The Dynamics of the Digital Divide

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Abstract

Digital divide is a popular metaphor used to describe the social and territorial differences in the adoption of the Internet. While some regard the divide as a transitory phenomenon, others ask for political measures to overcome the divide. In this article the phenomenon is examined from a macro perspective, a micro/meso perspective and with a look at the evolving topology of the Internet. Usually a static view on the divide problem predominates. Recent research reveals that the issue is not restricted to the question of access to the network but includes Internet usage and usage patterns. Thus, divide or digital differentiation and inequality are continuous rather than discrete properties. From the Internet's inception institutional and political factors have accounted for the emergence as well as the mitigation of differences concerning access to and use of the Internet. Differentiation tends to reproduce itself in the sense that with this highly innovative technology ever new features and services are developed, which turn out to be sources of new lines of differentiation. Moreover, research into the structure of large ('scale free') networks provides evidence that even equal access to and use of the Internet does not create a level playing field. Rather a 'power law' distribution of the number of connections per user or website (node) evolves. Here comparatively few nodes (hubs) have very many links, while the vast majority of nodes have only few connections to their network environment.

Digital differentiation

As access to and usage of the Internet has been increasing dramatically in the industrialised world since the second half of the 1990s, the research interest of social scientists has gradually shifted from focusing solely on access to the Internet to studying the social implications and repercussions of the network. But also in this context, as is emphasised in a review article by DiMaggio et al., 'research on inequality in access to and use of the Internet [remains] an important priority for sociologists' (DiMaggio et al. 2001, 314). The term 'digital divide' refers to this aspect of social inequality. Ironically it was coined in the United States where the Internet was first

set up and initially reached a comparatively high level of diffusion. But nonetheless the issue of Internet and inequality has drawn much attention, political as well as scientific, in the US.

One reason for this high degree of attention has been the institutionalisation of a broad universal service concept in the mid-1990s as part of the Clinton Administration's National Information Infrastructure Initiative. The US Telecommunications Act, which was adopted in 1996, contains the general Universal Service goal of promoting the availability of quality services at just, reasonable, and affordable rates. The obligations of Section 254 of this Act require public support to help, *inter alia*, schools, libraries and public non-profit health care providers that are located in rural areas obtain access to state of the art services and technologies at discounted rates. Stipulating 'state of the art services and technologies' the Act goes beyond the traditional focus on telephone penetration and includes access to the Internet (cf. Bertot 2003). The Telecommunications Act conveys the vision of an information society from which no citizen may be excluded (cf. Pisjak & Schrems 1997). Non-access to the Internet would limit the citizens' opportunities to obtain education, to find jobs, or to access market and government information. Conversely, access to the network would create opportunities 'to convene regardless of geographic, physical or financial constraints' and participate in political dialog. This would enable free speech and strengthen democracy (Keller 1995, 35).

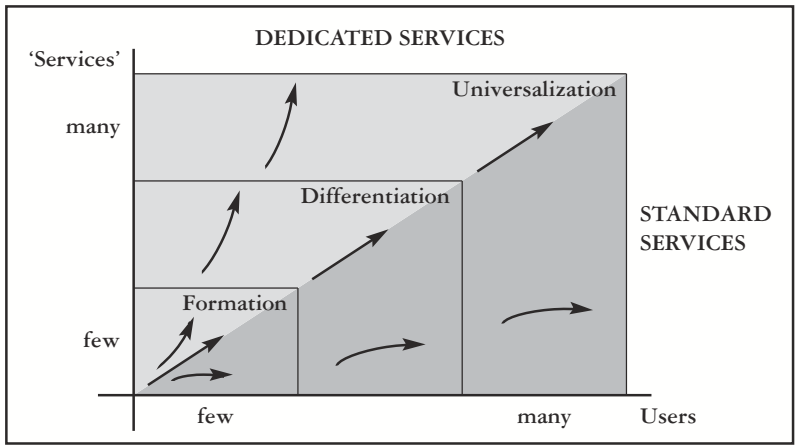
Against this backdrop of strong institutional support of the Internet, the US National Telecommunications and Information Administration (NTIA) started conducting surveys addressing differences in Internet access and use. The results were published in the 'Falling Through the Net' series. The first report, issued in 1995, stressed the divide between those without Internet access called the 'information disadvantaged' or 'have nots' and the 'haves' (NTIA 1995). Follow-up surveys reiterated the divide's persistence (NTIA 1999). But more recent studies indicate rapidly expanding access to and increasing use of the Internet by American people 'regardless of income, education, age, races, ethnicity, or gender' (NTIA 2002). The latest NTIA report, released in September 2004, cites President Bush, who established the national goal of providing

'universal, affordable access for broadband technology by 2007' (NTIA 2004, Foreword). Thus, the current political concern in the US is not access as such but broadband connection to the Internet.

These findings suggest that—at least in wealthy countries—the digital divide is gradually diminishing. Decreasing relative cost of access and network effects are critical factors determining whether people connect to the Internet. The Internet's network character, in particular, implies that its diffusion begins slowly but at some point accelerates rapidly until saturation is reached. The addition of new subscribers to the Internet increases the value of access to existing or potential subscribers.

This somewhat static view is undisputed (Hutter 2001). It ignores, however, that the Internet's character as a technical opportunity structure has changed. Many features or 'services' have been added which require more sophisticated hardware and software to be deployed and frequently also broadband connection to the network. The speed of innovation is high and the ensuing developments are new sources of differentiation on the side of the users and may be regarded as new levels of a digital divide. Figure 1 illustrates how the notion of the digital divide relates to the dynamics of the development of the Internet.

Figure 1. Internet 'services' and digital divide



Without suggesting a linear development of technology it is helpful to distinguish between different stages of a socio-technical system's 'maturity' concerning the technical features as well as the inclusion of users. At an early stage of system formation relatively few 'services' are used by a comparatively small number of pioneers. Usually the digital divide issue has no societal significance in this phase. Some of these services including access to the system may attract more and more users. The user base becomes more differentiated, and also new features are added to the services, but they develop incrementally. Eventually these services such as basic e-mail are regarded as 'standard services'. Here the digital divide issue arises. Primarily standard services should be affordable and universally available. Thus, the divide issue comes up if and when a service is generally regarded as standard. Potentially every new service can be socially or politically defined as a standard service, and we can expect the bouquet of standard services to grow. But not every sophisticated new service is designed to develop into a standard service. Service providers' strategies of product differentiation result rather in a variety of 'dedicated services' which only attract specific user groups. This is also true for some of the services whose software was developed by (pioneer) users and has been made available at no cost to the user/developer community. Thus the selective diffusion of dedicated services in differentiated user groups will only very rarely evoke digital divide concerns.

The arrows in the lower triangle in Figure 1 (dark grey) symbolise the development of services which grow comparatively slowly with respect to technical augmentation and which at the same time have the potential to be used by many subscribers. In this part of the picture underutilisation creates a digital divide problem whereas the upper triangle (grey) encompasses the area of sophisticated, often specialised services which develop fast and which are usually not expected to attract broad usage as is indicated by the arrows in this triangle. Here no digital divide issues arise if the average user cannot afford (most of) these services, although service providers struggling with relative underutilisation may wish to gain more subscribers. The diagonal arrows symbolise a relatively balanced situation in which new services and user groups attracted by them grow in parallel.

Figure 1 indicates that it would not be adequate to reduce the digital divide problem to one of access to the Internet. Access is in fact the necessary precondition of Internet usage. But the availability of connections at low access cost, which facilitates the Internet's diffusion to the majority of the population, transforms the issue. Accordingly a gradual, more subtle concept of digital differentiation must be added to the binary notion of a divide which only distinguishes between 'haves' and 'have nots'. Digital differentiation encompasses *inter alia* a technical dimension (software, hardware, quality of connectivity), a skill dimension (ability to use the different Internet features/services), and the evolving patterns of social usage of the Internet (cf. Hargittai 2002). Such a concept helps reveal the dynamics of the digital divide: While in the process of Internet adoption and diffusion some inequalities are remedied, others emerge (at a 'higher' level). Moreover, incorporating Internet usage and usage patterns in the concept of digital differentiation directs attention to issues that have rarely been recognised and understood, namely the emerging characteristics and structures of the network topology and their effects. The topology is shaped by and at the same time shapes the usage of the Internet and it has a strong impact on the network's 'democratic quality'.

The following analysis starts with a look at the digital divide from a macro perspective to examine how institutional factors in particular affect the adoption of the Internet. I then only briefly address the impact of micro and meso factors on digital differentiation because this is an area which most studies have focused on. Finally I turn to a type of digital differentiation which manifests itself in the evolving network topology as an unintended effect of collective Internet use—an aspect that has hardly ever been considered in social analysis.

The digital divide from a macro perspective

The macro perspective focuses on differences between countries in access to and use of the Internet. 'Socio-cultural resources' such as general favourable attitudes towards new technologies and the population's generalised trust are among the causal factors particularly affecting the initial diffusion

of the Internet (Bornschier 2001). Relevant socio-economic factors which account for the differences in interconnectivity are economic wealth and telephone density but also the countries' regulatory environments (Hargittai 1999; Chinn & Fairlie 2004).

Many macro factors are difficult to change. But the emphasis on regulatory environments directs attention to a set of institutional factors which have changed dramatically in many industrialised countries. Formerly public telecommunications administrations were transformed into private companies and the telecommunications markets were opened to competition (Schneider 2001). In addition the organisational landscape of international technical standardisation has become more heterogeneous (Werle 2001). In this period of change, technology policy and industrial policy had to adapt to the more liberal institutional environment in which traditional hierarchical coordination of development and diffusion of technological innovations was no longer feasible. Predominantly in Continental Europe these changes unleashed a dynamics of Internet diffusion and use that was hitherto unknown. This indicates that the 'old institutional order' in effect hampered rather than facilitated the diffusion of the Internet.

In the early 1980s when the Internet started to take shape in the United States, the industrial policy of most Continental European countries was geared to supporting single large national firms ('national champions') and protect them from competition. In accordance with the national technology policy these firms and the public telecommunications monopolies regularly concerted their innovative efforts developing a narrow set of technological options (Kogut 2003a). In the United States competition prevailed in the computer industry and after the divestiture of the private telecommunications monopoly AT&T in the early 1980s competition also emerged in this industry. Many Bell Operating Companies striving for new commercial opportunities entered the market for data networks and services. Public funding of technical development in the computer and telecommunications industry was provided by a plurality of partly competing funding organisations. They in effect protected niches in which a great variety of technological options evolved (CSTB 1999, 147–150; also Branscomb & Keller 1998).

Such institutional differences between Continental European countries and the United States only briefly illustrated here, accounted for the different speed of the Internet's initial diffusion. A crucial factor was the standards policy (David & Werle 2000). Supported by their national governments and by the Commission of the European Union the European telecommunications and computer industry joined forces in developing and implementing technical standards, which were supposed to be integrated parts of a more encompassing multi-layered architecture of 'Open Systems Interconnection (OSI)' standards. This architecture was adopted and promoted by the relevant international standardisation organisations. It was also officially supported by the US government. But in the heterogeneous and fragmented institutional system of the United States it turned out to be unfeasible to commit all relevant organisations to OSI standards, which moreover developed slowly. Some organisations adopted other standards for their computer networks. Many university computer centres opted for the evolving Internet standards based on the TCP/IP protocol stack. Although these standards were developed in R&D projects funded by the US Department of Defense they were not 'classified' but open public domain standards, which could be implemented free of charge.

Eventually TCP/IP and the Internet succeeded in the battle of standards and—from hindsight—the OSI policy appears to have completely failed. Of course, the picture is more differentiated. European political agencies as well as network operators and computer manufacturers had good reasons to opt for OSI standards. The problem was that for a (too) long period of time these organisations did not tolerate, let alone support, experimenting with Internet standards. In Continental Europe the winning technology was picked by a 'cartel' of stakeholders at an early stage of development while in the US the choice between competing technologies was left to the 'market'. In the case of the Internet the European stakeholders saddled the wrong horse and it took years until the borders were opened to TCP/IP technology (Werle 2002).

The advantage of the US as the first mover in developing and adopting the Internet was extended because the aforementioned stakeholders, including the Commission of the EU, hesitated to recognise the Internet's

potential. The Commission's so-called Bangemann Report on 'Europe and the Global Information Society' (CEC 1994), for instance, only mentioned the Internet in passing but strongly supported the ISDN technology and services concept whose basic ideas were rooted in the OSI and telephone monopoly era. It was not until the advent of the World Wide Web and the ensuing transformation of the Internet into a commercially viable global network that institutional barriers to the Internet's diffusion were removed. Most important was the liberalisation and privatisation of telecommunications at the end of the 1990s. Riding upon the 'wave of liberalization' (Kogut 2003b, 43) the Internet is catching up in Europe but it will take a few more years until the institutionally and politically induced digital divide between the United States and Europe is further reduced.

The digital divide from a micro perspective

Most empirical studies of the digital divide focus on differences at the micro level. Although Internet use continues to grow, the gap between those who are connected and those who are not has by no means completely disappeared. This is indicated by the NTIA surveys and many other studies, which at the same time show that the gap, if measured by access, is closing. The latest 'Digital Future Report' of the Center for the Digital Future in Los Angeles points out that 'the fastest growing Internet user populations are groups that were once considered the primary victims of the digital divide: Latinos, African Americans, and older Americans' (Center for the Digital Future 2004, 20). Similar trends can be observed in other industrialised countries concerning male/female, income and education differences. Resulting from a combination of individual efforts and public-private initiatives to promote Internet access 'underprivileged minorities' are catching up (cf. Frühbrodt 2003).

This phenomenon is not new. The divide between 'haves' and 'have nots' among researchers in universities and research labs was an issue as early as in the days of the ARPANET, the Internet's forerunner. Only scientists and engineers under research contract with the Department of

Defense or its Advanced Research Projects Agency (ARPA) were entitled to use the ARPANET, which linked computer centres and facilitated access to high performance computers as well as file transfer and electronic communication via e-mail. The divide stimulated efforts of the 'have-nots' to bridge the gap. Supported by the universities, public-private consortiums and other sources they launched networks such as Bitnet and CSnet and also regional research and education networks, which were functionally similar to the ARPANET though not as sophisticated (CSTB 1999, 78; David & Werle 2000; Mandelbaum & Mandelbaum 1996). Many of these networks were integrated into the Internet after the US National Science Foundation (NSF) got involved in computer networking and launched NSFnet the core of the emerging Internet. In a sense, the computer networks were both causes and consequences of digital disparities: The networks created a divide, which stimulated efforts to get connected or to build complementary networks with, if possible, better performance than the existing ones (Leib & Werle 1998).

As the Internet integrates print, oral and audiovisual communication modalities in a single system it provides many opportunities to augment existing and add new services with more and more highly sophisticated features. Consequently, and reinforced by the Internet's commercialisation, the structures and processes of communication change and become more differentiated (Castells 1996, 327 ff.). This may create new digital divides. While the Internet 'laggards' are catching up in the area of 'standard services' (see above Figure 1) the 'pioneers' embark on developing/using new services, which attract early users who directly (first mover) or indirectly (conspicuous use) benefit from the innovations. Bandwagon effects and chain reactions with more and more users subscribing to the new services may or may not ensue (Rohlfs 2001; Werle 1998; also David 1992). If they do not, new divides will stabilise. DiMaggio and Hargittai suggest using the term 'inequality' rather than 'divide' to denote this phenomenon of differentiated Internet usage (DiMaggio & Hargittai 2001). The authors emphasise that the incentives and constraints resulting from corporate strategies and government regulations account for the inequalities at the level of the Internet users.

Evolving topological divides

It has been argued repeatedly that the Internet mitigates social inequality if access to the network is granted to all citizens. It is also claimed that the Internet's democratic potential mitigates political inequality if only access to the network is assured. But we have already seen that access alone does not remedy most crucial inequalities, neither the social nor the political ones. Current research on the structural effects of Internet usage confirms this position. Rather than mitigating the divides, the Internet reflects, reproduces, and in some cases even reinforces 'real life' divisions.

The suspicion that specific patterns of Internet usage lead to a fragmentation or 'balkanization' of the network's topology was initially expressed with a view to scientific communication (Alstyne van & Brynjolfsson 1996; 1997). The underlying idea is that while scarce travel resources, time constraints and other restrictions usually prevent territorially scattered minorities of scientists from intensive communication, the Internet 'makes contacts, virtual meetings, information exchange and co-operation much easier' (Nentwich 2003, 229). Even small groups of experts in small areas of specialisation reach a 'critical mass' of interaction partners around the globe via the Internet. This helps establishing ever smaller self-sufficient groups of like-minded concurring colleagues whose internal communication is much more intensive than any contacts to external groups. Such patterns of communication fragment the Internet's topology, creating islands that are difficult to access from outside. Fragmentation is a familiar phenomenon, particularly with directed networks such as the World Wide Web. The networks break down into several 'continents' which, in the extreme case, are completely isolated from each other (Barabási 2002, 166).

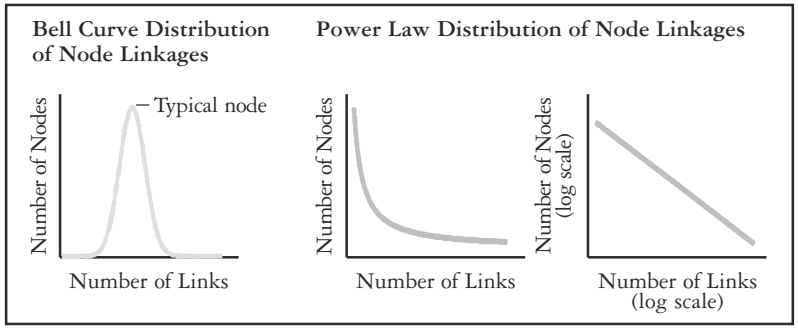
Examining the connection between the Internet and democracy appears to be more important to many social scientists than analysing, for instance, the relationship between this network and the structure of scientific communication. Does the Internet create a political digital divide or does it support a development towards an egalitarian, democratic and open society? International comparisons indicate that it is methodologically difficult to establish an unambiguous causal relationship between the Internet's diffusion and the democratic 'quality' of a country. While it has

been demonstrated that—controlling for other relevant factors—democratic governments facilitate the spread of the Internet (Milner 2003), the inverse causal proposition that interconnectivity increases a society's democratic quality has also been substantiated empirically (Kedzie 1997). Whichever position is right or wrong, both only look at access to the network and tell us little about the effects of Internet usage.

Users, individual and organisational, selectively utilise the Internet according to their political, commercial and social interests and preferences (cf. Werle 2000; also Kahler 2000). This includes subscribing to mailing lists, participating in chat rooms, launching websites or setting up links to other WWW sites. Typically the topological effects of Internet usage are not controlled by the users. These aggregate effects rather evolve unintendedly as a result of individual usage.

For a long time, science treated complex networks, including the Internet, as being random, i.e. users (nodes) were regarded as being connected with randomly placed links. In this perspective the networks appear to be deeply democratic because most nodes have approximately the same number of links. The distribution of the number of connections per node follows a bell-shaped binomial curve (Figure 2, left side). But recent empirical network research and simulation experiments have proved that this assumption is wrong. As a consequence, the generally optimistic expectations concerning the Internet's impact on democracy have been frustrated. The Internet does not provide all users with equal opportunities to gain a say and receive attention in the political process. It rather shares certain important characteristics with other large, still growing, so-called 'scale-free' networks. With these networks 'the popular nodes, called hubs, can have hundreds, thousands or even millions of links. In this sense the network appears to have no scale' (Barabási & Bonabeau 2003, 52 (box)). The connections per node show a 'power law' distribution. The term 'power law' describes the organising principle according to which very few nodes maintain a large percentage of the links in a network. A power law distribution does not have a peak. It can be described by a continuously decreasing function or as a decreasing straight line if plotted in a double-logarithmic scale (Barabási 2002, 71; Barabási & Bonabeau 2003, 53) (Figure 2, right side).

Figure 2. Random versus scale-free networks (Barabási & Bonabeau 2003)



Scale-free networks with power law distributions of nodes abound. They have been detected in 'cyberspace' as well as in the social world and the natural world. In the World Wide Web, for instance, a few hubs such as Google and Yahoo dominate. Search engines and other popular hubs are constitutive of what is called the 'small world' nature of power law distributed networks. In the case of the World Wide Web this means that with comparatively few 'clicks' one can get connected to any node in the network (Barabási 2002; also Buchanan 2002). Not only node connections in the WWW, but also the number of links per Internet router show a power law distribution. Such distributions have also been found in peer-to-peer networks such as Freenet (Hong 2001), in the landscape of mailing lists, or with the relatively new phenomenon of weblogs, where a small set of webloggers account for a majority of the traffic in the weblog world (Shirky 2004, 1).

Different factors account for the power law 'rich get richer' mechanism. They are summarised as 'preferential attachment', which includes first mover advantage, history dependence, frequency dependence, positive feedback, network externality, reduction of transaction costs, and a tendency towards agreement or conformity. A more detailed analysis of this bundle of factors and of other factors which have an influence on preferences is still missing. But given the virtually natural tendency of the Internet and all the networks within this network to develop a structure according to the power law, the 'vision of an egalitarian cyberspace' is 'utopian' (Barabási 2002, 58).

The emergence of hubs with a huge number of incoming links such as www.whitehouse.gov indicates that the Internet as it is does not mitigate real world political divides. Whatever most of us put on the World Wide Web it will remain unnoticed by the rest of the WWW. Cyberspace for better or worse is part of the real world.

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