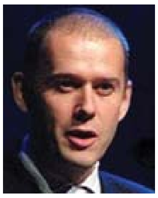
The Interplay between Competition and Co-operation: Market Players' Incentives to Create Seamless Networks[1)]

ØYSTEIN FOROS, BJØRN HANSEN



Øystein Foros is Professor, Norwegian School of Economics and Business Administration (NHH)

Bjørn Hansen is Senior Research Scientist, Telenor R&I

Competing network providers typically have to co-operate in different types of interconnection and infrastructure sharing arrangements (e.g. roaming) in order to provide seamless communication to customers. Thus, firms being active in the same market have to compete in some dimensions and co-operate in other dimensions. We discuss the interplay between competition and co-operation, and show some potential trade-offs between co-operation and competition. The trade-offs have implications for both business strategy and regulation policy. In some cases (but not all) firms can arrange their co-operation such that they are able to soften competition and increase prices. Whether such effects are present or not depends on technology and market characteristics. It is accordingly necessary to carry out case by case analyses in order to assess these issues

1 Introduction

Technological developments enable network convergence, and what used to be diverse communication networks can be merged into common platforms designed for the integration of the basic communication channels voice, video and data into a streamlined high-bandwidth communication environment supporting new technologies and new integrated applications. This makes it possible for users to communicate with each other and access information across networks in a seamless manner. Interactive media will increase customers' ability to select content, format, as well as time and place of consumption. However, seamless communications depends on the interplay between technological, economic, and cultural features. Even though seamless networks are technically feasible, it is not obvious that this will be neither the market outcome nor the optimal outcome. Economic incentives and business models will be of crucial importance in determining the degree of seamlessness.

Network providers are often both competitors and complementors. On the one hand, they compete for the same clientele in their attempt to attract customers. On the other hand, they are complementors to the extent that a quality enhancing investment by one provider may benefit customers connected to the rival's platform. An internet backbone provider who improves its platform functionality will also increase the quality of the rivals' backbones due to peering agreements (interconnection) between the backbone providers. Analogously, mobile phone operators share their networks through roaming agreements. Such platform sharing agreements (interconnection, peering and roaming) refer to the degree of compatibility chosen by network providers. All these examples emphasize the close interplay between technological features and the market players' abilities and incentives to create seamless networks.

In communication networks the utility of being a member of a particular network typically increases with the network size. This relationship is by some called Metcalfe's law (see Figure 1).[2)]

In economic theory, the phenomenon is called network effects and was first analyzed by Rohlfs (1974). Similarly to Metcalfe, Rohlfs focuses on the problem of starting up a new communications service, or more generally the existence of multiple equilibria. In contrast to Metcalfe, Rohlfs does not postulate a squared relationship. Rohlfs' work does however not take into account that there may be competing firms offering the network service. This is in contrast to Katz and Shapiro (1985) who analyze the implications of network externalities within a competitive environment. Katz and Shapiro pay particular attention to the choice of compatibility. They find that a large (dominant) firm may prefer too little compatibility, a small firm prefers too much compatibility, and the industry would jointly prefer too little compatibility.[3)] This last result is in contrast to Farrell and Saloner (1992) and Foros and Hansen (2001). This difference is

1) *Øystein Foros thanks SNF project no 1304 "Seamless Infrastructures, Business Models and Cultural Diversity", funded by The Research Council of Norway, for financial support. Bjørn Hansen thanks Telenor R&I for financial support. The article is written as an invited contribution to* Telektronikk *after the authors were awarded "Telenor Research and Innovation Prize 2007".*

2) *According to Simeonov (2006), in the early 1980s, Bob Metcalfe, the inventor of Ethernet, wanted to convince firms that it would be of large value to install a (Ethernet based) local network. The illustration of the value of the network being proportional to the square of the number of nodes (N^2) was used to motivate potential buyers. Later George Gilder coined this relationship Metcalfe's law.*

3) *The seminal analysis by Katz and Shapiro has been extended in a number of ways in the literature. A literature overview can e.g. be found in Liebowitz and Margolis (2002).*

ISSN 0085-7130 ©Telenor ASA 2008

explained by different assumptions regarding downstream competition. In this article we consider different cases and we demonstrate that the firms' incentives to provide seamless interfaces between their networks indeed depend upon technology and market characteristics.

The rest of the article is organized as follows. In section 2 we discuss co-operation in order to achieve economies of scale and scope. In section 3 we discuss market experience and firms' incentive to create seamless networks. Finally, in section 4 we provide some concluding remarks.

2 Co-operation to Achieve Economies of Scale and Scope

Deregulation and fast technological change have resulted in a rapid transformation of the telecommunications industry. The initial steps of the deregulatory process were, in most countries, designed so that newcomers would invest in some parts of the production chain and then rely on getting access to other parts of the production chain from a regulated incumbent. The terms and conditions for such access have typically been regulated. The rationale for regulating access is that the regulated segments are considered as bottlenecks, i.e. it is prohibitively costly to duplicate already installed capacity. The local loop in the fixed network is a classical example. The copper cable connecting residential customers to the network will typically have sufficient capacity to carry all telephony and internet related traffic. Thus it would be socially wasteful if newcomers had to install new cables to reach the household. This kind of access problems is one-way in the sense that newcomers need access but incumbents do not.

One-way access problems have been discussed in the literature, at least since the US Supreme Court's 1912 Terminal Railroad decision (considered as the origination of the essential facilities doctrine). Two-way access problems relates to situations where each network controls an asset, customers and/or capacity, which is valuable to the other party. Introductions and overviews of this literature and its applications to telecommunications can e.g. be found in Laffont and Tirole (2002) and Armstrong (2002).

In economic theory it is common to distinguish between increasing returns on the supply side and on the demand side, as illustrated in Figure 2. There are increasing returns on the supply side if it is cost efficient to produce several different products within one and the same firm (economies of scope) or if the average costs fall when each single product is produced in large series (economies of scale). Due to the fact that it has been difficult to separate services from

The systemic value of compatibly communicating devices grows as the square of their number:

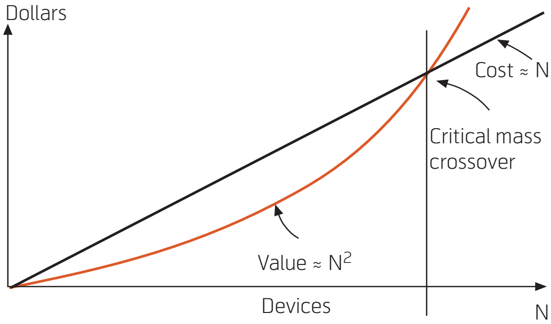


Figure 1 Metcalfe's law as illustrated by http://vcmike.wordpress.com/2006/08/18/metcalfe-social-networks/

the underlying infrastructure, economies of scope have historically been important in telecommunications. This kind of economies of scope is presumably smaller within the internet, due to the properties of the layered internet structure. In contrast, there is little doubt that the supply side economies of scale are significant. This is true both with respect to investments in infrastructure and in development of new services. Technologies like 3G mobile telephony and fiber-optics are characterized by considerable supply side economies of scale, and thus there are potential gains from making networks co-operate on the supply side.

Economies of scope on the demand side, which are placed in the lower right hand corner of Figure 2, are commonly described by the term complementarity. For our purpose we can say that two goods are complements if a price reduction or a quality improvement on one of them increases the demand for both goods. A lower price on internet browsers, for instance, is likely to stimulate sales of operating systems, and vice versa. This is an insight that Microsoft has taken advantage of. Economies of scale on the demand side are commonly named *network effects* and take place when the unit value of a product or a system increases with the number of users as illustrated in Figure 1.[4)] Willingness to pay for network membership typically increases with the number of communication partners. Thus there are potential social gains from making sure that networks interconnect in order to facilitate communication across networks.

Since there are gains from co-operation, one would expect that networks, being free to negotiate con-

	Scale	Scope
Supply side	Decreasing average costs	Gains from joint production
Demand side	Network effects	Complementarity

Figure 2 Increasing returns on the supply and demand side

ISSN 0085-7130 ©Telenor ASA 2008

tracts, would be able to design efficient contracts. However, networks are, at the same time, supposed to compete for customers. Thus there is a danger that networks design their access agreements in a way that softens competition. Furthermore, due to the network effects, if networks do not interconnect, one may experience "network tipping", i.e. that all consumers join one of the two networks and thus that one of the networks succeeds in gaining a monopoly position. Thus a firm may deny two-way access in an attempt to foreclose the market. At the outset we can accordingly expect that unregulated two-way access will in some cases yield efficient outcomes, in other cases there is too much access, and in yet other cases too little. It is accordingly not evident that regulatory intervention is required, and furthermore, if such intervention is required, it is likely that the regulatory design should depend upon characteristics of the market under consideration.

3 Market Experience: Network Providers' Incentives to Create Seamless Networks

In this section we will discuss some relevant two-way access problems for electronic communication services. We will comment on technological characteristics as well as market outcomes with respect to two-way access. Finally we will also briefly discuss the degree of regulatory intervention behind the outcomes.

In the literature on two-way access the focus is typically on shared market equilibrium. Parameter-restrictions are imposed in order to make sure that this outcome is achieved. Given these restrictions firms will typically gain from providing access. If, however, the parameter restrictions are violated, or some firms expect them to be violated, then the market will tend to tip in one or the other direction. Thus there will be competition *for* the market instead of competition *in* the market. Firms competing *for* the market will not necessarily enter voluntarily into two-way access agreements. Below we will argue that market observations indeed lend support to this assertion.

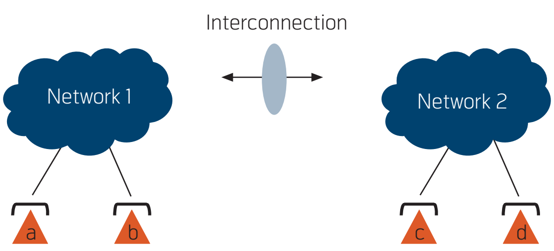


Figure 3 Interconnection

3.1 Interconnection in Voice Telephony

Without interconnection consumers on different networks can only make calls to other consumers on the same network; on-net calls. Due to interconnection consumers on a network can call consumers on another network; off-net calls. An off-net call from say consumer *a* to consumer *d* in Figure 3 can be divided into two parts. The first part is origination, i.e. to convey the call from the caller, consumer *a*, to the interconnection interface. The second part is termination, to carry the call from the interconnection interface to the receiver, consumer *d*.

Interfaces for interconnecting line-switched fixed and mobile telephony are well established and all firms providing fixed and mobile telephony are typically directly or indirectly interconnected to all other networks. This ubiquitous interconnection is the result of a long historical process. Currently it is common to make ubiquitous interconnection a requirement in the license for telephone companies.

There are some examples of non-interconnected phone companies from the early days of telephony history. In the period 1881 to 1886 there were two competing phone companies in the capital of Norway, Kristiania.[5] The two companies rolled out parallel access networks and they competed head to head. It was not possible to make calls from one network to the other. The period characterized by access competition ended in 1886 because the local authorities forced the two companies to merge by denying the companies licenses to install new cables until they merged. According to Rinde (2005), p. 146, it was in particular the merchant community of the city that wanted the two firms to merge. The arguments were twofold; they wanted all phones to be interconnected and they wanted to avoid duplication of civil works from network roll out. Similarly, in the period between the end of the Bell patents in 1893 and the Kingsbury commitment in 1913, a number of phone companies independent of the Bell system were denied interconnection (Brock, 2002). During this period, phone companies competed head to head in the US and network effects were used strategically.

[4] *It is common to distinguish between direct and indirect network effects. For instance, we have direct network effects between owners of telephones; the more people that have installed a telephone, the greater its value (this is also labeled a* real *network). An example of indirect network effects is that between users of PCs; a large number of PC users imply that there will be a large demand for PC compatible software. This in turn tends to generate a large variety of PC software, which increases the user value of the PCs (this is an illustration of a* virtual *network).*

[5] *The name of the city was changed to Oslo in 1924.*

During this early period there was a notable difference in the speed of telephony adoption in areas with local competition as compared to areas characterized by local monopolies. As an example, according to Rinde (2005), the rate of telephony adoption in Kristiania was twice as high as the rate of adoption in Copenhagen, which had a local monopoly. This example emphasizes a potential tradeoff between competition and co-operation. Without an interconnection agreement market shares matter, and this may certainly increase the degree of competition between the firms. They may reduce the end-user prices and/or invest into higher coverage (and other quality dimensions) in order to gain a competitive advantage. Due to network effects, the customers will prefer to connect to the firm with the largest market share, all other things equal. With seamless interfaces, customers do not care about the firms' market share when they decide where to subscribe.

As mentioned above, interfaces for interconnecting line-switched fixed and mobile telephony are now well established and all firms providing telephony are typically directly or indirectly interconnected to all other networks. While the quality level for off-net communication equals the quality level for on-net communication, termination charges are probably the most hotly debated issue related to interconnection for voice telephony. At present, the termination rates of incumbent fixed operators are subject to regulation in both Europe and the US. In the US, the Telecommunications Act of 1996 requires reciprocity of termination rates (see e.g. DeGraba 2003). Thus, fixed-line entrants are required to charge the same termination rate as the incumbent. In Europe reciprocity is not currently embedded in the regulatory framework, and the national regulators have to decide whether termination rates should be reciprocal or not. Recently, the European Commission view is that we should have a development towards reciprocity of termination rates also in Europe.

There are in particular two features of the termination markets which raise the concern of excessive pricing in an unregulated market. First, when termination rates are determined unilaterally, each provider has a monopoly with respect to offering termination to their own subscribers (see e.g. Armstrong, 2002, Laffont, Rey and Tirole, 1998a, 1998b, and Vogelsang, 2003). Second, when prices differ between networks, consumers are often ignorant about the price they actually have to pay – labeled consumer ignorance (Gans and King, 2000). Consumers may then be likely to base their demand on average prices. All other things equal, this will induce the firms to increase their termination prices to an inefficiently high level. The reason is that an increase in the termination price from network A will only affect the demand for network A through the average price. In an unregulated environment, providers will then have incentives to set high termination prices.

As a consequence, the theoretical literature based on these assumptions show that there is a need to regulate termination tariffs for all providers, and the majority of this literature suggests that this should be done through symmetric termination prices. Armstrong (1998), Laffont, Rey and Tirole (1998a, 1998b) consider models where termination tariffs are set at stage 1, and at stage 2 the firms compete in retail prices. A major insight from the work by Laffont Rey and Tirole (1998a,b) and Gans and King (2001) is that the incentives with respect to setting the price of termination depends upon the contracts in the downstream market. When there is uniform pricing in the downstream market, the mobile firms can use the termination rate as an instrument to soften competition. By raising each other's marginal cost they reduce the competitive pressure. In Laffont Rey and Tirole (1998b) it is demonstrated that this effect changes if one considers two-part tariffs in the downstream market. Then the profits of the mobile firms are independent of the termination rate. Finally Gans and King (2001) consider network based discrimination, i.e. the price for on- and off-net traffic being allowed to differ, and find that a low termination rate may be used as an instrument for increasing profits. Observed mobile networks typically offer a menu of contracts where they simultaneously offer uniform prices and two-part tariffs both with and without network based discrimination. Thus the theoretical literature hardly provides any guidance as to the incentives of mobile firms in setting symmetric termination rates. An empirical investigation of the relationship between termination rates and profits in the European mobile industry by Andersson and Hansen (2007) lends support to the profit neutrality result by Laffont Rey and Tirole (1998b).

Extensions to a framework where firms are asymmetric are provided by Carter and Wright (2003), Peitz (2005a, 2005b) and Dewenter and Haucap (2005). Dessein (2003) considers consumer heterogeneity and Jeon, Laffont and Tirole (2004) analyze the implications of willingness to pay for receiving calls. Gans, King and Wright (2006) provide a recent comprehensive overview of this theoretical literature.

3.2 Interconnection in the Internet

Interconnection in the internet is arranged quite differently from telephony. It is a hierarchy, and the hierarchy and its associated interconnection contracts have evolved as a result of market forces and not as the result of regulatory intervention. The internet is accordingly an interesting case for comparison.

The internet is a set of interconnected data networks all using the same system of addresses and protocols enabling communication between users on the different networks. Interconnection is evidently a key element in this architecture. There are two main types of interconnection arrangements in the internet, peering and transit (see e.g. Kende 2002). The internet hierarchy is often divided into three levels or tiers. Each level is characterized by the types of interconnection agreements they are engaged in.

Peering is a barter arrangement where two networks mutually agree to exchange traffic free of charge. The traffic being exchanged is between customers (of customers) on the two peering networks. Peering networks do not accept traffic to third parties (traffic from one peer to other peers). The other type of contract is transit where one network is paid for accepting any traffic to and from its contract partner, i.e. also to third parties. With the terminology introduced earlier in this chapter peering can be characterized as two-way access, and transit is one-way access.

At tier 1 of the hierarchy we find the global internet backbones; such networks are only engaged in peering arrangements. At tier 2 we find networks with a mix of contracts, both peering (typically regionally) and buying transit from one or more of the tier 1 networks. Finally a tier 3 network is not engaged in peering. An overview of the peering arrangements various networks are engaged in can be found at http://www.peeringdb.com/. There is unregulated, seemingly well functioning competition at each level in this hierarchy. Local access is however an exception. Local loop unbundling as well as other measures are used by regulators to facilitate competition at this level too.

In Norway we have recently had a hot debate due to Telenor's decision not to participate in the NIX[6] for a period in 2006. In the late 1990s the topic of major providers' incentives to degrade the interconnection quality towards smaller ISPs was also hotly debated. A common view among policy makers was that big firms usually would have the abilities and incentives to degrade interconnection quality towards smaller ISPs. In 1998 two tier 1 networks, MCI and WorldCom merged. The merger would result in a significant increase in market concentration among tier 1 networks, and both European and US anti-trust authorities approved the merger under the condition that the Internet business of MCI was divested. The concern was that the merged firm would degrade interconnection quality towards smaller rivals (see FCC, 1998, Cremer et al., 2000, and Economides, 2006).

Motivated by the Norwegian market structure, Hansen and Foros (2001) provide an explanation for voluntary peering agreements between ISPs by showing that the ISPs can reduce the competitive pressure by increasing interconnection capacity.

Foros and Hansen (2001) consider a two-stage game between two ISPs. In the first stage the two ISPs choose the level of compatibility (i.e. quality of a direct interconnect link between the two networks). In the second stage the two ISPs compete in prices à la Hotelling. Foros and Hansen then show that ISPs can reduce the stage 2 competitive pressure by increasing compatibility due to the network externality. The firms will thus agree upon a high compatibility at stage 1. When it is costly to invest in compatibility, Foros and Hansen find that the firms overinvest, as compared to the welfare maximising investment level (see also Farrell and Saloner, 1992).[7]

In contrast to Foros and Hansen (2001) and Farrell and Saloner (1992) Cremer, Rey and Tirole (2000) find that dominant firms may have incentives to degrade interconnection. There are a number of differences with regard to assumptions between the results. By its very nature, it is difficult to make general predictions, and case by case analyses are needed to evaluate whether the providers have incentives to achieve seamless interfaces between their networks. We should also emphasize that the above-mentioned results show that seamless interfaces need not benefit customers.[8]

3.3 Infrastructure Sharing in Mobile Telecommunications

In most industrialized countries, mobile firms are upgrading their networks to 3G.[9] The cost of obtaining a given geographical coverage is much higher on 3G as compared to 2G. Thus the cost of introducing 3G is significant. Competing networks are rolling out networks in parallel. There are accordingly evident potential gains from co-operation at the investment stage.

Internationally there is considerable variation with respect to whether mobile firms co-operate in this dimension. Sweden is a particularly interesting

6) *Norwegian Internet Exchange, see http://www.uio.no/nix/*

7) *There are some notable differences between Foros and Hansen (2001) and the Farrell Saloner (1992) model. In contrast to Farrell and Saloner, Foros and Hansen consider vertical differentiation; the suppliers share the cost of compatibility and this functionality is bundled into the product.*

8) *Roson (2002) compares Foros and Hansen (2001) and Cremer et al. (2000).*

case.[10] In December 2000 four 3G licenses were issued in Sweden based on a beauty contest. All the firms being awarded a license promised very aggressive network investments. The dominating firm, Telia, was not that aggressive in the beauty contest and was accordingly not granted a license. Soon after the licenses were issued, Telia formed a joint venture with the second largest mobile firm, Tele2. The joint venture, called Svensk UMTS nät AB, rolled out a 3G network based on the license awarded to Tele2. Both Telia and Tele2 offer 3G services to end-users based on capacity from the joint network. The Swedish Competition Authority (2002) approved the co-operation under a set of conditions. The Swedish case implies a high degree of co-operation at the investment stage. Less extreme examples of co-operation are Germany and the UK. Taking Germany as an example, the European Commission[11] has approved the sharing of sites, and they have approved national roaming for a limited time period.

Both the Commission, in its decision on roaming in Germany, and the competition authorities in Sweden[12] try to balance gains from co-operation against the possible adverse effects on competition in the end-user market. In both cases the approval of co-operation is time limited. From the decisions in UK and Germany it is quite explicit that the firms will not be allowed to co-operate on roaming after the approval expires. This is in contrast to Sweden.

Foros, Hansen and Sand (2002) analyze infrastructure sharing (national roaming) in the market for mobile telecommunications. Firms undertake quality improving investments in network infrastructure in order to increase geographical coverage, capacity in a given area, or functionality (e.g. 3G). Prior to investments, roaming policy is determined. Foros, Hansen and Sand show that under collusion at the investment stage, firms' and a benevolent welfare maximizing regulator's interests coincide, and no regulatory intervention is needed. When investments are undertaken non-cooperatively, firms' and the regulator's interests do not coincide. Contrary to what seems to be the regulator's concern, firms would decide on a higher roaming quality than the regulator. The effects of allowing a virtual operator to enter are also examined.[13]

The quality improvements from investments in mobile networks can take the form of improved capacity and/or improved coverage. Foros et al. (2002) are focusing on capacity. This is in contrast to Valletti (2003) where the emphasis is on coverage as a means to vertical differentiation. The duopoly equilibrium in the Valletti model is characterized by maximum differentiation. One firm chooses maximum coverage, the other chooses minimum coverage (minimum coverage is typically specified in the license). In Valletti (2003) national roaming is unprofitable for the firms. Thus roaming is only profitable if the firms collude. This result is in contrast to Foros et al. In their review article Gans et al. (2006) argue that the Valletti result is due to simplifying assumptions.[14] Furthermore, observed market behavior indicates that mobile firms tend to set similar coverage.

The market experience reviewed above revealed that mobile firms in several countries indeed co-operate over roaming and investments. Furthermore, the regulating authorities, given a set of conditions, have approved the co-operation. Given the approach taken by the regulating authorities an interesting issue to analyze would be to look into the implications of allowing co-operation only in a limited time period.

3.4 Internet-based Applications

The internet enables ubiquitous data connectivity. Thus any pair of users can in principle communicate, but they need interoperable applications to facilitate this communication. E-mail is an example of an application (or service) running over the internet such that any e-mail user can communicate with any other e-mail user. This is in contrast to other communications services provided over the internet where interconnection is an issue.

The necessary architecture for providing messenger[15] services and voice over the internet (VoIP) has some important similarities. In both cases *servers*[16] contain databases linking user names (or phone numbers) to IP addresses such that a user, being logged on, can be reached irrespective of physical location. When a communication session is initiated the servers feed address information to the necessary

9) *The standard for 3G mobile networks being deployed in Europe is called UMTS; Universal Mobile Telecommunications System, whereas GSM (Global System for Mobile Communications) is the 2G standard.*

10) *See Hultén et al. (2001) for a description of the 3G license process in Sweden.*

11) *See European Commission (2003).*

12) *See Swedish Competition Authority (2002).*

13) *Gans et al. (2006) based their discussion of the implications of national roaming on results from Foros et al. (2002).*

14) *Gans et al. (2006) argue that the Valletti result is due to the assumed pure vertical differentiation. If there is horizontal differentiation in addition to the vertical differentiation, then firms may set identical coverage and instead compete in other dimensions.*

15) *A messenger platform enables users to engage in text based real-time dialogues over the internet.*

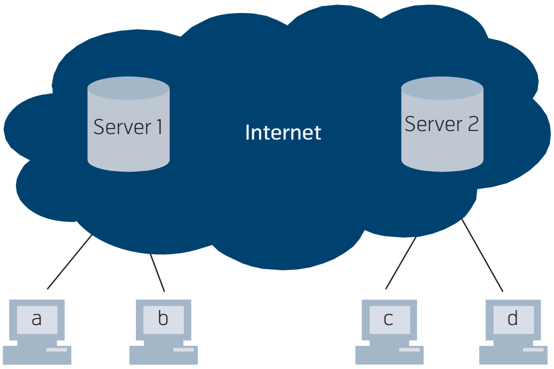


Figure 4 Real time communication on the internet

systems such that the actual media stream (e.g. the voice call) is not passing through the server.

Technically, direct interconnect between networks requires that servers are able to "talk to each other" in order to exchange address information, and that end-systems are sufficiently compatible (e.g. that the technology for transferring voice to IP packets and back are interoperable).

In Figure 4 we have illustrated two telephony networks on the internet. User *a* and user *b* as well as server 1 belong to network 1. When user *a* makes a call to user *b*, the software on the originating computer will communicate with the call-server in order to obtain the necessary address information. Provided with this information, the software on computer *a* establishes direct contact with the software on computer *b* and the actual call takes place. The call itself does not pass through the server. If user *a* wants to communicate with user *d* in Figure 4, the two servers must exchange address information in order to facilitate a communication session.

As compared to traditional telephony, the entry barriers for providing services over the internet are relatively low. An entrant wanting to offer e.g. VoIP must establish a call-server, and distribute necessary software to end-users. Thus local access is no longer a bottleneck. Referring to Figure 4, users on network 1 and 2 can already communicate, e.g. by e-mail. The problem is, however, to find the address of the one you want to communicate with. Thus the servers must exchange information in order to facilitate interconnection. With the introduction of VoIP a possible new bottleneck is accordingly access to these databases. In addition technical compatibility can be used strategically to gain competitive advantage. The examples provided below demonstrate that denying interconnection of databases as well as incompatible technical solutions indeed are important issues in these markets.

There is a number of large global messenger networks, notably MSN Messenger, Yahoo! Messenger, AIM/ICQ, GTalk and QQ. In 1999 Microsoft tried to establish interconnection between MSN messenger and AIM, but the attempts were blocked by AOL, the owner of AIM/ICQ (which still has a dominant position in the US market). In the seven year period 1999 – 2006 none of the large IM networks were interconnected. However, in July 2006 MSN and Yahoo! became interconnected, and recently it has been announced that GTalk and Yahoo are going to be interconnected. Interconnection is evidently a strategic issue for these firms.

Telephony networks based on VoIP are rapidly gaining market shares. The situation within the VoIP market has similarities to the messenger market. Most VoIP-networks are accordingly not directly interconnected.[17)] Some VoIP-networks like Skype have managed to enter the telephony market without interconnecting with other networks. Other VoIP-networks are taking a more traditional route by installing a gateway to the established circuit-switched telephony networks.[18)] By doing so the entire installed base of telephony users on both fixed and mobile becomes available from VoIP. Since many VoIP-networks have a gateway to the traditional telephony network, they are also indirectly interconnected. Thus, instead of routing a call between VoIP customers on different networks directly over the internet, the call is routed via gateways and through the traditional telephony networks. This is illustrated by the dotted line in Figure 5.

This way of facilitating interconnection between different VoIP-networks seems inefficient. By interconnecting call-servers and making software sufficiently compatible the call could instead be routed directly over the internet. As the proportion of customers on VoIP increases, and thus the proportion of VoIP to VoIP calls increases, the significance of the inefficiency will increase.

There are accordingly likely to be gains from direct interconnection. A possible future development is that some firms will deny all kinds of direct inter-

16) *For instant messaging and telephony the servers are called IM-servers and call-servers, respectively. The server functionality may be physically distributed, but logically it works as a database.*

17) *There are some notable exceptions, in particular the US-based network Free world dial up. According to their web site, their customers can use FWD to talk with people who use other networks to make calls over the internet.*

18) *In addition to the components illustrated in Figure 4, interconnection with the circuit switched network also requires a gateway.*

ISSN 0085-7130 ©Telenor ASA 2008

connection; others will want to interconnect with all others, while a third group of networks will choose targeted degradation. It is not unlikely therefore that interconnection will continue to be an issue for regulators. The focus will, however, shift from local access towards access to address information (i.e. interconnection of servers) as well as compatibility and standardization.

4 Concluding Remarks

Seamlessness and standardization yield obvious benefits since they typically result in gains from economies of scale and scope on both the demand and supply side. At the same time seamlessness and standardization may soften competition resulting in higher prices, slower network roll out and less innovation. Thus there is a tradeoff. Similarly, firms typically try to strategically exploit economies of scale and scope on both the demand and the supply side. The result may be a welfare maximizing market equilibrium, but it may also be too much or too little seamlessness and compatibility in equilibrium. Furthermore, a particular network or technology may be characterized by a low degree of seamlessness in some periods and high degree of seamlessness in other periods as demonstrated by the instant messaging example above. There is accordingly no "one size fits all solutions" with respect to the choice of business model and strategy in such markets. One has to carry out case by case analysis. One consequence is that regulatory policy also has to be determined on a case by case basis. In some cases regulators have to try to induce the market to choose a higher degree of seamlessness, in other cases a welfare improving regulatory policy should push in the opposite direction.

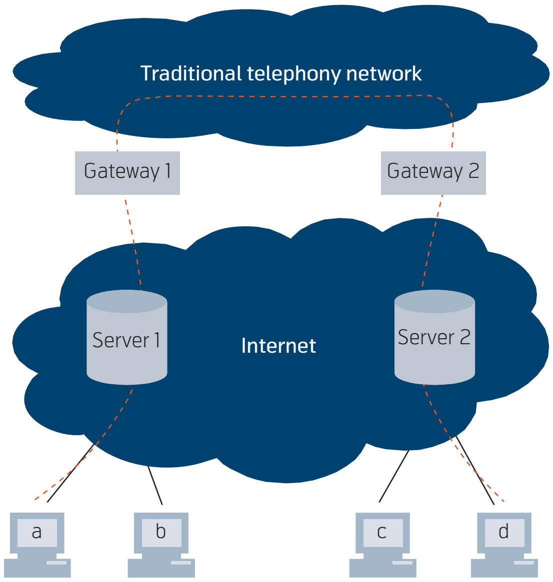


Figure 5 A call routed via the traditional telephony network

5 Literature

Andersson, K, Hansen, B. 2007. *Network competition : Empirical evidence on mobile termination charges and profitability*, mimeo. Available at: http://home.bi.no/a0510011/

Armstrong, M. 2002. The theory of access pricing and interconnection. In: Cave, M, Majumdar, S, Vogelsang, I (eds). *Handbook of Telecommunications Economics I*. Amsterdam, Elsevier Publishers.

Armstrong, M, Vickers, J. 2001. Competitive price discrimination. *Rand Journal of Economics*, 32 (4), 579-605.

Brock, G W. 2002. Historical overview. In: Cave, M, Majumdar, S, Vogelsang, I (eds). *Handbook of Telecommunications Economics I*. Amsterdam, Elsevier Publishers.

Carter, M, Wright, J. 2003. Asymmetric network interconnection. *Review of Industrial Organization*, 22, 27-46.

Cremer, J, Rey, P, Tirole, J. 2000. Connectivity in the commercial internet. *The Journal of Industrial Economics*, 48 (4), 433-472.

D'Aspremont, C, Jacquemin, A. 1988. Cooperative and noncooperative R&D in duopoly with spillovers. *American Economic Review*, 78 (5), 1133-1137.

DeBondt, R. 1997. Spillovers and innovative activities. *International Journal of Industrial Organization*, 15 (1), 1-28.

DeGraba, P. 2003. Effcient intercarrier compensation for competing networks when customers share the value of a call. *Journal of Economics & Management Strategy*, 12 (2), 207-230.

Dessein, W. 2003. Network competition in nonlinear pricing. *Rand journal of economics*, 34 (4), 539-611.

Economides, N. 2006. The Economics of the internet backbone. In: Cave, M, Majumdar, S, Vogelsang, I (eds). *Handbook of Telecommunications Economics II*. Amsterdam, Elsevier Publishers.

European Commission. 2003. *Commission approves 3rd generation mobile network sharing in Germany, IP/03/1026*. Date: 16/07/2003. available at: http://europa.eu.int/rapid/pressReleasesAction.do?reference=IP/03/1026&format=HTML&aged=0&language=EN&guiLanguage=en

Farrell, J, Saloner, G. 1992. Converters, compatibility, and the interfaces. *Journal of Industrial Economics*, 40 (1), 9-36.

FCC. 1998. *Memorandum opinion and order, in the matter of application of WorldCom, Inc. and MCI Communications Corporation for transfer of control of MCI Communications Corporation to WorldCom, Inc.*, FCC 98-225. Washington DC.

Foros, Ø, Hansen, B. 2001. Competition and compatibility among internet service providers. *Information Economics and Policy*, 13 (4), 411-425.

Foros, Ø, Hansen, B, Sand, J Y. 2002. Demand-side Spillovers and Semi-Collusion in the Mobile Communications Market. *Journal of Industry, Competition and Trade*, 2 (3), 259-278.

Hultén, S et al. 2001. *3G mobile policy : The case of Sweden*. Geneva, ITU. Available at: http://www.itu.int /osg/spu/ni/3G/casestudies /sweden/Sweden_fin3.pdf

Jeon, D S, Laffont, J J, Tirole, J. 2004. On the "receiver pays" principle. *Rand Journal of Economics*, 35 (1), 85-110.

Katz, M L, Shapiro, C. 1985. Network externalities, competition and compatibility. *American Economic Review*, 75 (3), 424-440.

Kende, M. 2002. *The digital handshake : Connecting internet backbones*. Federal Communications Commission, Washington DC. OPP Working Paper No. 32.

Laffont, J J, Tirole, J. 2000. *Competition in telecommunications*. Cambridge, The MIT press.

Laffont, J J, Rey, P, Tirole, J. 1998a. Network competition I : Overview and non-discriminatory pricing. *RAND Journal of Economics*, 29 (1), 1-37.

Laffont, J J, Rey, P, Tirole, J. 1998b. Network competition II : Price discrimination. *Rand Journal of Economics*, 29 (1), 38-58.

Liebowitz, S J, Margolis, S E. 2002. Network Effects. In: Cave, M, Majumdar, S, Vogelsang, I (eds). *Handbook of Telecommunications Economics I*. Amsterdam, Elsevier Publishers.

Matutes, C, Regibeau, P. 1988. Mix and match : Product compatibility without network externalities. *Rand Journal of Economics*, 19 (2), 219-234.

Rinde, H. 2005. Et telesystem tar form 1885–1920. *Norsk telekommunikasjonshistorie bind I*. Oslo, Gyldendal.

Rochet, J P, Tirole, J. 2003. Platform competition in two-sided markets. J*ournal of the European Economic Association*, 1 (4), 990-1029.

Rohlfs, J H. 1974. A theory of interdependent demand for a communications service. *Bell Journal of Economics and Management Science*, 5 (1), 16-37.

Rohlfs, J H. 2006. Bandwagon effects in Telecommunications, In: Cave, M, Majumdar, S, Vogelsang, I (eds). *Handbook of Telecommunications Economics II*. Amsterdam, Elsevier Publishers.

Roson, R. 2002. Two papers on internet connectivity and quality. *Review of Network Economics*, 1 (1), 75-80.

Shapiro, C, Varian, H. 1998. *Information rules : A strategic guide to the network economy*. Boston, Massachusetts, Harvard Business School Press.

Simeonov, S. 2006. How can Metcalfe's law be updated for web 2.0? – Metcalfe's law is more misunderstood than wrong. *The Web 2.0 Journal*. Available at: http://web2.sys-con.com/node/259624

Swedish Competition Authority. 2002. *Undantag – samarbete om UMTS-nät*. Beslut 2002-03-12, Dnr 321/2001. Available at: http://www.kkv.se/beslut/01-0321.htm

Valletti, T. 2003. Is mobile telephony a natural oligopoly? *Review of Industrial Organization*, 22, 47-65.

Øystein Foros is Professor, Dr.Oecon, Norwegian School of Economics and Business Administration (NHH). Foros was previously Senior Research Scientist in Telenor R&I.
email: oystein.foros@nhh.no

Bjørn Hansen is senior researcher in Telenor R&I. He holds a PhD (2006) in economics from the Norwegian School of Management (BI) and a Master in economics from the University of Oslo (1992). Since joining Telenor R&D in 1997, his interests have been in regulation, business models, business strategy, and pricing.
email: bjorn.hansen@telenor.com