated' (Law, 1987; p. 111). It is what happens when all actors involved share an understanding of what a technology is and what it can do. During the first three stages identified above, there was closure within each, which became undone as new actors became familiar with the Internet and wanted it do different things. As the Internet became more of a general academic resource and less focused on the particular needs of computer science professionals during the late 1980s, new developments centred around sharing information and developing friendlier interfaces for less competent users. More recently, the communication needs of academics, for example, have been overtaken by the commercial demands of newer users who have increasingly connected their internal networks to the Internet. In Section 5, we identify some of the difficulties associated with ever-increasing numbers of new users; difficulties for both the new users themselves and those with more experience.

The above account of the development of the Internet has demonstrated that closure is, at best, temporary. This supports the view of Misa (1992) who argues that not only is closure provisional but its provisionality is necessary for socio-technical change.

Closure must be seen as a contingent achievement of actors and not a necessary outcome of controversies. If achieved, closure implies more than temporary consensus; it is how facts and artifacts gain their 'hardness' and solidity. As a social process, closure may frequently involve the creating or restructuring of power relationships. Accordingly, this concept should not be seen as being in opposition to change but rather as facilitating the order that makes change possible, (pp. 110–111).

Summerton (1994) argues that technological systems or networks, such as the Internet, are dynamic and therefore, can rarely be closed permanently. She identifies three types of reconfiguration, or the undoing of closure. One type involves, ''the territorial expansion and interconnection of similar systems across political borders, transforming regional systems into national ones and national systems into transnational ones'' (p. 5). A second involves different types of border crossing in which parts of different systems are recombined, such as transport with communications. The third type is one of institutional border crossing in which monopoly systems are opened up to competition, as is happening in many public utilities in western Europe and north America. All three types of reconfiguration can be found in the history of the Internet. When the UK JANET community finally embraced TCP/IP in the early 1990s, the Anglo-American interconnection was complete. The second type of reconfiguration can be seen in the turf wars between the established telcos with their commitment to voice and the upstart providers of data communications, which eventually resulted in the blurring of both technical and organisational boundaries. This reinforces the third type of institutional border crossing, exemplified by the divestiture of AT&T in 1984 and the privatisation of BT in 1981, and also by the privatisation of the NSF Internet backbone in 1995. Growing competition in telecommunication has been accompanied by growing concentration in related areas, such as in semiconductors or user interfaces. Further migratory tendencies will be discussed more fully in Section 5.

Some form of closure was achieved in relation to the Internet during the late 1980s. The basic technology had been stabilised, and the Internet had been dominated by an international group of actors, but a relatively homogenous group with shared academic

needs, priorities and perceptions of what the Internet could do. At present, there are many new actors with a huge variety of needs and an even greater variety of ideas about how to meet them. We shall later illustrate this diversity with reference to the range of metaphors currently being used to capture the direction of the Internet and to the range of issues which are currently open to negotiation and closure. First, let us chart some of the key points in the 'opening' and reconfiguring of the Internet, as it becomes more commercial in its overall orientation.

5. The Cuckoo's Egg? Accommodating the commercial Internet

The key date in the switch of the Internet from an academically oriented network to a commercially oriented one was, as mentioned above, the decision of the National Science Foundation in 1991 to amend its 'acceptable use policy' to allow commercial traffic across NSFNET. This was quickly followed by the creation of the Commercial Internet Exchange (CIX) in the USA, to regulate the exchange of traffic between the newly emerging commercial Internet service providers (ISPs) and to act as an ISP association (see **www.cix.org** for details). The number of such service providers grew rapidly, and they began to differentiate the market according to whether they operated nationally or regionally, whether they provided services to organisations or individuals, etc. Developments in the USA were mirrored, with a shorter or longer time lag, in other countries.

The growth of the commercial part of the Internet was given a crucial push after the World Wide Web protocol (one of the last innovations from the 'academic' era) became accessible via a graphical user interface after 1993. The combination of this interface and the extensibility of the Web which allowed it to incorporate multimedia features and integrate previously separate services such as information access, file transfer and electronic mail, meant that it became easy to demonstrate the potential of the Internet to prospective users. In particular, firms saw the advantages of having an 'online brochure' which could advertise their goods and services around the world at low cost. The growth of the commercial sector has been extremely rapid: the Network Wiz-

ards surveys of Internet hosts (computers with Internet addresses—see **www.nw.com** for details and definitions) show recent changes very clearly. Out of all hosts using generic domain names, 71% were identifiably in the commercial sector (having .com or .net domain names) in July 1998, up from 47% in the first survey in January 1995, with 26% (48% in 1995) coming from the public sector (.edu, .mil, .gov and .int) and less than 3% (5% in 1995) from non-profitmaking organisations (.org). These figures have to be treated as no more than approximations of the relative sizes of the sectors; the way in which hosts were counted changed somewhat between 1995 and 1998, and the figures do not take account of hosts—approximately one third in each survey—which use country-specific domain names instead of the generic ones and which are more likely to be owned by non-commercial organisations. [2] However, they provide a decent, if partial, indicator of the growth of the commercial sector of the Internet from a very low base at the end of the 1980s to a dominant position less than 10 years later.

The decision to admit commercial traffic created many organisational problems. In some ways the move was analogous to the process of the privatisation and liberalisation of telecommunications: functions that used to be taken care of automatically by the 'monopolist' now needed regulating, and new organisations had to be set up to ensure fairness of treatment in a competitive environment. For instance the Internet Society, perhaps the nearest thing to a governing body for the Internet, was reorganised in 1992 to take account of the new commercial constituency, and in 1993 the InterNIC was created by the NSF to provide Internet-related services such as name registration, directories and network information. These InterNIC functions were subcontracted to different firms, with Network Solutions being given

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[2] Public sector and educational organisations outside the USA are generally satisfied with a country-specific designation, whereas commercial organisations often choose the generic .com domain to give them an 'international' image or for reasons of cost and convenience. Some country names, however, have been 'captured' for commercial purposes because their abbreviations form English words or the 'trademark' symbol: hence, not all hosts in Tonga (.to), Austria (.at) or Turkmenistan (.tm) are where they seem to be! For a fuller discussion, see OECD (1997).

what turned out to be an important contract to manage name registration services (the assignment of generic Internet 'domain names' such as microsoft .com and eff.org). The original NSF network was privatised in 1995, since when commercial providers have run the US Internet backbone network, although NSF still runs a research network.

One key problem for the new commercial actors was how to 'capture value' from the Internet. Early attempts at commercialisation were clumsy. For example, several sites tried to enforce a cumbersome registration procedure and password identification before allowing users to access the bulk of the information contained in the site (this was especially favoured by online newspapers and magazines, the idea being that they wanted precise figures on their readership as opposed to unreliable raw data about the number of 'hits'). Some sites demanded advance subscriptions for information services—successfully in the case of some pornographic sites, but noticeably less so elsewhere—and many sites made use of intrusive banner advertisements on their pages. The problem was that, with the number of Web sites increasing rapidly, users could generally shop around and find a substitute for any site that enforced inconvenient login procedures, where the ratio of advertising to useful content was high or which demanded payment.

Commercial sites faced major difficulties when attempting to make customers pay for Internet content. In general, payment systems which were cheap, efficient and secure were not yet in place. Some business areas could thrive on the Internet by using credit cards as the basis of their transactions, but many users were wary of giving out their card details online, despite the fact that other card-using media were also insecure. Also, both firms and other organisations using the Internet faced the problem of working out how to translate their existing products into products appropriate to the new medium.

Gradually, those early attempts at capturing commercial value from the Internet are being superseded by more sophisticated commercial strategies, and in the wake of a great deal of investment the outlines of general electronic commerce systems (based on emergent secure trading standards) are beginning to take shape. A body of experience-based learning has been created which can guide business strategies.

Some firms (e.g., the oft-cited Amazon online bookstore) have benefited from 'first mover' competitive advantage; others (e.g., Railtrack in the UK) are finding that the Internet can increase the scale of its services more easily than human-based enquiry services; in addition to this, companies such as Dell have shown that interactivity can be a big selling point in computer sales, as knowledgeable customers can configure their own PC systems and get instant feedback on prices and alternatives. The Internet is fostering opportunities both for 'disintermediation' as suppliers can reach customers directly and for new intermediaries (e.g., Web design, hosting and consultancy services) providing specialist Internet expertise.

All of this has not been universally popular, however. A vociferous section of the Internet-using population is uneasy about the effects of commercialisation on the traditions and practices which made the Internet successful in the first place. With some justification it could be claimed that it was ever thus: the disparagement of 'newbies' (newcomers to the Internet) probably set in with the creation of the *second* online newsgroup, and was certainly a feature of online society throughout the 1980s as the Internet expanded (mostly) within the academic community. The scale of this problem was such that a sizeable portion of the classic Usenet 'netiquette' documents dealt (and still deal) with the adverse effects of newbie clumsiness and oldtimer arrogance. But although some of the current angst about the effects of commercialisation can be attributed to the turnover of generations of users and a prevalent 'more means worse' mentality, underneath all this there are some genuinely substantive problems.

Most of these can be reduced to the question of whether the new commercial practices are tending to undermine the attributes of the Internet which made it successful in the first place. There is an ongoing debate about exactly which attributes have been most crucial in creating the Internet's success. Free marketeers, including the libertarian variety which Richard Barbrook has provocatively deprecated as the 'Californian ideology', tend to see success as having been brought about by lack of government control and the unfettered competition of ideas and products (Barbrook, 1996); their opponents on the other hand stress the positive contributions made by the original

public-sector character of the Internet, including the 'kick-starting' of government finance, the free exchange of ideas and software and the openness of the non-proprietary Internet protocols and standards (See Borsook, 1996. The debate is discussed at length in Hudson, 1997; Part V.)

The argument is illustrated by proclamations from the different sides about 'what's wrong with the net'. For instance, from a commercial perspective the 'old' Internet has been routinely seen as 'not ready for business' because it was too open, too amateur and too steeped in academic/nerd culture. In contrast, commentators such as Barbrook and Borsook worry that the commercial pressures will lead to an Internet which is mean-spirited and which will exacerbate inequalities and disenfranchise significant groups within society.

6. Pressure points: contested Internet terrains

Clearly, the clock cannot be turned back and the Internet cannot revert to being the preserve of an academic elite. But this is not to say that only one future is possible. In attempting to identify how the interplay of different actors and their interests is shaping the Internet we can examine some of the 'pressure points' caused by the transition to commercialism, points which are likely to be important in configuring the future development of the Internet. We will look (briefly) at interconnection, telephony, new protocols, name allocation, 'push' technology, intellectual property rights, encryption, taxation and censorship.

6.1. Interconnection

One of the core elements of the Internet is how different networks connect to each other. The original Internet model was based on the existence of (relatively few) networks which were all in one way or another publicly funded. Interconnecting was a matter of agreeing a network access point with the owners of the nearest part of the Internet, solving the technical problems and then monitoring traffic in order to manage load levels. The missing element (from the perspective of, say, a telephone company) was charging for the carriage of network traffic.

Network owners commonly argued that the addition of a billing mechanism would impose an unnecessary technical and bureaucratic overhead and, given that nobody at the time was trying to make money out of internetworking, there was no need to calculate payments for traffic flows. This model was so well established by the beginning of the 1990s that it survived the growth of the commercial Internet and became one of the reasons why the cost of Internet access remains so low. Novice users are still astonished that they can access a server halfway round the world for an incremental cost—once the flat-rate access fee has been paid—of a local telephone call. Doubts, though, have been raised about whether this model of 'free' traffic exchange can survive in the medium term future. It obviously contains the possibility that some network providers will have to pay an 'unfair' cost while others will be given a 'free ride'.

The question of how much, if anything, network owners should pay to interconnect is closely bound up with that of who can connect to whom, and where. Since the retirement of the NSF from network backbone provision, commercial Internet carriers have set up 'public' interconnection points. Carriers wishing to use these interconnection points usually have to pay a subscription and meet various terms and conditions. Early problems concerning the location of the original connection points and the often inefficient routes taken by Internet traffic crossing from one network to another have been mitigated by the growth of regional and national interconnection points around the world. Non-USA networks have an ongoing complaint about the exorbitant costs of providing international leased-line connections to the top level interconnection points, all of which are located in the USA (see Davies, 1997), but this is partly counterbalanced by the costs of providing transit capacity which have to be borne by US carriers.

Smaller carriers have recently found it more difficult to meet the conditions and pay the fees of the main interconnection points, and some of the larger carriers have made it a deliberate policy not to peer directly with carriers who cannot offer comparable services and a rough balance of traffic. Currently, there is enough competition for this not to be a major problem in most countries, but this (together with

other factors such as scale economies) has tended to strengthen pressures for rationalisation amongst Internet service providers. This is a particular problem in relation to Internet backbone carriers where a large market share is held by a few big firms. Worldcom, currently the owner of the largest share of Internet backbone capacity, was in the summer of 1998 forced to sell the Internet infrastructure it acquired when it bought MCI, in order to stave off anti-monopoly concerns. Smaller carriers may be able to ally themselves with larger ones—but this just reinforces the trend towards oligopoly, and the largest carriers may in future be in a strong position to dictate prices for backbone carriage, which will inevitably affect end user charges.

The call for such peering problems to be resolved by the introduction of 'settlements' (payment from one carrier to another for the balance of traffic passing between the two networks) is an example of how the entry of new actors is bringing pressure for the Internet to change from its existing model to that of an older system—telephony. This may be connected to the fact that, following initial disinterest, telephone companies are now increasingly enthusiastic about becoming Internet service providers as well as providers of basic transmission capacity. (For an extended discussion of Internet interconnection issues see OECD, 1998).

6.2. Internet telephony

The collision of the Internet interconnection model and that of the traditional telephone/telecommunication companies is thrown into sharp relief by the recent growth of Internet telephony. The Internet is currently a poor medium for voice carriage because of the variable delays in end-to-end packet transmission, but—over certain routes at certain times of day—reasonably good voice communication is possible. Improvements in software and the emergence of new Internet protocols with provisions for guaranteed 'quality of service' mean that Internet telephony is being taken very seriously as a future mass-market service. If and when Internet telephony does take off, it will pose a significant challenge to the traditional pricing policies of the telephone companies. If you can make a long-distance call on the Internet for the price of a local call, then why pay international

telephone rates? The answer for the moment is sound quality and a vastly larger number of stations which can be called, but both of these factors are likely to be weakened over time.

Regulatory models are also challenged, as was shown by the 1996 appeal of an association of American telephone carriers (ACTA) for Internet telephony to be regulated by the FCC in the same way as mainstream telephony. This appeal was not accepted, but it is hard to avoid the conclusion that certain aspects of telecommunications regulation (licensing of public carriers, universal service obligations, interconnection tariffs and conditions, etc.) will need to be scrutinised as a consequence of the growth of Internet telephony. In the meantime, several of the main telephone carriers are hedging their bets and preparing to offer Internet telephony as part of their Internet service packages, sometimes with special time-based tariffs which partly negate the original advantage of Internet telephony. It will be interesting to see whether the telcos can take over from independent software companies like Vocaltec as the main drivers of Internet telephony and whether the growth of Internet telephony will ultimately cause greater changes to the practices and regulation of the Internet or of telecommunications.

6.3. New protocols

The changes to the Internet protocols mentioned above may have other consequences. The 'resource reservation' provisions introduced as part of IPv6 (and reinforced by analogous 'quality of service' provisions in underlying telecoms technologies such as ATM) were intended to provide service classes suitable for the transmission of real-time voice and video. Essentially, they provide various classes of throughput for packets of information sent across a network, so that services like real-time voice and video can reserve bandwidth and give their packets guaranteed delivery times, thus avoiding jerky animation and audible 'wow and flutter'.

While this is technically a sensible practice, it also provides the opportunity for providing a higher speed delivery of other services (file transfer, Web access) for which guaranteed delivery times would be beneficial but are not essential. Of course, the overall bandwidth would have to be available but,

given that precondition, the new protocols will give network providers an opportunity to charge for their bandwidth on the basis of a user's willingness to pay for a particular service class. While this would no doubt improve the quality of service for some users, it would undermine the traditional flat rate access model for Internet network capacity and potentially increase inequalities in Internet service provision, with wealthy users being offered a 'Concorde' class service, at a price, while other users would have to settle for 'economy' transport. To what extent this actually happens will depend on a variety of factors —technical difficulties, price, implementation time-tables, etc.—but the possibility of providing end-to-end bandwidth guarantees (rather than just guaranteed bandwidth to the nearest Internet interconnection point, as at present) will no doubt be seen as a valuable selling point by some access providers.

These changes to IP, though still some way off full implementation, show that even those parts of the Internet which had been considered to be the most 'closed', can be reopened and become key sites of contestation. In his book on the construction of the new Internet protocol (IPv6), Huitema details how the design of the new addressing plan was, somewhat controversially, tailored to the topology of large service providers as opposed to political or geographical boundaries, which could lead to increased switching costs for users and/or more complex routing tables (Huitema, 1998, pp. 66–68). Of course, the larger the Internet becomes, the more difficult it becomes to implement such fundamental changes. Ways have had to be found to maintain backward compatibility with existing standards, and a complete, simultaneous changeover of protocols, such as happened at the start of 1982, is now inconceivable. But the point is that the strategies and interests of major Internet actors can affect even its most fundamental technical attributes.

6.4. Domain names

Throughout 1998, the question of who should regulate access to Internet domain names was much in the news, chiefly because of controversy caused by the proposal of the US government to change the basis of the registration system for generic Internet domains (primarily .com and .org names), which contradicted an existing plan worked out by members of the Internet Society. Details of this controversy could take up a paper in itself, but the crux of the matter rested on who had the power to decide on the format of the name registration system: how far should control be kept in the USA, and how much representation should commercial actors be guaranteed. Other aspects, such as which new top-level domains were to be offered, how many registrars there should be for each domain, who they should be, where the root nameservers would be located, etc.—all of which are of the utmost importance to users of the Internet—hinged on this key question. Since the opening of the Internet to business users, domain names have taken on a significance much greater than the technical convenience they originally represented, because of the commercial advantages associated with trade marks.

At the time of writing it appeared that a compromise had been reached between the US government and ISOC, and that a new system of international domain name governance would be put in place by the year 2000. Details had yet to be finalised, despite the rapidity with which a new organisation, ICANN, was set up following the death of Internet numbering supremo Jon Postel in order to manage the non-competitive functions of name and number registration. The controversy can be seen as an argument between old and new actors, and between a national government and the diverse users of an international network. The responses to the US government's Green Paper allowed the interests of actors from different countries and sectors to be clearly expressed, with opinions dividing along the largely predictable of US/other and commercial/non-commercial. (For documentation, start at **www.ntia.gov** and **www.isoc.org**).

6.5. 'Push' technology

While electronic commerce has been the focus of the commercial Internet in general, one particular sector has had other concerns, principally about whether the Internet was a suitable medium to deliver the kind of information which the sector had traditionally provided via other media. TV and movie studios have been experimenting with ways to deliver 'Web TV' and 'video on demand', and paper-

and screen-based media firms in many sectors were evaluating the Internet as a medium for repackaging information. One of the key differences between the Internet and many other media—its capability to offer high levels of interactivity, so that for example information content is delivered across the Web only in response to a user's choice to click on a particular link—has been viewed by media providers with mixed emotions. In particular, the new media companies in the world of cable and satellite TV had operated with a 'channel' model where they packaged information and entertainment under different channel labels and then offered these channels to customers. So-called 'push technology', which was introduced to the Internet in the mid-1990s, is an attempt to replicate that model at least partly. With push technology the user chooses to have information from, say, a news channel and a sports channel, and then such information is delivered to the desktop during the 'idle' periods of network connection, without the need for further intervention on the part of the user. The attractions for channel providers who want to package advertising along with the information are obvious.

More traditional Internet users, who had been used to a much smaller distinction between users and producers of information and services, were worried about the potential for Internet interactivity to decline and for the large media players to dictate Internet content. Such worries may still have some foundation, although push technology seems to have been stalled by lack of universal, cheap Internet bandwidth (it is not popular with users who have metered local telephone calls) and lack of processing power and memory within personal computers (accessing push channels tends to bring older computers to a standstill). But push technology may just be waiting for its time to come, along with increased PC power and network bandwidth. It is a clear example of a sector trying to shape the Internet in its own image, by superimposing a 'one-way' communication model onto a 'two-way' interactive system.

The recent attempts by various organisations to create 'portals'—large Web sites which act as gateways to a wide selection of their own and other organisations' Internet content (and as a magnet for advertising)—may also be viewed as a way to package content and to channel users' choices. Interest-

ingly, different kinds of organisation are converging on the portal terrain: online content providers like AOL, software providers like Microsoft and Netscape (though the latter is in the process of merging with AOL), search engine providers like Yahoo and Excite, media giants like Warner. This may be viewed simply as a way to rationalise the 'chaos' of the Internet, but some portal providers are attempting to increase switching costs by doing deals with ISPs to make their portals the default page of the supplied browsers and by integrating content and services with specialised software.

6.6. Intellectual property rights

It is easy to create Internet content, especially basic Web pages. The syntax of hypertext markup language (HTML) is easy to learn, and widely-available software allows would-be Web authors to create pages without even having to learn HTML at all. In addition, features built into Web browsers enable users to capture content created by other people with a minimum of effort. This means that 'users' of the Internet can easily become content 'producers'. [3] But while this conforms to the interactive, participative ideal of the original Internet community, it poses a problem for people who are trying to make a living from the provision of content. The ease with which content can be copied, processed, and then reproduced, together with the rapid proliferation of Internet sites, has resulted in a major headache for producers and owners of material that falls under copyright protection. This has been exacerbated by the cavalier attitude of many Internet users who appear to have given their own spin to the slogan commonly attributed to Stewart Brand, publisher of the *Whole Earth Catalogue*: 'information wants to be free'.

Even well-meaning content producers can find it difficult to trace the original authorship of Internet

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[3] There are, however, contradictory tendencies at work. The growth of scripting languages like Javascript, programming languages like Java, new protocols like XML and the integration of Web pages and databases have meant that major Web sites are now constructed by people with significant programming capability—so not all users can be producers. This requirement is to some extent moderated by the development of user-friendly tools to automate some of the coding.

content which they want to reproduce, and when they do find the author, making the appropriate royalty payments can be a cumbersome procedure—especially for multimedia sites, which may have to deal with several different collection agencies. Authors trying to secure their copyright to specific material can find it difficult to track down all instances of abuse: it is possible to do so, but it takes a lot of time and effort, because the Internet has vastly increased the number of potential publishers of such material. This has led to an imbalance between different types of authors/owners of copyright material, with a few large organisations—generally experienced publishers in other media—zealously targeting all infringers of their copyright down to the smallest 'fanzine' pages, while other authors lack the resources to stop most cases of copyright violation. New electronic commerce facilities enabling the efficient transactions of small amounts of money, together with 'electronic watermark' techniques, may help to defuse some of the tension surrounding Internet copyright in future, but primarily this is a problem of balancing the rights of producers to be compensated for their work with the ability of users to access and process material created by others. Like other legal conundrums in the Internet sphere, achieving this balance is made more complicated by the contradiction between nationally based laws and the international nature of Internet access and publication.

6.7. Encryption

The regulation of encryption is an area which clearly highlights the different interests of actors such as government, business, political organisations and individuals. Despite the fact that much is made of the Internet's military origins, it was not designed as a medium for secure communications. Messages sent across it can be monitored by systems managers at any of the points along the route where information is stored and forwarded, as well as by people with access to 'sniffer' programs on the network or knowledge of security holes in widely distributed Internet software. As the Internet constituency has spread out from its academic origins to a wide variety of users and as the Internet has become central to many economic and social activities, more

people have reasons to want to keep their communications private to themselves and the intended recipients. Encryption is seen as the best means of ensuring such privacy, and also of enabling the authentication of communications so that the receiver can have confidence that a message does indeed come from the apparent sender and has not been forged in any way. The commercial advantages of using encryption are obvious.

But these very advantages for commercial and personal users create problems for other interested parties, primarily law enforcement agencies. Currently, the struggle between those people trying to devise 'unbreakable' encryption methods and their opponents who are improving their code-breaking techniques appears to be being won by the encrypters: i.e., it seems that the latest methods of strong encryption cannot be broken except by organisations with large-scale resources and massive amounts of time or unusually good luck. (This does not mean that the latest methods are always implemented, so many organisations are still vulnerable to attack because of investment in earlier vintages of encryption technology.) Both criminals and law enforcement agencies are not slow to appreciate the implications of strong encryption, and so governments around the world are trying to reconcile the commercial advantages of encryption and the rights of individuals to privacy with the needs of law enforcement agencies to have access to the communications of people suspected of serious crimes.

The 'solutions' proposed by various countries have all been criticised, either on civil liberties grounds or simply on the grounds that they are likely to be ineffective: no system of 'key repositories' has been shown to be completely secure, and no government can prove that any 'key escrow' or 'trusted third party' system can never be abused by its law enforcement agencies. In addition, it is argued that 'real' criminals would not use whatever system of law enforcement access was devised. On the other hand, few governments would find it politically acceptable to be seen to sanction the potential use of 'unbreakable' encryption by terrorists and organised crime. The situation has been made more complicated by the fact that encryption is closely associated with issues of national security: the US government in particular has been extremely keen to control the

export of encryption techniques developed within its borders.

If electronic commerce is to become a mainstream activity, then some form of encryption will have to be employed, and it is likely that an international standard will have to be introduced (or at least a very small set of options). The question is to what extent governments can shape the kind of encryption which is put to widespread use, or to what extent they will have to follow the lead of other actors in international commerce, or even of individuals with access to strong encryption software such as that provided via PGP. It is doubtful whether consistent, international policies can be formulated quickly enough to encourage the growth of secure, global electronic trading, so the probability is that there will be considerable unevenness between countries and sectors. (For an attempt to provide some international guidelines for policy formulation, see OECD, 1996.)

6.8. Taxation

Another area where business, consumers and government may find themselves in opposition is that of taxation. The international reach of the Internet makes it a suitable medium of trade in goods and services between countries. Whereas goods still have to be physically transported across borders, and are hence relatively easy for customs and excise officers to deal with, some Internet-based services, and the costs of processing all kinds of Internet transactions, are less easy for governments to capture for purposes of taxation. This has led certain governments and intergovernmental organisations to consider whether it is appropriate to levy taxes on Internet traffic itself as the most convenient proxy for the underlying 'intangible' transactions (for instance, in the European context, see Soete and Kamp, 1996). The faster the growth of electronic commerce, the greater the potential loss to the revenue base of national governments, and so the concern of governments is understandable. However, taxation would certainly alter the economics of Internet provision and access, and it is difficult to find a convenient yet fair means of ensuring revenue collection. The 'bit tax', for instance, has been criticised for unfairly equating too many different kinds of traffic: there is no necessary relationship between the size of a transmission and

its value. Some governments, notably the USA in its 'Framework for Global Electronic Commerce' (US Govt., 1997), have declared themselves to be in favour of an Internet which is as far as possible unfettered by bureaucracy and taxes, and it is unclear how far nationally specific taxation systems can differ without creating economic disadvantages for the highest-taxing countries. The debate on Internet taxation has to some extent mirrored that on trade and tariff issues generally: the greater the dominance of a country, the more it tends to be in favour of 'free trade'.

6.9. Censorship

Finally, let us consider one more area where governments are confronting problems thrown up by the worldwide growth of the Internet. As with the intellectual property rights and taxation, a key issue is the contradiction between the international scope of the Internet and the national basis of government authority, although the underlying issue is the effect of the coming together of many different (and sometimes incompatible or antagonistic) communities of interest on a general-purpose network.

Much of the argument about censorship of the Internet has focused on the topic of pornography, partly because it is an easy subject for the media to hype, but also because it is a significant business area and because it does raise issues of regulation of access, especially to minors. However, the problems associated with Internet censorship are broader. While most—though by no means all—people would agree that it is advisable to block access by certain types of user (e.g., children) to certain types of material (e.g., 'hard core' pornography), there is no universal agreement on which kinds of material should be kept from which kinds of user. Furthermore, there is disagreement about where is the best place to place the block. Prohibitions on the production of illegal material can be fairly effective within national boundaries, but are useless when the material is produced abroad in a country where it may be legal. Injunctions against distributors (such as Internet service providers) are problematic because they place an enormous burden of content monitoring on organisations which are generally viewed as carriers rather than publishers of information. Even placing

responsibility at the user end, via software which blocks access to specific sites or filters out undesirable words or images, is not always an ideal solution: who decides which sites should be rated as unwelcome or which words should (always?) be blocked? For instance, recently there have been problems with filtering software blocking access to newsgroups containing serious discussions and advice about breast cancer.

Despite the intentions of the failed 1996 Communications Decency Act in America and the precedent of the Bavarian court mentioned in the introduction, it seems that a more informal system of regulation is becoming widespread in Western countries: a voluntary ratings system can be combined with 'blocking' software and the agreement of Internet service providers retrospectively to remove any content which is manifestly (though not necessarily proven to be) illegal. The wider question concerns censorship of other kinds of material: political, controversial, potentially defamatory, etc. Again, the problem is that what is acceptable to one country, organisation, group or individual is unacceptable to another. The famous saying that ''the Internet interprets censorship as damage, and routes round it'' has some validity, but it rings hollow in countries which have only a small number of service providers, all of them tightly controlled by the government. Although even in such situations it is possibly for determined, technically knowledgeable and (probably) wealthy people to obtain some Internet access from abroad, the suppression of information can, in the short term at least, be achieved for the majority of the population. The 'Internet experience', therefore, may not be as universal as some net evangelists would have us believe. While there are common features inherent in the technologies used, the Internet may nevertheless be shaped differently for different categories of user in different places.

7. Shaping the Internet: actors, models and the persuasive use of metaphor

The Internet of the 1980s and early 1990s, dominated by the needs and activities of academic users, is being transformed as a variety of new actors enters the arena. The sections above indicate a number of areas where changes are occurring. It remains unclear how these will be resolved and around what aspects any new closure will occur. The changes of the immediate past may be deceptive. The commercialisation of the Internet has expanded access, cheapened prices, made software easier to use, and increased the number and variety of information and communication services. But this has largely been done by overlaying an existing configuration with new features and facilities. The question is what will happen when the new actors who have provided these features and facilities (many of whom are 'old' actors in other spheres of activity) try to remove aspects of the old culture and remake the Internet into something that more closely approximates their own image. The qualification 'more closely' is important because the activities and self-image of the actors will themselves change as a result of the move of these actors into new territory.

In this article, we have implicitly identified clusters of actors who currently play significant roles in the shaping of the Internet. These are:

· the 'old' academic and technical Internet community
· Internet hardware, software, access and consultancy providers
· telecommunication companies
· 'traditional' media companies
· the commercial sector generally
· governments
· individual users

Clearly, this classification will not stand up to close scrutiny. Telecom companies may be access providers, the commercial sector and individual users are extremely diverse, and it is probably unfair to lump the various kinds of Internet equipment and service providers together. However, they do delineate constituencies with definable sets of interests. They do not have equal economic, social and political power, but they each possess a range of instruments to help them to realise their interests, ranging from the ability to set de facto standards and/or influence de jure standards, access to technical skills, access to information dissemination channels and to

opinion formers, ability to influence government, the means of generating employment, to the ability to choose where to spend money.

Earlier sections have emphasised the importance of economic and political interests. Before concluding this paper, let us briefly examine the powerful role of language, especially of metaphor. In the pursuit of their interests, actors will try to enrol other actors to their cause, and one way they can do this is by manipulating language so that their cause becomes, or seems to become, the obvious choice. Also, there is a more general significance to the use of language in the shaping of the Internet. An ever-growing number of people are coming into contact with the Internet in an ever-expanding range of contexts, including education, entertainment, shopping and work. As a result, the Internet enters more widely into public debate. Faced with this new phenomenon, people and organisations try to make it familiar by using metaphor, by comparing it to something they already know. The range of metaphors currently on offer reveals a great deal about how different actors perceive its current and future functions.

Metaphors are not merely descriptive. Their use has a normative dimension; they can be used to help the imaginary become real or true. Different social groups use different metaphors to capture and promote their own interests and desires for the future. Lakoff and Johnson (1980) observe that, ''[n]ew metaphors...can have the power to define reality. ...[W]hether in national politics or everyday interaction, people in power get to impose their metaphors'' (p. 157). Thus, an understanding of the metaphors in play can enrich our understanding of the economic, political and technical interests at work.

Highways, railroads, webs, frontiers, tidal waves, matrices, libraries, shopping malls, village squares and town halls all appear in discussions of the Internet. Retailers promote the shopping mall metaphor in the interest of extending their markets, for which they need to be able to provide secure and reliable methods for funds transfer. Librarians and other information providers rely on the images of libraries with which they are familiar. The Internet as library would place greater demands on the processing speed and storage capacities of hosts and servers. As discussed in Section 6, traditional media providers

deploy broadcasting metaphors to support their commitment to one-way communication and push technologies rather than using the notion of webs of interactivity.

A prominent metaphor war is taking place between those who use engineering metaphors, such as US Vice-President Al Gore, the most notable proponent of the 'Information Superhighway' concept, and those who use evolutionary metaphors, such as the contributors to *Wired*. Virginia Postrel attacks the engineering metaphors of highways and bridges used by politicians, suggesting they are deeply bound up with government funding, teams of experts and large bureaucracy:

''Like an earlier Clinton/Gore plan to overlay the Net with a centrally planned and federally funded information superhighway, their bridge to the future isn't as neutral as it appears. It carries important ideas: The future must be brought under control, managed and planned—preferably by 'experts'. It cannot simply evolve. The future must be predictable and uniform: We will go from point A to point B with no deviations. A bridge to the future is not an empty cliché. It represents technocracy, the rule of experts.'' (1998, p. 52).

On the contrary, contributors to *Wired*, archetypes of the Californian ideology derided by Barbrook (1996) are more likely to be, ''drawn toward organic metaphors, symbols of unpredictable growth and change'' (Postrel, 1998, p. 54). Steve Steinberg expresses this dramatically in relation to the development of the Internet. ''Like some kind of technological Godzilla, IP has gobbled up WANS and LANS, leaving behind a trail of dying equipment vendors. ...And—whomp!—the IP snowball rolls on'' (Steinberg, 1998, p. 80). Although Joseph Schumpeter (1934) himself deployed biological metaphors —his use of mutation as a descriptor of change, for example—he rejected a wholesale application of Darwinian, evolutionary metaphors to economic development and technological change because that would involve adopting what he perceived to be the gradualism, inevitability and universalism of Darwinism.

Some elements of closure associated with previous stages of the Internet have become undone. In addition, new possibilities are added through con-

necting more machines, developing more user friendly interfaces and increasing functionality. But there are also powerful reasons for maintaining much of what is currently in place. Metaphors are powerful rhetorical devices deployed both by actors and commentators in the continuing reconfiguration of the Internet. Elsewhere in this paper, we have also used a variety of metaphors in order to convey our own ideas about the development of the Internet. The use of 'stages of development' for example could be seen to support an evolutionary approach. However, we suggested that while this might provide a useful retrospective heuristic, it was important to remember that it was an attempt to impose order on what we later demonstrated was actually a much messier process of socio-technical change, during which there had been alternatives and choices.

Underlying our analysis is a more conflictual, spatially oriented metaphor of a battle on contested terrain. We have used the latter phrase; we have also referred to battles over standards or protocols; we have pointed to the ways in which obstacles can be overcome or avoided. We are not endorsing the desirability of a conflict ridden world, but we are arguing that conflicts can be productive of change. Even though the outcomes of conflicts are usually weighted in favour of already powerful groups, sometimes new weapons can be forged and successfully deployed by the less powerful. Small, new groups can use their control over key resources, such as operating systems or browsers, to become larger and more influential.

Such warlike metaphors contrast with colonisation metaphors which are also common amongst the contributors to *Wired*. The Electronic Frontier Foundation, for example, reflects this in its choice of name. Such metaphors are useful because they draw attention to the newness of the spaces and resources created. The opening of the New World and the American frontier was only partly about the creation of a new, more democratic order. It was also bloody, brutal and a replay of many of the conflicts of the Old World. Similarly, the exploration of space was not simply an appeal to people's imaginations of a new and better place; it was deeply embedded in Cold War politics.

In this brief section, we have suggested that in addition to examining the technological and eco-

nomic factors shaping the development of the Internet, it is important to examine some of the rhetorical devices which actors use. Metaphors can play a cognitive role by influencing design paradigms, and they can also serve a more normative function, in buttressing the other assets of actors in their ongoing efforts to reconfigure the Internet.

8. Conclusions

The history of the Internet is not an instance of historical inevitability. This paper has illustrated that the Internet we have today was not the only possible choice. There were alternatives not chosen; for example, systems based on videotex technologies or proprietary e-mail services used in the 1980s. At different moments during the history of the Internet, closure has been variously made and undone, with the involvement of new actors, the connection of networks using different protocols, and the development of new interfaces and applications.

Some elements of the Internet are relatively fixed, but it is again in a period of transformation. We have argued that this uncertainty is reflected in the variety of metaphors currently being used to describe the future direction of the Internet. In addition, we have suggested that there are a number of areas which remain contested, including payment for interconnection, standardisation issues around protocols and domain names, new technical developments in 'push' technologies and the technical, organisational and regulatory challenges posed by Internet telephony.

The outcomes of such contestation—in the form of the configuration of Internet-based service, their accessibility and cost, etc.—will be shaped by a number of factors, including the extent of competition in the various layers of Internet provision (from physical transmission media to services and consultancy), the persistence of 'old' cultures and mores alongside emergent ones—see for instance Richard Barbrook's article on the 'hi-tech gift economy' (Barbrook, 1998)—the regulation of the converged media/communications space, the relative power of national and supranational actors, and the extent of openness and diversity within the Internet.

The latter may turn out to be the most crucial issue. Different social and technical changes have led

to different amounts of openness and choice. In transport, for example, the growth of one set of new opportunities—the private automobile—has had the effect of shrivelling an existing set of facilities based on public transport and thereby restricting the mobility of people who, for whatever reason, are unable to take advantage of the new opportunities. In other areas, e.g., the rise of television, the shrivelling of 'old' opportunities has not been so evident, although both radio and the cinema have had to adjust in order to accommodate the newcomer. (These examples are over-simplified, and do not reflect the full range of substitutable facilities and activities, but the main point is that—even allowing for limits set by availability of money and time—different changes will have unequal impacts on existing provision.)

The question for the Internet is: how far can it continue to grant increased access for large numbers of people to information and communication services if it is being shaped mainly by organisations trying to turn it into a transaction medium? A combination of industrial concentration in Internet services and the development of efficient charging mechanisms and effective technical means of ensuring copyright might mean the end of a brief 'golden age' of general access and availability, with previously free information and services becoming chargeable, and large areas of the Internet becoming closed to people without the means to pay for online goods and services. In different circumstances, the transaction, information and communication spheres might all be able to flourish without impeding each other, with regulatory and market mechanisms combining to ensure widespread access to services at an affordable cost. Castells (1996) may be convinced that, ''the IT paradigm does not evolve towards its closure as a system, but towards its openness as a multi-edged system'' (p. 65) but, while this is certainly a possibility, we would argue that where the future of the Internet is concerned there is no guarantee that such openness will manifest itself in ways which improve life-chances and increase opportunities for expression and creativity for the majority of people. The future direction of the Internet cannot simply be assumed, as the account of its history presented here demonstrates. The very openness suggests both that there are choices open to actors who want to shape its future and that analysts need to continue to pay

attention to the ways in which those choices might interact and what the interactions might mean for the future shape of the Internet and the types of access available to different groups of actors.

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References

Abbate, J., 1994. The Internet Challenge: growth, conflict and compromise in computer networking. In: Summerton, J. (Ed.), Changing Large Technical Systems. Westview Press, Boulder, CO, pp. 193–210.

Barbrook, R., 1996. Hypermedia freedom. CTHEORY 19 (1), available at http://www.ctheory.com.

Barbrook, R., 1998. The hi-tech gift economy. First Monday 3 (12), available at http://www.firstmonday.dk/issues/issue3_12/barbrook/index.html.

Borsook, P., 1996. Cyberselfish. Mother Jones, July/Aug.

Bouwman, H., Christoffersen, M., 1992. Relaunching Videotex. Kluwer Academic Publishers, Dordrecht.

Castells, M., 1996, The Rise of the Network Society. Blackwell, Oxford.

Davies, D., 1997. Intercontinental Cost Sharing in the Internet between Europe and the USA (DD-97-027, February 1997), available at http://www.dante.net/policy/co-fund.html.

Dempsey, L., 1993. Research networks and academic information services: towards an academic information infrastructure. Journal of Information Networking 1 (1), 1–27.

Fedida, S., 1975. Viewdata—an interactive information service for the general public. Proceedings of the European Computing Conference on Communications Networks, pp. 261–282.

Hafner, K., Lyon, M., 1996. Where Wizards Stay Up Late: the origins of the Internet. Simon and Schuster, New York.

Hudson, D., 1997. Rewired: a brief (and opinionated) net history. Macmillan Technical Publishing, Indianapolis.

Huitema, C., 1998. IPv6—the new Internet protocol, 2nd edn. Prentice-Hall, Englewood Cliffs, NJ.

Lakoff, G., Johnson, M., 1980. Metaphors We Live By. Univ. of Chicago Press, Chicago.

Law, J., 1987, Technology and heterogeneous engineering: The case of Portuguese expansion. In: Bijker, W., Hughes, T., Pinch, T. (Eds.), The Social Construction of Technological Systems. MIT Press, Cambridge, MA, pp. 111–134.

Misa, T., 1992. Controversy and closure in technological change: Constructing 'Steel'. In: Bijker, W., Law, J. (Eds.), Shaping Technology/Building Society: Studies in Sociotechnical Change. MIT Press, Cambridge, MA, pp. 109–139.

OECD, 1996, Recommendations of the Council Concerning Guidelines for Cryptography, available at http://www.oecd.org/dsti/sti/it/secur/prod/e-crypto.htm.

OECD, 1997, Internet Domain Names: Allocation Policies, (OCDE/GD(97)207) available at http://www.oecd.org/dsti/sti/it/cm/prod/e_97-207.htm.

OECD, 1998, Internet Traffic Exchange: Developments and Policy, (DSTI/ICCP/TISP(98)1/FINAL) available at http://www.oecd.org/dsti/sti/it/cm/prod/traffic.htm.

Postrel, V., 1998. Technocracy R.I.P. Wired January, 52–56.

Schumpeter, J., 1934. The Theory of Economic Development. Harvard Univ. Press, Cambridge, MA.

Soete, L., Kamp, K., 1996. The 'BIT TAX': the Case for Further Research. Paper Produced for Debate in the Context of the Work of the High-Level Expert Group. European Commission, DG V, available at http://www.ispo.cec.be/hleg/bittax.html.

Steinberg, S., 1998. Schumpeter's Lesson. Wired, January, 80–84.

Summerton, J., 1994. Introductory essay: The systems approach to technological change. In: Summerton, J. (Ed.), Changing Large Technical Systems. Westview Press, Boulder, CO, pp. 1–21.

Thomas, G., Miles, I., 1989. Telematics in Transition: the development of new interactive services in the United Kingdom. Longman, Harlow.

US Govt., 1997. A Framework for Global Electronic Commerce, available at http://www.whitehouse.gov/WH/New/Commerce.