The Relation between the Internet Infrastructure and the 'Internet Industry' as a Matching of Networks

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Résumé:

The scene is set by a survey of 'new' location factors for mobile investment in Europe, published by the European Commission in 1993. This leads to two questions the first of which concerns the exact definition of the Internet industry. The second question is about the Internet infrastructure. How do the two connect? How to establish the importance of the Internet infrastructure for the location of the Internet industry? Technological determinism and urban dissolution are debunked as myths. A conceptual innovation is called for: to conceive of the connection between infrastructure and industry as a match between networks according to the new science of networks. If networks work for winners, 'how do latecomers make it in a world where only the rich get richer'?

Mots clés: Internet infrastructure Internet industry new science of networks.
Classification: Infrastructures et réseaux / Infrastructures matérielles et immatérielles.

It is the new science of networks that provides a new look on economics:

'Until recently economists viewed the economy as a set of autonomous and anonymous individuals interacting through the price system only, a model often called the standard formal model of economics. The individual actions of companies and consumers were assumed to have little consequence on the state of the market. Instead, the state of the economy was best captured by such aggregate quantities as employment, output, or inflation, ignoring the interrelated microbehavior responsible for these aggregate measures. Companies and corporations were seen as interacting not with each other but rather with "the market", a mythical entity that mediates all economic interactions.
In reality, the market is nothing but a directed network. Companies, firms, corporations, financial institutions, governments, and all potential economic players are the nodes. Links quantify various interactions between these institutions, involving purchases and sales, joint research and marketing projects, and so forth. The weight of the links captures the value of the transaction, and the direction points from the provider to the receiver. The structure and evaluation of this weighted and directed network determine the outcome of all macroeconomic processes' (Barabási, 2002, 208 – 209).

1. To set the scene

Back in 1993, the European Commission has published a survey of new location factors for mobile investment in Europe on the national and regional levels (Commission of the European Communities, 1993). Mobile investment is classified in five broad sectors. Only one of them slightly refers to ICT ie 'services including software and financial functions'. The survey still covers the pre-Internet or pre-World Wide Web era. Similarly, no reference is made to the Internet infrastructure as a location factor. 'Quality of telecommunications' comes closest as one out of four infrastructure indicators. If one looks at companies identifying quality of telecommunications as critical to choice of region, this location factor was most critical for offices (European headquarters), followed by services with respectively 39% and 27%. Compared to other factors, quality of telecommunications finished respectively joint first and joint third. Table 1 refers.

Companies identifying quality of telecommunication as critical to choice of region

	Critical %	Rank	Future Trend
MANUFACTURING PLANTS	2[a]	Joint 18	Important increasing [b] Important, stable [c]
HEAD OFFICE OR OFFICE FUNCTION	39[d]	Joint 3	Critical, increasing
EUROPEAN DISTRIBUTION	10[e]	Joint 9	Critical, increasing
SERVICES INCLUDING SOFTWARE AND FINANCIAL FUNCTIONS	27[f]	1	Critical, increasing
RESEARCH AND DEVELOPMENT	-	-	Important, increasing

[a] road/rail: 15; port:6; airport:6;
[b] high-tech
[c] traditional
[d] road/rail: 46; airport: 46
[e] road/rail: 35; airport: 25
[f] road/rail: 27; airport: 7

Table 1: Location factors mobile investment in Europe: the relative importance of quality of telecommunication by sector

In the prospective part of the 1993-study quality of telecommunications has been guesstimated as being ‘critical, increasing’ for both sectors (this also holds for the sector of European distribution).
To do a better job, one has to focus explicitly both on the Internet industry and the Internet infrastructure. There is, however, an important lesson to be learned from the past: there is no single overriding location factor, hence no simple model of location factors can be constructed. This should be taken as a warning against the myth of technological determinism associated with ICT (Offner, 2000; Drewe and Joignaux, 2002). Back in 1993, quality of telecommunications, as a critical location factor for services on the regional level, finished joint first alongside of presence of similar firms, availability of skilled labor and quality road/rail services (each of them scored 27% followed by supporting services, R&D, cost land/premises and cost of rented premises: each of them scoring 20%).

2. What exactly is the ‘Internet industry’?

According to Castells ‘…it would be too narrow a vision to consider the Internet industry as made up exclusively of Internet manufacturers, Internet software companies, Internet service providers and Internet portals. The commercial Internet is not just about web companies, it is about companies in the web’ (Castells, 2001, 213). This definition is not very helpful when it comes to empirical research. The European Commission has carried the definition problem a step further, at least conceptually, as shown in figure 1 (European Commission, 1998, 2).

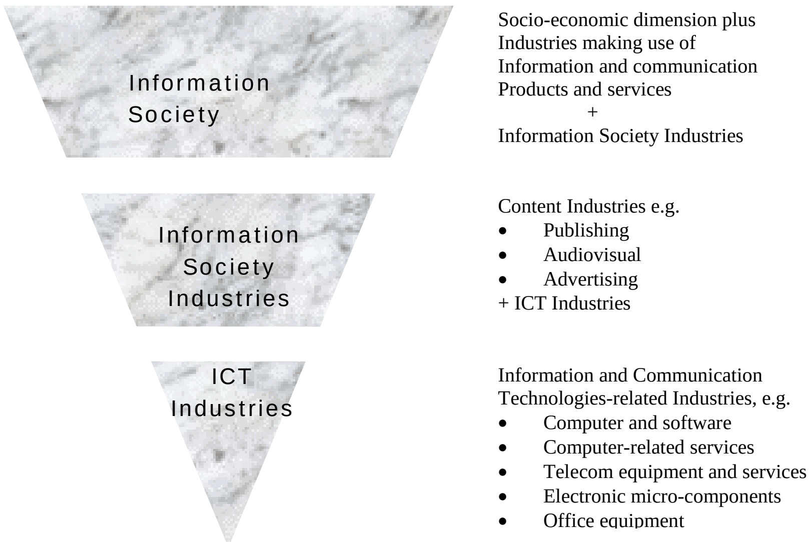

Figure 1: The Internet industry according to the European Commission

The Commission distinguishes three layers:

- the ‘Information Society’ includes both households and established business firms using ICT products and services
- ‘ Information Society Industries’ produce content on the net such as publishing, audiovisual or advertising
- ‘ICT industries’ sell a number of clearly defined products and services.

Unfortunately, the three layers were not measured. Existing (Eurostat) statistics do not yet allow of this.

One of the first attempts to measure the Internet industry has been made by Zook (1999). Het defines commercial Internet content business ‘…as enterprises involved in the creation, organization and dissemination of informational products to a global marketplace where a significant portion of the business is conducted via the Internet’ (Zook, 1999, 2). Using domain names (dotcom) to systematically analyze the Internet industry proved to be far from easy. The study deals with the relationship between domain name specialization ratios, on the one hand, and on the other hand, location coefficients for two clusters of industries:

- ‘Internet technology industries’: computer manufacturers, telecommunications and software
- ‘Informational industries’ such as media and publishing, entertainment, advertising and public relations and advanced users.

These clusters correspond to the Standard Industrial Classification and can therefore be measured by existing statistical data. There is an important conclusion to be drawn from the dotcom definition provided by the author:

‘…it encompasses firms from a wide array of traditional industries because the new methods for communication and distribution offered by the Internet have a wider impact than any one particular sector. In a very real sense, these firms are actively engaged with a technology that could restructure the current organization and boundaries of their industries’ (Zook, 1999, 2).

It would therefore be erroneous to refer to the Internet industry in terms of ‘new economy’ as opposed to ‘old economy’. It is Porter (2001) who has reached the same conclusion: ‘…the “new economy” appears less like a new economy than like an old economy that has access to a new technology… The old economy of established companies and the new economy of dot-coms are merging and it will soon be difficult to distinguish them' (Porter, 2001, 78). There are strategic imperatives for dot-coms as well as established companies. Dot-coms, for example, should create customer value and charge for it directly ('the end of free'), rather than relying on indirect forms of revenue. For established companies to be successful it is important to improve traditional activities by using the Internet and to develop new combinations of physical and virtual activities. Zook in a study of e-commerce in the US concludes, for example. '… that E-commerce is continuing to shift away from the entrepreneurial startup prevalent at the end of the 1990s to more established 'bricks and mortar' companies' (Zook, 2001, 19). What really counts are applications of Internet in the value chain. In order to identify them, one needs to 'unblackbox' any statistical aggregates of the Internet industry shifting to individual data.

The question to be addressed is how individual firms are positioned in the evaluation of information technology in terms of five overlapping stages: from early simple automated discrete transactions (such as order entry and accounting) to the upcoming connection of various activities and players in the value system and the optimization of its working in real time (see Porter 2001, 74-75).

Dot-coms, in a short time span have moved from expansion/explosion (1995-2000) via implosion (2000-2002) to consolidation/normalization (Ladendorff, 2003).

The hype is over, but the '… real legacy of the Internet is not the birth of thousands of new online companies but the transformation of existing businesses . We can see its signature on everything from mom-and-pop stores to multinational agglomerates ' (Barabási, 2002, 216).

3. The Internet infrastructure

The Internet infrastructure, although new and almost invisible can nevertheless be mapped and measured with less ambiguity than the Internet industry. The results presented here are based on an analysis of the European Internet (Drewe, 2002). A definite physical structure and hierarchy mark the Internet infrastructure. It is organized from the top of Network Access points (NAPs) down to Internet Service Providers (ISPs) via the intermediate levels of National Backbone Operators and Regional Network Operators. From NAPs down to ISPs the infrastructure serves the Internet business and consumer market most directly through ISPs. That is why our analysis has focused on the ISP backbone. The European transit backbone of MCI in 2002 has served as an example (figure 2).

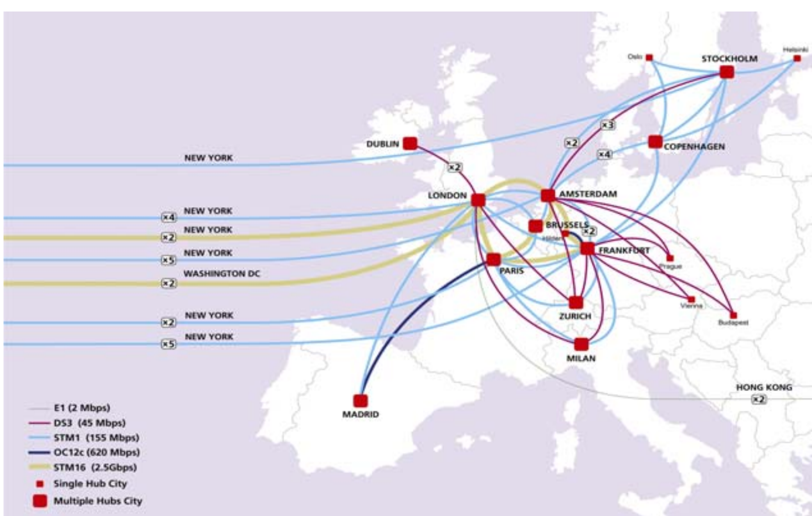

Figure 2: The European transit backbone of MCI

One counts 19 nodes, mainly capital cities and 40 links within Europe. There are also 10 overseas links. The position of a given node or city on the European net depends, first of all, on the number of direct, binary connections. The core of the net is composed of 4 cities: Frankfurt, Amsterdam, London and Paris, from 12 down to 8 direct connections (counting only the European links). If one includes the oversea links (to New York, Washington DC and Hong Kong). London becomes the number two at the expense of Amsterdam. In both cases. Stockholm appears as runner-up to the core group.

Of course, the importance of the links varies. To gain more insight into the position of a city, the direct connections need to be weighted for their capacity or bandwidth. And they need to weighted for multiple paths, too.

Bandwidth is measured in terms of megabytes of gigabytes per second (in mbps or gbps). Total bandwidth in Europe confirms the existence of a core group, however, with two major exceptions. The German node of Hilden (near Düsseldorf) being an important switchboard, occupies the fourth position. And London drops to the seventh position. But it is the uncontested number one if one includes the oversea links thanks to a 10 gbps connection with Hong Kong.

What about multiple paths? They depend on the proximity of a node to an Internet exchange point. The more ISPs are involved, the more important the exchange point. Whether an exchange point really offers multiple paths on the net, however, depends on peering agreements between the different ISPs. To peer means to cooperate, not to compete. It should be noted that a growing share of traffic is exchanged at private exchange facilities. And peering has become more of a problem as a few carrier 'fat cats' refuse to connect to thousands of smaller players. All of the 19 nodes have at least one Internet exchange point. Some have more, in particular Paris and London. The number of associated Internet service providers (which by the way is constantly changing) varies. LINX and AMS-IX are the biggest with respectively 130 and 127 ISPs. Some, not all of the exchange points publish a so-called peering matrix on the web (go to: http://www.ep.net/nap-seu2.html for more detailed information). It does not suffice to measure the Internet infrastructure in terms of direct connections, bandwidth and multiple paths. One also has to check the endowment with infrastructure for its actual performance, the actual traffic on the Internet. The question can be answered by traceroute (Dodge, 1999). The traceroute results can be compared to a weather report. The Internet may function smoothly in 'good weather' with physical distance between cities or nodes turning into milliseconds. But one may encounter 'bad weather', too, such as delays (roundtrip times well exceeding the average of 200 milliseconds). Moreover, information packets may get lost or even blocked, not reaching their destination. One packet of information equals 200 bytes of information which is the equivalent of 200 keyboard characters (see also Vaneeclo, 2003)

The functioning of the Internet, of course, also depends on the demand for sending data flows by companies of the Internet industry.

At the end of the day, the Internet functions as any traditional transport infrastructure in terms of interrelations between supply, demand and performance. Figure 3 refers.

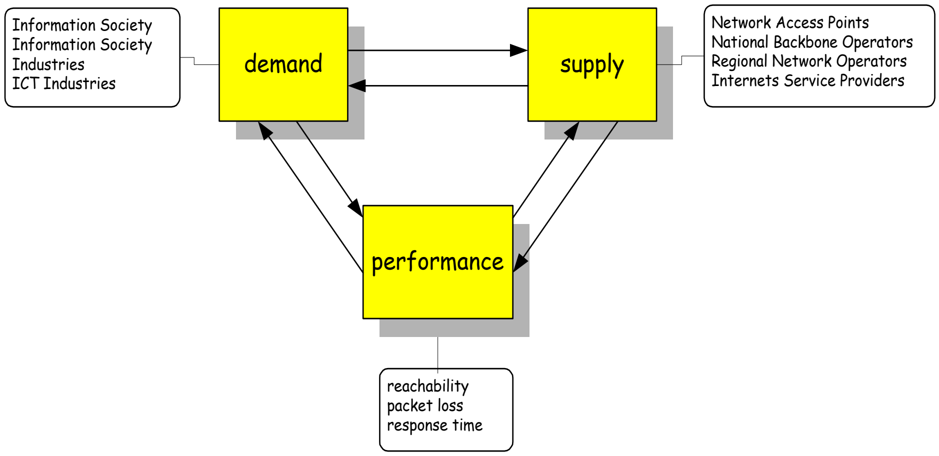

Figure 3: The Internet-interrelations between supply, demand and performance

It is important to note that a given assessment of connectivity needs to be updated regularly as the four components and level-cutoff points tend to change. Not only is bandwidth still increasing at international and domestic levels, one also notes that with the rise of so-called colocation facilities the relative importance of public exchange points is declining (colocation facilities are large data centers with high-speed connections to one or more backbone networks; facilities where many Internet and intranet servers are residing). And, finally, access possibilities and their speed continue to change dramatically; access possibilities such as ISDN, satellite or wireless optical.

4. Internet industry & Internet infrastructure: the connection

How important is the Internet infrastructure as a location factor for the Internet industry? How do the two connect? Some empirical evidence has been provided by Zook (1999). As mentioned before, he has established statistical relations between domain name (dot com) specialization ratio's and location coefficients for two clusters of industries (Internet technology and informational industries in the United States in 1998). There is a stronger relation between Internet content and informational industries than between Internet content and Internet technology industries: 82% of CMSAs, specialized in domain names are also specialized in informational industries – compared to only 32% of these same areas being specialized in the Internet technology cluster (CMSAs, by the way, stand for Consolidated Metropolitan Statistical Areas).

The link with the Internet infrastructure, however, is at best an indirect one. If one takes the three leading metropolitan regions for Internet content in the US (leading both in terms of absolute size and degree of specialization), two of them are NAPs (Network Access Points): San Francisco and New York. NAPs represent the highest level of the hierarchically structured Internet infrastructure. Los Angeles, the third leading center, is a Metropolitan Area Exchange (MAE). There are only three NAPs in the United States, the third of them being Chicago which surprisingly is not a leading region for Internet content. Could there have been other location factors at work that have impeded a more important role of Chicago back in 1998?

For a detailed analysis of the US Internet infrastructure see Gorman (1998) and Malecki (2002).

Some empirical evidence on the connection between Internet infrastructure and Internet industry is also available for the Netherlands (Louter et al, 2001).

The Randstad in general and Amsterdam in particular – one of the hubs of the European net - are confirmed as the favorite location of:

- so-called ICT-sensitive sectors
- ICT services
- ICT content.

A notable exception, however, is ICT hardware which is concentrated in the South-Eastern part of the country which includes Eindhoven. Take the map of ICT sensitive sectors as an illustration (figure 4). These sectors are (in decreasing order) of ICT sensitivity:

- communication (post and telecom)
- commercial services
- publishing and graphic industry
- insurance
- media and culture
- banks
- transportation services
- wholesale
- research.

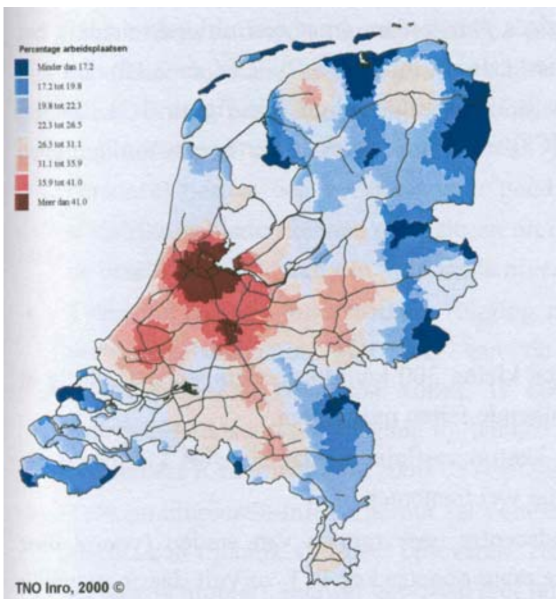

Figure 4: ICT-sensitive sectors in the Netherlands: % of total employment from: Louter et al (2001).

What do these examples tell us about the ICT infrastructure as a location factor for the Internet industry?

It is not possible to assign a causal explanation to the relationship between infrastructure and industry. They are only coterminous, covering or involving the same area. That direct connections, bandwidth and multiple paths are a critical location factor for the Internet industry in the largest sense – necessary but not sufficient – appears as a plausible hypothesis though. But to assume that the new infrastructure is the single overriding location factor for the Internet industry would amount to technological determinism. Earlier empirical evidence suggests that telecommunications rather are rather a complement to or at least not a strong substitute for face-to-face interactions (Gasper and Glaser, 1998). What is exchanged here is tacit knowledge as opposed to codified routine information. This exchange serves the purpose of conceiving new products or services (conceptual core skills), efficient production (competence) and organizing networks (connections). Companies that exchange only codified information using ICT regularly show a greater flexibility with respect to their location or the location of specific activities within the company (Traxler, 1999). Face-to-face interactions are more important for front than for back offices (Louter et al, 2001). Zook has found statistical evidence for Top 1000 websites and Top Internet firms in the US being related to venture capital investments. 'Rather than being an easily moved and fungible commodity, venture capital investing depends upon non-monetary inputs such as knowledge about possible investments and prefers to be close to companies in order to monitor and assist them (Zook, undated, 1). Money is also a social relation (Martin).

Hence when it comes to the choice of a location, there are two opposite forces at work:

' (1) The constant transformation of complex and unfamiliar coordination tasks into routine activities that can be successfully accomplished at remote but cheaper locations (e.g. commodification), and thus an ongoing tendency toward deagglomeration or dispersion of production.

' (2) Bursts of innovations that create new activities requiring high levels of complex and unfamiliar coordination, which generate burst of agglomeration' (Leamer and Storper, 2001, 3-4).

According to the authors the geography of the Internet ago is thus double-edged as Leamer and Storper, 2001, 30.

Both the evolution of the Internet industry and the Internet infrastructure seems to move into the same direction. Forces for deagglomeration in mass production are likely to be more than offset by tendencies toward agglomeration as far as more specialized and differentiated production is concerned. 'All in all, F2F contact is at the heart of a key advantage of the city today, its "buzz" (Storper and Venables, 2001, 1). And the Internet infrastructure – as demonstrated in section 3 for the European transit backbone – manifests a 'tentative relation with the urban hierarchy' (Malecki). These are moves toward cities which debunks the myth of urban dissolution, of the Internet making cities obsolete.

5. Matching networks

How important is the Internet infrastructure as a location factor for the Internet industry? Even with more empirical evidence one can hardly expect to find a clear-cut, unilateral causal relationship. As said before, the Internet functions as any traditional transport infrastructure in terms of mutually interacting supply, demand and performance. Figure 3 refers. Both the Internet infrastructure and the Internet industry represent networks that are hierarchically structured and composed of nodes and links. MCI's European transit backbone is a clear illustration as far as the infrastructure is concerned. With regard to the industry, there is already a classic notion of networks in terms of input-output linkages, including access to markets (Storper and Venables, 2002). Face-to face contact, considered by the same authors as a ‘major missing element in the theory of agglomeration and urban growth today’, is a network concept, too. It is about social networks within the (Internet) industry.

To deal more adequately with the Internet infrastructure as a location factor for the Internet industry asks for a conceptual innovation. The ‘new science of networks’ (Barabási) provides a promising avenue of research. Barabási is a physicist who does research on complex networks. ‘The construction and structure of graphs is the key to understanding the complex world around us’ (Barabási), 2002, 12). Graph theory is indeed the basis of our understanding of the complex Internet infrastructure (see Gorman, 1996 undated; Drewe, 1999). And the new science of networks also applies to the network economy as shown by Barabási (2002, 199-217).

What are the key elements of this way of looking at infrastructure and industry? Networks, in general, manifest a power-law degrees distribution. There are very many nodes with only a few links and only a few hubs with a large number of links (figure 5 refers).

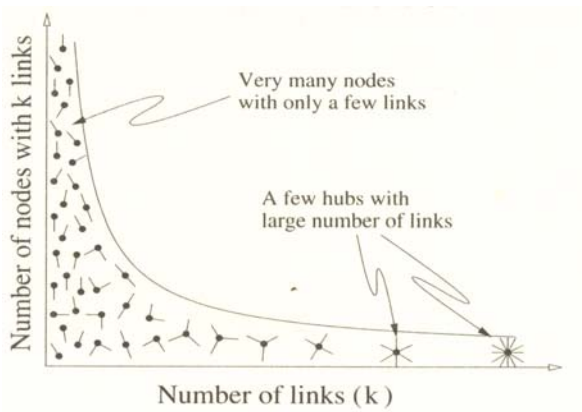

Figure 5: Power law distribution

Visually this is similar to the air traffic system in which a large number of small airports are connected to each other via a few major hubs. This also holds for the Internet infrastructure in general and for MCI’s European transit backbone as shown by figure 6.

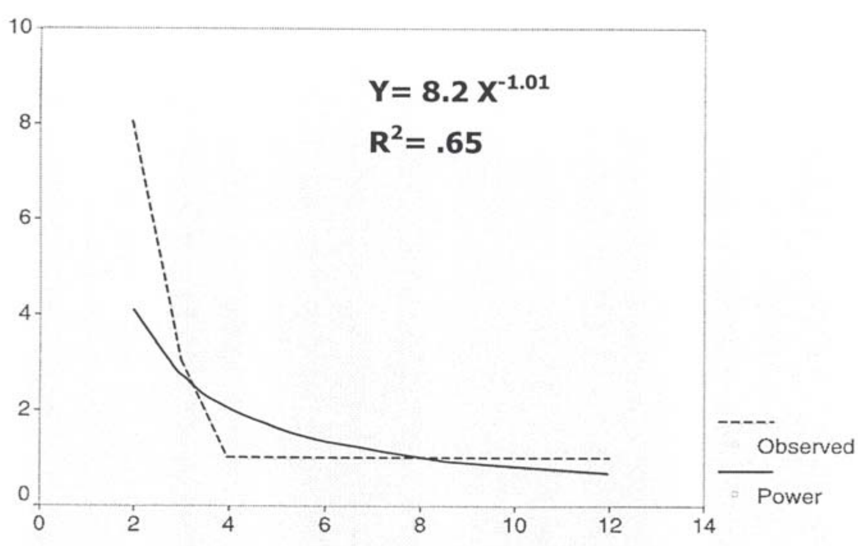

Figure 6: Power law distribution MCI’s European network

Whether the Internet industry is structured likewise cannot be established because of lack of suitable data. But indirect evidence is available that points into this direction, for example:
The spatial distribution of the top 1000 business firms in Europe (figure 7 from Bundesamt, 2002, 4). This also holds for similar indicators as shown by Rozenblat and Cicille (2003).

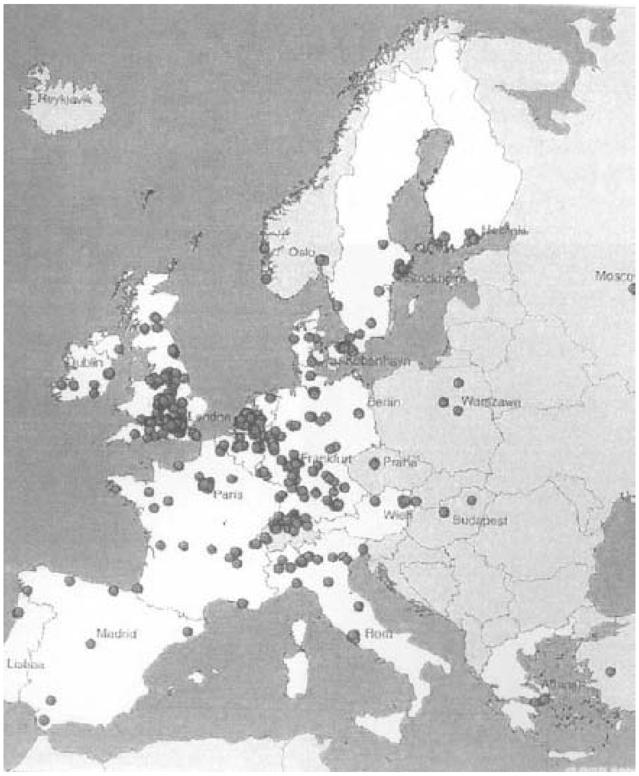

Figure 7: The location of the top-1000 business firms in Europe

How do networks grow and evolve? Here another concept comes into play: preferential attachment, meaning that links are added at a higher rate to those nodes that are already heavily linked. But one also has to take into account that each node has a certain fitness or every network has its own fitness distribution which is related to competition in complex systems. A fitness connectivity product is introduced standing for the product of a node's fitness and its number of links. It is referential attachment that induces 'a *rich-get richer* phenomenon that helps the more connected nodes grab a disproportionately large number of links at the expense of the latecomers'. And – in the case of a power-law degree distribution – 'networks display a fit-get-richer behavior, meaning that the fittest node will inevitable grow to become the biggest hub'.
These concepts need to be operationalized for both the Internet infrastructure and the Internet industry. It looks as if this will be easier for the former than for the latter. The infrastructure fitness of a node can be rather easily measured by its performance in relation to the demand (figure 3). Difficulties in measuring the industry fitness are related to the problem of defining them. If one gives up the new/old economy dichotomy and adopts a broad definition of the Internet industry, one has to deal in fact with the entire economy. It would therefore be easier and more useful to conduct case studies about clusters of economic activities demarcated in terms of their position in the evolution of ICT (according to the stages distinguished by Porter, 2001). Lessons from past rounds of infrastructure improvement, in especial road infrastructure improvement, teach us that the matching of infrastructure and industry networks

should be lead by the demand side, ie the Internet industry instead of being, in a voluntaristic spirit, supply led which is a variant of technological determinism or simply wishful thinking.
Networks work for winners, but ‘how do latecomers make it in a world where only the rich get richer?’ Which is another important question raised by the new science of networks. It will be addressed in the final section.

6. Many are called, only a few are chosen?
This final section is about the future perspectives of ‘non-hub’ or weakly positioned nodes (cities or regions). Influenced by competition or the paradigm of competition, those nodes are pressured to attract mobile investment and to meet with corresponding infrastructure requirements. This is valid for all types of mobile investment and infrastructure. The Internet industry and its infrastructure are no exception to the rule. Hit parades of places, produced by the ‘top-of-the-pops school of geography, tend to put pressure on decision-makers. Who does not want to be, for example, a world city; if not an Alpha, than at least a Beta or Gamma world city? (according to Beaverstock et al, 1999). There is also a socio-Darwinistic undertone to this as only the fittest are supposed to survive. But, as can be learned from the new science of networks, there are different degrees or levels of fitness. As far as the match between the Internet industry and the Internet infrastructure is concerned, the important thing is to achieve a balance between demand and supply on *all* levels. Demand is the driving force for the growth of the networks involved. Dang Nguyen (2002) has developed an operational method for this focusing on broadband ICT. It is a two-step process with supply following demand:

- evaluation of medium-term professional needs for broadband services, both public and private in a given city or region,
- calculation of investment and operational costs of providing the necessary broadband networks.

This method has already been applied in France in a number of cases with territorial authorities as main actors.
Demand as a driving force, in this day and age is not predictable as the recent dot.com downturn has demonstrated. And the future of the Internet is just one of many sources of uncertainty. How to deal with uncertainties on the local or regional level? Scenarios can play an important part in the management of uncertainties helping to identify levers of action. Recently, a French group has developed scenarios with regard to networks of ICT, energy and transport. The group is convinced that, on the road to 2020, the governance of territories depends on the mastering of (these) networks (see Crozet and Musso, 2003). A first scenario, called Global, introduces the external shock of globalization. One way of reacting to this shock is described by the so-called Glocal scenario. Translating these scenarios for ICT pictures a world marked by a power-law degree distribution (a few top and many smaller companies for the Global scenario. And, for the Glocal scenario, a dual world of top companies and local innovative milieux or environments. It is the latter that provide an important lever of action for cities or regions, a way of managing uncertainties. The concept of local innovative milieux ties in with the work of GREMI, the Groupe de Recherche Européen sur les Milieux Innovateurs’. See for example Crevoisier and Camagni (2000) for the fifth edition of GREMI dealing with urban milieux, but compare also the other editions (publications): <http://www.unine.ch/irer/Gremi/accueil.htm> Innovative milieux, in brief, are based on the synergy of business firms, territorial authorities and knowledge centers. Milieux are about local interactions which promote technological innovation (Storper and Venables, 2002): new or improved goods, services and processes. To produce these innovations the economically relevant knowledge goes far beyond ‘technology’. It also comprises design,

management, organization, marketing, logistics, administration and finance. Moreover, the very creation of an innovative milieu is essentially a social innovation. See for example Klein and Fontan (2003).

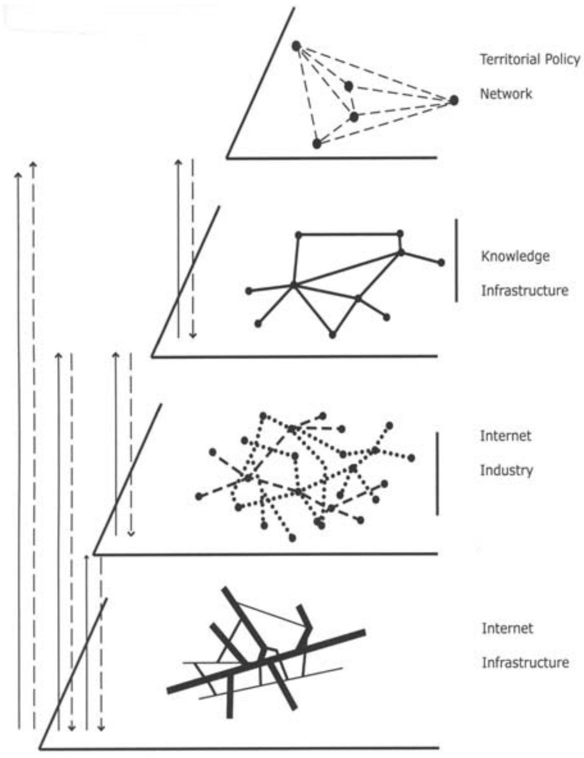

Figure 8: Four Networks

With the introduction of innovative environments, two networks are added to those considered so far, ie networks of territorial authorities and networks of knowledge centers such as universities or, in general, R&D institutions (figure 8). This complicates the task of matching. It may help to do this per cluster of economic activities. Clusters are very popular today. But they should not be used uncritically. It is a matter of developing cluster-based strategies, measuring cluster development, critical success factors, contributory factors, and complementary measures and the policy environment (according to Ecotec, 2004). See also the related French concept of local productive systems (DATAR, 2001).

But once again, the matching must be led by demand not by supply. This can be problem as knowledge centers and in particular universities tend to fever a supply-led approach. Back in 1994 the European Commission had every reason to recommend a methodology for so-called Regional Technology Plans according to which the assessment of the regional R&ID and innovation demand should be tackled *before* the analysis and assessment of regional technology supply. ‘Various studies have pointed out… that the approach followed in many regions was a top-down (and technology push) approach rather than a more bottom-up (and demand-pull) approach, which takes into consideration the R&TD needs of the local firms’ (European Commission, 1994, 13).

Both the Internet industry network and the Internet infrastructure network have no territorial boundaries and knowledge centers, too, may engage in transnational networking. Therefore it is important for territorial authorities to follow in lockstep.

Various European programs are promoting international cooperation focusing, in particular on ‘latecomers’ (and SMSEs) involving the four networks. ‘Regional programmes of innovative actions’ have three priorities:

- to encourage regional economies based on knowledge and technological innovation,;
- to stimulate the information society at the service of regional development,;
- to strengthen regional identity and sustainable development (European Commission, 2002, 4).

But as always: the proof of the pudding is in the eating…

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