Making room for broadband

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The Swedish ICT Commission

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Preface

The development of an IT infrastructure is a matter of great concern in many countries today. When investments in broadband networks are discussed, a number of perspectives are present at the same time in the debate. On one hand, the vertical integration between services at the top of the value chain all the way down to the dark fibre or masts for radio antennas is considered to be an adequate model for the financing of the infrastructure. On the other hand, to separate the dark fibre infrastructure (or masts) from the production of services, from transmission up to services with a high value added is considered to be the right way to establish a proper competition upon the physical dark fibre network or its alternatives. In this last case, the fibre network could from some aspects be perceived as a natural monopoly.

This report explores what economic theory has to say about IT-infrastructure. I reaches the interesting conclusion that even if a black fibre infrastructure can be understood as a natural monopoly, it does not necessarily mean that the state either has to build it nor finance it. There are many other options and opportunities. Jan Odhnoff, professor in economics at Royal Institute of Technology (KTH), has written the report in cooperation with Inga Hamngren, journalist, and Kurt Lundgren, professor in economics, Royal Institute of Technology (KTH) on behalf of the Swedish ICT Commission.

The report really is about how to take a standpoint to the industrial organisation of the Swedish broadband network. The technology and its use are decisive for an economic theoretical discussion of different models for the judgment of the role of the state. The authors have thus put a great emphasis on the description of the framework for the industrial organisation, a framework where both the development of technology and the use of it are placed in a dynamic economic model. The results have a great general importance and have implications on many levels in society concerning the development of an IT infrastructure.

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Making room for broadband

A report compiled for the Swedish IT Commission by Jan Odhnoff et al.

The report was delivered in February 2000. The brief of the Swedish IT Commission is concerned with defining a standpoint on the industrial organisation of Sweden's broadband network, the task being to show how IT infrastructure investments can be regarded in an economic perspective. Taking economic theory as the starting point, the principal models of IT infra-structural finance are to be addressed and the economic impact of various model options illuminated. At the same time, *the dynamics of interaction* between different models in parallel use shall be considered, as a basis for discussing the role of the State in connection with IT infrastructure investments.
Since, in our opinion, technology and its use have an important, not to say decisive, bearing on a discussion, in terms of economic theory, of the dynamics of interaction between different models for assessing the role of the State, we have attached great importance to describing the framework of the industrial organisation, a framework in which both technical progress and use are made part of a dynamic economic model.

Discussion framework

As a framework for this analysis and discussion, we have chosen to consider what may constitute "technology pull", and not only the forces and their economics amounting to "technology push"[1]. The discussion of IT infrastructure has to a great extent come to be dominated by technology and its various forms, and has been far less concerned with the uses of technology.

Schematically speaking, infrastructure technology is usually described on a number of levels. The Infrastructure Commission's five levels from applications level to ducting level reflect to some extent, different degrees of permanence,

[1] "Technology push" and "technology pull" are terms taken from innovation literature.

the applications level being the most dynamic. But, at the phase which network technology will be passing through in the next five or ten years, there are dynamic elements at all levels. In the history of technology, similar phases can be identified in the development of network industries, e.g. electrification a hundred years ago. Corresponding levels of technology were developed over several decades into progressively more stable patterns for the basic levels of the infrastructure, at the same time as applications technology found more and more paths along which to develop.

The main technical levels on which we focus in this report are the two constituting the basis of the ground-based IT infrastructure, namely the line level and the ducting level. "Line" here refers to what are termed passive networks of cables containing optic, dark fibres which can be leased, partly or wholly, to operators. Ducting means laying the cables in pipes (conduits) below ground. There is technical development at these levels, but of quite a different permanence from that of the higher ones. Spokesmen for the industry say that no alternative technique of effective mass communication is open to a rapid increase of bandwidth in the foreseeable future[2].

Another reason for including levels of technology in the discussion of technology push is that they also reflect the industrial organisation of the technology in production and products. In computer communication, the leading examples of which exist in the USA, a clear specialisation prevails, with keen competition but also with development co-operation at the different levels, or at least above the two basic ones. In the telecommunications industry, firms in a strong dominant position have integrated their organisation to encompass all five levels. With the onset of telecommunications deregulation at the end of the 20th century, rival companies penetrated the tiered system from above but, due to the position of the

[2] We disregard mobile communication, the development of which will be subject to different constraints from those affecting the ground-based variety. As we see it, mobile and stationary technology are mutually complementary.

dominant companies, had difficulty in reaching down to ground level. The integrated enterprise has an advantage carried over from its earlier standing as a "natural" or de facto monopoly. This is reflected, for example, in the pricing of inter-communication.

During the past decade, the technology of computer communication has gradually merged with and transformed telecommunications technology. The need for what is termed broadband has come about as a natural consequence of data, image and sound being transmitted together in digital packets of information (IP-packets) which are assembled at the receiving end. These packets require far greater line capacity than traditional telephony. Technical progress at the transmission level has provided scope for using far more of the potential capacity of the dark fibres, thereby opening up new application areas.

In our framework, then, *the technology*, the IT infrastructure, is connected to *technology use* manifested in the form of learning, variously organised. Production in the national IT sector, as we conceive of it, can be described by a function of the IT technology and learning variables. The thing is to find the economically optimal combination of these factors of production, a balance which should be possible to express in a political vision. If we want to investigate the dynamics as they can most easily be calculated in the model, the natural recourse is to study how the growth of production in the IT sector comes about.

Industry and its products in Sweden are undergoing a renewal, though less rapid than in the USA and not with the same breadth everywhere in the IT spectrum. The imbalance between IT infrastructure technology and user learning exacts a price in the form of limited speed and scope of progress. If the Swedish Government were to act like the US federal authorities, its most immediate concern would be the promotion of education and research in this field.

The likelihood is that the organisation of research and education in Sweden has an inertia giving rise to imbalances

which stand in the way of optimum IT growth. The university system is responding too slowly to the demands inherent in the potential user opportunities. Professor Nathan Rosenberg of Stanford University has shown, in his scrutiny of European universities, that, by reason of their organisation, they have lagged far behind their American counterparts in terms of responsiveness. Sweden, admittedly, comes off better in his study than the continental European countries, but his examples make clear that Swedish universities are performing badly as regards keeping up with the technology user side of things.[3]

The possibilities of the public sectors stand well for a political renewal, not only in the sphere of educational policy but also through a serious examination to identify needs, both technical and user-related, which can be provided for through a renewal of social policy. The challenge of IT infrastructure use to defence policy appears to have its appointed place in the post-JAS[4] era.

One conclusion to be drawn from this cursory overview of the user side of technology is that the impediments to optimally balanced development of Sweden's IT structure lie in organisational shortcomings on the political side, especially in the sphere of research and education. Growth of demand in other political sectors will also hinge on the availability of sufficiently qualified manpower.

Industrial organisation

The remit calls for the analysis of two extreme models of industrial organisation, one of which says that it is efficient for infrastructure development to be based on competition between those wishing to offer services on the web, while the other tells us that infrastructure – more exactly, cable-laying and fibre or suchlike – constitutes a "natural monopoly", whereas the services which can be carried by the infrastructure should be

[3] Prof. Rosenberg described his studies in a lecture at the Royal Institute of Technology (KTH), Stockholm, in November 1999.
[4] Multi-role combat aircraft.

produced and delivered on a competitive basis. In this latter instance a clear distinction is made between line without hardware ("dark fibre") and, on the other hand, the services and equipment ensuring that data packets reach their destination. In practice, several alternatives are conceivable in between these extremes.
Thus a discussion of the alternatives in the remit will necessarily touch on industrial organisation at different technical levels. But the remit draws no distinction between backbone and more user-proximate parts of the network, especially the metropolitan area networks, which are now being rapidly expanded, sometimes under direct municipal auspices and sometimes through a network provider such as Telia (Swedish Telecom). Experts perceive a risk involved in municipalities "confusing their own triple roles as purchasers of network services, as providers (e.g. through their own energy utilities) and as authorities charged with safeguarding citizens' interests".

During a pioneering phase it may be important that municipalities – for the simple reason that they see areas of application for which they are responsible – take the initiative by constructing networks. At the same time it is vital that competition should if possible prevail all the way to the end user, which is seldom the case at present. Thus the discussion of options under the remit should not be confined to the backbone but should also include the more user-proximate networks such as metropolitan area networks and local loops, through which the infrastructure reaches all the way out to end users, e.g. households.
Essentially, in a governmental perspective, the option of active competition monitoring is contrasted with that of "natural monopoly".

In reality, the competition option has a number of restrictive features that are typical of network industry. The most important of them are connected with operator and network functions etc. being provided by the same enterprise, vertically integrated. Production being integrated, it is hard for an outside operator to rent his way, on reasonable terms, into a dark fibre belonging to the integrated enterprise. The latter will find itself

in a complicated position if, for reasons of laws regulating impediments to competition, it is forced to let someone else into its network. Questions like what is a reasonable rent to cover the investment and development costs of the integrated operation are difficult to resolve, all the more so as important incentives for development are liable to fade. From a user perspective, of course, it is vitally important to acquire options if one is already connected to the integrated enterprise because no options were available previously. The "natural monopoly" has frequently been associated with high charges and with poor technical renewal and compelling necessity to the user. Experience from the deregulation of Europe's telecommunications industry has shown the former monopolies digging their heels in and, by virtue of their well-informed position, becoming experts at devising new ways of preserving their dominance without giving competitors a chance of introducing new ideas and services.

The remit is concerned with introducing a new provider, renting out space on the fibre network, with the prospect of effective competition for both the hardware industry and operators. In order for this new player to be regarded as a "natural monopoly", all other players, somehow or other, would have to transfer to this new player the fibres currently at their disposal. We will not, for the present, go into detail as to how this could be accomplished: the "natural monopoly" is an extreme alternative introduced for the sake of argument, as well as a competitive option with perfect competition all the way out to the end users. Monopoly status could be defended on grounds of benefits of joint operation, the slowness of technical progress at the ducting level and the laying of standardised fibres. As regards the rate of technical progress, everything hinges on the existence of effective competition on the hardware side (the IP and transmission levels) and at the operator and applications stage. The openness of this monopoly shall guarantee as much.

A competitive option with effective competition also entails preconditions in the form of a regulation of competition that is

not readily predictable, given the discussions attending the deregulation of the European network industries[5]. From a report on the European network industries we quote the following principles which should apply to the regulation of competition in an ideal world for long-term competition compatible with welfare in the community[6]:

- Transparency and fairness.
- Symmetry in the treatment of competitors, symmetry being defined as a scheme of rules by which low-cost providers are not prevented from producing services.
- Balancing of the problem of prices which can cover present-day costs and a dynamic development of the industry.
- Appropriate powers over all parts of the industry, including all potential players.
- Minimum political interference through the objectives of comprehensive community service. These objectives shall be achieved with the aid of transparent systems that do not distort competition.

The following argument has been guided by these principles, insofar as they have been applicable.

Compared with the form of limited monopoly involved here, the competitive alternative is not necessarily the most cost-effective. So long as the possibility exists of many players being integrated over several stages of production in a competitive alternative, it is debatable which alternatives afford most transparency and fairness. In this instance the monopoly discussed has the advantage of opening the way to transparency in the business relationship between buyers and sellers of dark fibre capacity.

In other branches of industry, competition and the pursuit of cost-effectiveness have led to a high degree of outsourcing, with components and systems in supplier chains being

[5] Bergman, Lars, et al.: Europas nätverksindustrier, SNS, 1999.

[6] We have not quoted the parts which are references to other sections of the report.

manufactured quite outside the firms responsible for the final assembly of the product. The same thing happens in the networking industry, with its integrated parts of providers and communication services. A development of this kind could argue in favour of the competitive option acquiring greater efficiency and transparency at a later stage of things.

The earlier European model of a "natural" state monopoly of networking industries, such as the telecommunications industry, is, however, far from desirable in present-day Europe, given the aim of broadening the competitive element in those industries. Developments should instead be guided by the above mentioned principle of achieving the objectives of comprehensive service to the community with the aid of competitively neutral, transparent systems.
Breaking free of the "natural" monopoly as a starting point of national industrial policy is also a matter of necessity in view of the steady convergence today of telecommunications and data communication, which in turn is opening the way to the broadband boom. In this latter field, competition is axiomatic when discussing ways of achieving maximum cost-effectiveness, fairness and transparency.

Inspired by Nobel laureate R. H. Coase and his advocacy of an approach emanating from a situation which approximates "what actually happens", we consider what the State can do to guarantee that the infrastructure will be open to everybody, on non-discriminatory terms at cost-based prices[7]. An opening of the infrastructure would prevent future dead ends and a possible local monopolisation of the infrastructure, which is very liable to occur if network proprietors, who at the same time are service providers, are permitted to take charge of the network build-up. The cross-subsidisation occurring today with telecommunications services and/or distribution can be prevented. Another risk referred to in the industry is that, with the present network proprietors in charge of the expansion, we may end up with an oligopoly.

[7] Coase, R.H.: The Problem of Social Cost, Journal of Law and Economics, Vol. III, October 1960.

Our argument presumes the existence of demand on the part of many users of line capacity who wish to rent capacity on non-discriminatory terms at cost-based prices. In the full text of the report we show that there is a solution in economic theory whereby the State takes the initiative in creating a system of negotiation/planning/procurement whereby a process can be inaugurated that is aimed at "forming coalitions of representatives of the future users. These are expected to have a strong interest in an expansion materialising (i.e. a large anticipated consumer surplus), so that this surplus can be used to cover the costs which would not be financed with a purely market-driven solution." We see that a process of this kind should have the strongest possible local roots, so that the coalitions can be identified and established more easily.

One of the government's first steps could be to gather interested users of line capacity round an *arena* (prepare the ground, as it were) for the joint expansion of backbone and other networks so as to accommodate essential fields of application – both those with a potential on the market side and those which are otherwise politically desirable. How could such an arena materialise? It is possible that there are several solutions of principle, but the following will serve as *one* answer.

The government could proceed by the following stages:

1. The government formulates its intention and indicates priority applications (e.g. medical care, schools and other education, and research), for the promotion of which it advocates establishing an alliance representing all interested and affected walks of society (see the section on Promotion of broadband use).

2. Through a suitable governmental agency/corporation, a company is formed which shall be autonomous and whose articles of association express what the government wishes to achieve in the form of a national infrastructure offering great security and growth capacity, providing equal opportunities for users of the network and transparency in

the matter of cost-based pricing. The articles of association shall also indicate how it is intended to enlarge the circle of owners.

3. The circle of owners will be enlarged by users (and, possibly, interested providers) of line capacity being invited to become owners, and also by means of a wide-ranging new stock issue in the share market, aimed at achieving broad-based popular ownership.

4. Additional capital is raised to develop the company in the desirable build-up of broadband infrastructure.

The company's success at these various stages will of course depend on its being given an experienced management capable of inspiring and co-ordinating different interests. The biggest challenge lies in being able to utilise the technology pull occurring in the expanding applications that operators and service enterprises are more and more clearly intent on exploiting. Much will of course depend on how active municipalities and the State prove to be as purchasers of services for schools and universities (see the section headed Promotion of broadband use). Given the high level of Internet service use existing in the market, and judging by American experience of the impact of IT products (see Geoffrey A. Moore, Inside the Tornado, 1995), growth is likely to be very swift.

We wish to emphasise that success in developing the new network capacity company will depend on interaction with the promotion of broadband use, as proposed below through a wide-ranging commitment involving business enterprise and the whole of the politically controlled sector. The industrial organisation of IT infrastructure is not a question to be decided in a static economic calculation. Such is the ("tornado") rapidity of technical and commercial development, which the industrial organisation needs to evolve in a *process* that can soon derive benefit from techno-economic advances.

The need for bandwidth

Bandwidth needs vary from one user category to another, and successive, differentiated development is therefore warranted. Images of the future, taken together, show that all categories will be using ever-new applications on the Internet if bandwidth provides sufficient speed and good enough image and sound quality. In many advanced fields, such as multimedia and video, use today is limited by the slowness of networks. The increasing volume of traffic will also demand a greater bandwidth.

The following is an exemplified description of the needs of different groups, their access to bandwidth, and the measures which need to be taken.

The municipalities

Many municipalities are having difficulty in establishing broadband communication at reasonable cost, not only in rural areas but also between major localities within their own boundaries. The principal localities of the different municipalities find it easier, though sometimes very expensive, to communicate with each other. One fundamental problem is that in many municipalities there is only one party to negotiate with when purchasing broadband communication on the web. The costs of Internet connection are often so high that municipalities prefer to invest in networks of their own.

Metropolitan area networks

All over Sweden, therefore, new metropolitan area networks are being rapidly constructed. Some 170 muni already have metropolitan area networks or are in the process of building them. According to a review undertaken by the newspaper Dagens Nyheter on 13th January 2000, fibre networks are under construction in 136 municipalities, creating new opportunities for the production of broadband. Another 20 municipalities have decided in favour of fibre network development. In this way there will be more competition on the local telecommunications market and surfing the Internet will be made less expensive.

AB Stokab, which is owned by the Municipality of Stockholm (91 percent) and the Stockholm County Council (9 percent), is Sweden's biggest metropolitan area network, with 220,000 km fibre in Stockholm itself and in 23 other municipalities in the Stockholm region. The company leases dark fibre commercially to more than 30 operators and also to other customers, such as municipal and county council administrative authorities, private companies in banking, commerce and media, and universities. In certain municipalities where Stokab has constructed fibre networks, the municipal authorities may still have resolved on constructing their own metropolitan area network, in which case we have two municipally owned metropolitan area networks competing with each other.

It is only in certain larger cities the metropolitan area networks have been established by an operator. The market has shown no interest in establishing infrastructure in sparsely populated areas. Little more than 20 percent of the metropolitan area networks will cover the rural areas of the home municipality, if replies to the Dagens Nyheter questionnaire are anything to go by. Coverage is lowest in the sparsely populated rural municipalities. In many municipalities, lack of communication possibilities makes it expensive to organise activities in elderly care, schools, children care

and home nursing. This could be overcome in a rational manner, using modern IT aids, but lack of competence in the IT sector is an obstacle to the development of infrastructure, especially where security is concerned.

Schools

The number of computers in schools continues to grow steadily. In 1999 Sweden's compulsory schools had one computer for every ten pupils, as against one per 38 in 1993. High schools (known as "upper secondary schools") had one for every five students in 1999, as against one per 11 students in 1993.

The proportion of computers with Internet access varies a great deal between the two kinds of school. Eight out of every nine computers in high schools have Internet access, compared with little more than half in compulsory schools.

Schools in the County of Stockholm connected to the Stokab schools network have boosted demand for bandwidth, with the result that Stokab is now testing new technology for producing more broadband on networks. Bandwidths of 2 Mbps are far from sufficient when making video recordings of lessons for use in other schools. Distance teaching with interactive video calls for still greater bandwidth. Demand for Internet access has also grown rapidly in schools, and their capacity needs are expected, initially, to grow faster than those of other categories, due to the promotion of school computers and network supply for schools. A report commissioned by the IT Infrastructure Commission indicates that household capacity needs will not exceed those of schools until 2005.

It is a matter of national interest that all schools should have Internet access. If all schools in Sweden are reached, this will make it easier to reach households. It could very well be a national policy on the education side to support the development of optic fibre networks so that they will reach all schools in the country. The network should be upgraded at the rapid rate demanded by increased traffic volume and the development of applications and services.

Municipal responsibility is of prime importance, but market players should also be interested in participating here. Greater bandwidth will spur the development of a host of new applications, programs and systems for education. Computerisation in schools means a future demand for products and services and infrastructures, also for households, which in turn creates commercial opportunities.

Universities and colleges

The Swedish university network (SUNET) links together about 40 of Sweden's universities and colleges. The National Rail Administration is responsible for network construction, and the backbone passes between Sundsvall, Stockholm, Göteborg (Gothenburg) and Malmö, with the universities and colleges linking up to these nodes through local loops. Almost half a million Swedes have Internet access through Sunet. The State bears just over a quarter of the cost, while the bulk of expenditure is incurred by the universities and colleges themselves.

Sunet's bandwidth has been steadily increased to keep pace with rapidly growing demand. If the trend continues, 1 Gbps will be needed before much longer. It is doubtful whether the National Rail Administration can accomplish such a rapid upgrade. In the Greater Stockholm area, where Sunet has access to dark fibre from Stokab, the speed is four times higher already and further increases to 2.5 and 10 Gbps have been discussed, the latter so as to catch up with American universities.

Libraries

Public libraries play an important role in enabling the general public to utilise various databases and web services. Kommunernas Lärcentra (Municipal Learning Centres) is an important part of a political endeavour to enable the general public to make use of electronic library services, video conferencing systems etc. All these various instances require considerable bandwidth. Several of Sweden's public libraries have Internet access through SUNET.

Telemedicine

The trend in medical care favours a growth of services and care away for hospitals. This calls for high-speed networks to both hospitals and health centres, especially in sparsely populated rural areas where there are long distances involved. Telemedicine also includes distance medical advice between hospital and ambulance and between caring institution and the patient's home. Other tele-medical applications are distance diagnosis, consultation during surgery, VR applications, conferences and training. Tele-radiography is the commonest application, both in Sweden and abroad.

It is above all interactive video consultations with moving images – with their very high image quality requirements – and sound that demand high bandwidth capacity.

The disabled and elderly

The IT Infrastructure Commission notes that the people with the biggest communication problems stand to benefit most from rapid access to the networks and the resources they have to offer. The more cut off people are from the outside world. The greater their liberty becomes when they are enabled to communicate unimpeded with others. The Internet can have a revolutionary impact on the lives of persons with functional impairment, if only the bandwidth is sufficient.

Business enterprise

Many firms today that do not have their own high-speed network connections complain that connection through operators is slow and very expensive. In several places there is only one operator to choose from. Many relocated Call Centers and ticket reservation companies have for a couple of years now been experiencing great problems in the form of repeatedly broken connections, resulting in serious losses of earnings.

Large firms more often have a direct connection, so as to be permanently on-line. The capacity-demanding applications and the real-time requirements that they already have today call for fibre-optic local loops. Applications of this kind include, for example, IP telephony, e-commerce, VR techniques, multimedia services, electronic documentation and access to large

volumes of data, contacts with public authorities and other businesses, support for the disabled, teleworking and video-conferencing in real time with participants from other countries. The Federation of Swedish Industries wants business enterprise and the State to co-operate in quickly achieving a new, open, optic backbone independent of operators. The Federation could also contemplate this being organised as a jointly owned company.

Households[8]

At the end of August 1999, according to Sifo (the Swedish Institute of Public Opinion Research), there were 3,179,000 Swedes surfing on the Internet, rising to 3.5 million in October. This being so, the number of web users was 843,000 up on the same period of the preceding year, according to observations by Sifo Interactive Media. The main increase during the past year has occurred in the 50-70 age group.

An article published in Computer Sweden at the beginning of 2000 reported that more than half of all Swedes aged between 12 and 79, i.e. 3,666,000 persons, were surfing the web in December 1999. The number of web users, according to Sifo Interactive Media, is 24 per cent up on the corresponding period of last year. Women account for the biggest increase. The only group not showing a substantial increase is males between the ages of 12 and 24, who have always been keen surfers. In other words, there has been something of an equalisation.

31 per cent of the population had access to the Internet in their homes at the beginning of 1999, according to Medie-barometern. The 15-24 age group are the most frequent Internet users, with a preponderance of boys. The total time input for Internet use, spread out over the population as a whole, was 10 minutes on an ordinary day at the beginning of 1999. The average for Internet users is just under 50 minutes daily.

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[8] Most of the statistical data in this section come from *Teldoks Årsbok 2000*.

Sweden has quickly developed into one of the world's leading countries in terms of PC ownership. Domestic Internet access in Sweden has also increased dramatically. In 1990 there was no quantifiable number of Internet connections. Ten years later one finds an estimated 2.6 million PCs and 1.9 million Internet connections in Swedish households, and the number of households on the web is expected to reach 2.7 million in 2005.

The 18-24 and 25-34 age groups are the busiest users. Those in the lower age group use the Internet more than other age groups for following up a question, are the most frequent users of databases and information services, order goods and services and play games more often than other age groups.

The Datamonitor analytical company predicts a dramatic growth of e-commerce, with the Swedes spending MSEK 3,200 in 2003 as against MSEK 32 in 1997. One-third of Internet users today shop on the web.

What do Swedes buy on the web? According to a study by Intelligence Web Survey in February 1999, computer software, books and music top the list, followed by computer hardware, clothes and jewellery.

"IT-framtider" presents the results of another attitude survey, showing 81 per cent of Swedes to be of the opinion that schools make an important difference to Internet use. Swedish Internet users, according to this survey, can be divided into three types: those using the Internet for entertainment and social experience, those using it in order to search for information and communicate, and those using it to order goods, do banking business and so on.

Promotion of broadband use

The corporate idea presented above is to a great extent based on the active generation of ideas for broadband communications applications. To this end we recommend an *alliance*

construction, partly inspired by Canada's CANARIE[9].

In 1993, on the initiative of the Canadian government, a consortium, CANARIE, was formed which is a private, non-profit organisation with 120 members from industry and the public sector – universities mainly. Its aim is to accelerate advanced Internet use in Canada by encouraging the development and used of advanced Internet infrastructure and encouraging the next generation's applications, products and services, the objective of the whole thing being for Canada to preserve its global competitive strength and the leadership which it has attained in many IT sectors.
Lifelong learning and e-commerce are critical sectors.

The network is being jointly developed by the government, industry and the research and education community, thereby harnessing the synergy which the aggregate fund of knowledge can offer, at the same time as the increased bandwidth will revolutionise procedures for co-operation between the government, industry and researchers, speeding up research and the interchange of information. It should be noted that Canada is very much concerned with strengthening the research side, which can pay important dividends in education and in industrial development. We have already pointed out, in the section on the economic model, that there are serious shortcomings in Sweden's organisation of its research and education sector, resulting in a shortage of skilled manpower and thus disturbing the balance of the whole of the IT infrastructure commitment. That commitment will be handicapped unless room is made on the web for network research and appurtenant education.

What we mean to say by this is that initiatives by the government to create a company which will open the way to a competition-friendly IT structure will not suffice to bring about balanced development of the use of that infrastructure. Conceivably, the first governmental initiative could be supplemented by an invitation to universities, municipalities,

[9] CANARIE home page: http://www.canarie.ca

business enterprise and other interested parties to form an *alliance* capable of structuring ideas into projects for the promotion of purpose-oriented use of the IT infrastructure. Even though the Canadian consortium has a broader and more planning-based assignment, the combination and focus of uses can point the way for a Swedish infrastructure alliance.

The idea of a structure like CANARIE is to gather all forces – public and private – in the nation for what is judged to be an urgently necessary effort to make the best possible use of a globally emergent infrastructure. As we noted in the preceding section, there are a number of bandwidth needs, provision for which would enhance the quality of service, e.g. in social and educational policy. In addition, of course, there are all the more commercially accessible needs that can be catered to through the market.

As remarked in our review of needs, safety in the use of telemedicine, e.g. in connection with surgery, requires the available network to be equipped with redundancy for the avoidance of interruptions. Similar requirements exist in other fields – defence, for example. This in turn calls both for high network capacity and a network topology making possible alternative paths of communication between the agents connected. User co-operation is one way of deliberately developing a formulation of requirements for the enhancement of purchaser competence. In all the fields where, owing to high requirements of quality and security, the sufficiency of spontaneous market demand is open to doubt, competent purchasers have to be found.

How will competence-forming processes of this kind come about? They will of course be developed in practical activity, whether public or commercial. If the purchasers are municipal authorities, e.g. for educational purposes, this will require a definition of budgeting priorities, which again will need to be based on ordering competence. Schemes for the use of broadband will often mean traditional activities entering on completely new paths. The challenge facing the alliance will be that of creating an awareness that, in order to derive the greatest possible benefit from IT technology, we will on many points

have to develop a new organisational mind-set.

We thus propose the formation of a user alliance to raise the level of awareness, competence and imagination in the development and use of broadband technique. What this boils down to is paving the way for a new kind of thinking. The State has its allotted role in inviting all conceivable interests to join together in the alliance. Organisationally, the alliance could work through projects whose team members represent a variety of interests within a specific field.

In order to provide the proper incentives, the funding and follow-up of projects should be shared between the alliance members, but a governmental element should also be included, by way of underscoring the overall national interest.

Balanced development

As we remarked in the preceding section, widespread social utilisation of IT growth will depend on public and commercial investments in broadband technology and on use of that technology more or less keeping pace. In the economic model which we began by introducing, an optimum balance had to be achieved between IT infrastructural technology and learning as factors of production. Shortcomings in the organisation of learning have been pointed out, as well as the danger of those shortcomings weakening national technical development on the hardware side.

The development of the proposed SwedNet company has to be viewed in this light. It is not our task to discuss the company's strategy, but the question of IT infrastructure finance is closely bound up with the company's first stage of expansion. Given the inevitably limited resources conferred by stock issues and available credit opportunities, there has to be a certain basic parallelism between the company and the alliance for the promotion of broadband use. Some concluding viewpoints on the stepwise development of the company, therefore, will perhaps be in order.

1. The development of a very high capacity backbone (more

than 1 Gbps) between the higher education localities should have top priority. It is important that this network provide space for an accessible test bed for research, as well as giving rapid dissemination via education (on the web). A broadening of the present limited educational resources is absolutely necessary (there is room here for an early project within the alliance). If SwedNet at its inception could include, or have distinct interaction with, important parts of the metropolitan area network of the higher education localities – not least with pattern-setting Stokab in Stockholm – this initial phase would stand a good chance of getting off to a flying start.

2. The next step will be mainly concerned with extending the backbone towards the metropolitan area networks of other municipalities, so that all the schools, public libraries and folk high schools in Sweden can link up with the high capacity network. The aim should be for all schools to have access to the same capacity. Apart from schools, medical care has high priority, not least in cases where broadband technology can offer superior quality and save lives.
3. It is only at the third stage that, in our belief, the aim of reaching al households in the country with broadband will come into play. If the aim is to reach everyone in more sparsely populated areas with broadband, reliance will have to be placed in radio technology, as with the next generations of mobile technology. Radio access will be an interesting rival to fibre and other lines for the last part of the way to the individual customer.

For financing the second and third stages, it may be important for the company to float new stock issues in share markets, coupled with rights issues to new interests with adequate resources and competence.

This stepwise expansion may also be a way of practically ensuring that capacity and topology on the network meet desirable requirements of quality and security at the user end. The overall national picture and international linkages can only be the responsibility of Riksdag (the Parliament) and Government.

In a national perspective, as expressed in Canada's CANARIE, the speed or otherwise with which these steps are taken is of strategic importance. If the Swedish government is equally interested in occupying the vanguard of international development so as to attract research, industrial development and attention in the fields of application, then Government and Riksdag will have to demonstrate as much, both by rapidly developing the three stages and through projects in the alliance indicating how broadband is meant to be used, not least in catering to the needs of rural communities. EU support could be mobilised for development in sparsely populated areas. There is reason for not regarding this development as a residual item. In an EU or global perspective, experience of how such projects are accomplished has a power of attraction that can even elicit a commercial demand.