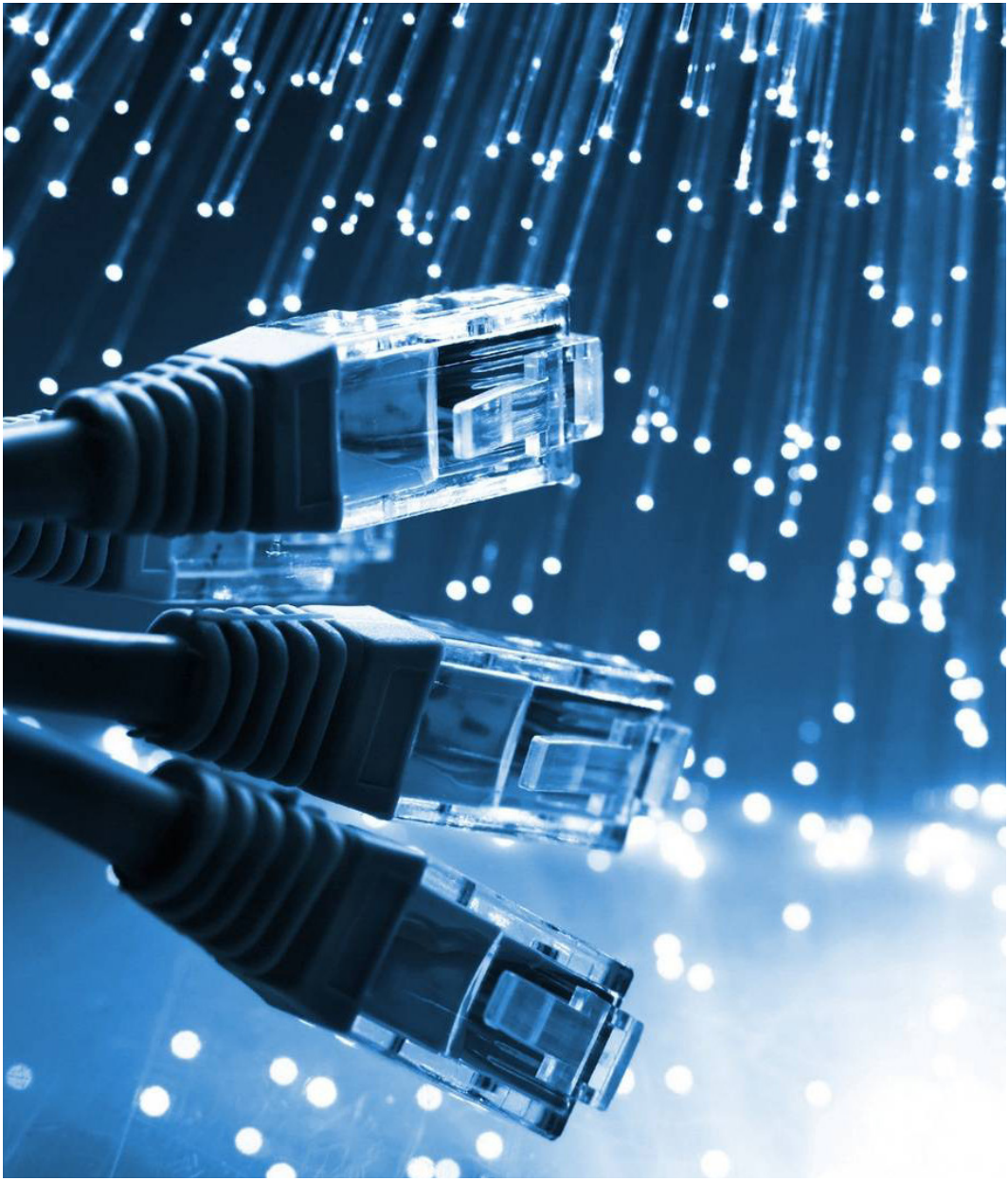
Summary of follow-up report 2016/17: RFR1

Committee on Transport and Communications

SVERIGES RIKSDAG

The IT Infrastructure – Today and in the Future



Summary

The Committee on Transport and Communications' working group on research issues has chosen to conduct a closer study of issues concerning IT infrastructure. IT infrastructure refers to the infrastructure that enables connection to the internet and mobile telephony. Our interest will be directed towards both the capacity of the infrastructure (the number of users who can use mobile telephony and broadband and the quality of the service) and how robust it is (that is the reliability of the system and how sensitive it is to disruptions).

Our focus of attention will be on today's availability, what efforts are being made to increase accessibility and what the results of these efforts might be. The issues to be tackled also include how mobile telephony and the internet are expected to develop, as well as future needs of IT infrastructure and consequences of different levels of IT infrastructure. In October 2016, the working group submitted the report "The IT Infrastructure – Today and in the Future" 2016/17:RFR1 to the Committee on Transport and Communications.

Objectives for IT infrastructure

Most people are to have access to a fast internet connection by 2020

There are political objectives stating that everyone should have access to the internet and that most people should have access to a very fast internet connection. Under the Electronic Communications Act, everyone with reasonable demands should have access to a functional internet connection in their permanent place of residence or regular business location. The Act stipulates that the end-user should be able to receive data at a speed of 1 Mbit/s.

The broadband strategy formulated in 2009 says that 90 per cent of households and companies should have access to broadband of at least 100 Mbit/s by 2020. In 2011, the Riksdag adopted Sweden's IT policy

objectives. An interim objective is that electronic communication should be effective, secure and robust as well as being able to meet the needs of users. Another interim objective is that Sweden should have world-class broadband. An overall objective for mobile coverage has not been formulated, but the Swedish Post and Telecom Authority currently has coverage requirements in three frequency bands.

Public funding as a complement

In Sweden, the development of broadband and mobile telephony takes place on a commercial basis, and market actors are responsible for 95 per cent of the development of land-based and mobile broadband structures. Public funding for broadband development is a supplementary measure intended to increase access to broadband in areas where there is a lack of commercial interest. Within the framework of various programmes, approximately SEK 3 billion have been allocated from central government funds to broadband development since 2007.

Access in 2016

Good but unevenly spread access to broadband

More and more people are gaining access to fast broadband services, that is broadband with a speed of at least 100 Mbit/s. However, access differs greatly from one part of the country to another. Access to fast broadband is considerably poorer in households and workplaces outside urban areas and rural communities. The situation is the same regarding access to fibre-optic connections. Coverage for mobile broadband is greatest, primarily in densely populated areas. More people in sparsely populated areas experience problems with the mobile network than people living in densely populated areas.

By international standards, access to broadband in Sweden is good, but the differences within the country are still significant. The demand for and expectations regarding fast broadband are also high. The

demand for fibre solutions continues to be high. There is also a greater interest among market actors to extend their fibre networks to residential areas. Many households and companies are close to properties that are already connected to fibre networks, and this facilitates continued development. Work to develop access networks (the final stage of the network connecting a household or place of work to the rest of the network) in the country's more sparsely populated areas remains.

There is an uncertainty as to how far the rapid development pace will reach. In sparsely-built areas, there are also fewer end-customers. This means that there is less incentive for the market to make investments. There is currently no overall picture of the areas that lack a market-driven development of networks between different districts. The cost of achieving 90 per cent access by 2020 is estimated at between SEK 32 and 50 billion. The Swedish Post and Telecom Authority considers that there are good opportunities for achieving the objectives of the broadband strategy, while other stakeholders are more uncertain. The Internet Foundation in Sweden (IIS) is concerned about the fact that there is no holistic approach to how the Swedish infrastructure should be designed and be connected at the national, regional, municipal and local levels. Some stakeholders consider that fibre should be regarded as a public infrastructure, and that a state IT infrastructure is therefore needed.

Unreliable access?

There is a risk that certain parts of the country may be cut off from their broadband connections in the case of damage to the network. The Swedish Civil Contingencies Agency (MSB) has drawn attention to the fact that public authorities, county councils and municipalities are highly dependent on electronic communications, at the same time as there is often no analysis of how robust their communications systems actually are. Others have also highlighted shortcomings as regards robustness and reliability.

The operators are responsible for their networks and services and take certain measures to protect their respective parts of the infrastructure from incidents. The Swedish Post and Telecom Agency's new regulations to ensure that all market stakeholders pursue long-term and ongoing operation reliability measures came into force in January 2016. Among other things, the regulations include specific requirements regarding reserve energy supply and redundancy. Reinforced perimeter protection, crisis roaming, mobile base stations, reserve power plants and the online service www.ledningskollen.se are all examples of measures to increase reliability and robustness. A new trade standard for installation of fibre networks was adopted in June 2016.

Ambiguous picture of mobile coverage

The overall picture of mobile coverage in Sweden is ambiguous. On the one hand, it shows a strong development where new networks have been developed and coverage and capacity are improving all the time. At the same time, consumers have reported that making calls and surfing are difficult in many places. The extent of the coverage varies significantly between different counties. There continue to be major coverage problems, in particularly in sparsely-populated areas. Minor problems also exist in more densely-populated areas.

Future IT infrastructure requirements

Greater dependence

Information and communications systems are, today, an important and critical resource within practically all areas of society. As a result of digital developments in recent years, many areas have become completely dependent on one and the same network. Previously there were different means of information, for example, telephone, television and

the internet. The current development is that more and more information is transmitted within the same network.

Tolerance to disruptions and other disturbances diminishes as society becomes increasingly dependent on modern technology. Gradually, as eGovernment is established, many actors in the public sector have an increasing need to convey large volumes of electronic information between each other, which increases the need for accessible and protected IT infrastructures.

The future places major demands on capacity and mobility

It is believed that IT will be more present but less visible in the future. It will be characterised by constant connectivity and seamless networks of communicating units. Large volumes of data will be collected, stored or pass through the cloud, analysed and will form the basis of various services. Users in the future will produce large volumes of information, which places greater demands on capacity upstream. In parallel with this development, the need for services that guarantee that information does not end up in the wrong hands is needed.

It is assumed that developments in the area of smart phones and mobility will continue, as will consumption of moving images. Stationary computers will probably become less important. Sensors will be placed on objects and people in order to collect and provide information. The number of connected units will grow significantly in the next 10 to 15 years. Together with, among other things, increasing mobility, consumption of moving images and great volumes of data will place major demands on the IT infrastructure. 5G-technology will probably provide even faster and more reliable communications. At the same time, researchers indicate that there are technical limitations. There is, for example, a ceiling for the transmission capacity of optical fibre.

Consequences of the future IT infrastructure

At the request of the Committee on Transport and Communications, Professor Erik Bohlin and his research team at Chalmers University of Technology have developed a research-based in-depth study of the consequences at different levels of Sweden's future IT infrastructure. The section contains both reasoning from previous research and team's own econometric estimates. The discussions concern both the spread of broadband (broadband penetration) and the capacity or speed of the broadband. The effects are divided into economic, social and environmental effects.

Major economic effects in the long term

The economic effects of broadband have been the subject of more research than the social and environmental effects. There is a relatively large volume of unanimous evidence of the impact of the broadband infrastructure on GDP and employment. The results from the studies of the impact of broadband on GDP are robust and show a positive effect. An increase in broadband penetration by 10 percentage points leads to an average growth in GDP of about one per cent. Some of the positive effects appear immediately as the development of the broadband network leads to increased employment and GDP. However, the most important economic effects emerge in a more long-term perspective, when the infrastructure is in place and has started to be used. The effects occur when economic activities are adapted and reorganised, individual competence increases and innovations arise. The impact on GDP then occurs primarily as a consequence of improved productivity among companies and household use of broadband which leads to an increase in their real income. However, the delays are neither permanent nor uniform, and they are affected, for example, by institutional factors and regulations. It is also believed that the benefits derived will decrease at very high penetration levels. There can, in other words, be a saturation point after which the marginal effects of further broadband penetration decrease.

In addition to a positive impact on GDP, the research indicates positive effects on productivity, household incomes, innovations, employment, the number of companies, and company turnover. As regards income, employment and companies, however, there is a pattern that indicates that the greatest positive effect occurs in the services sector, in urban centres or towns and among households and individuals with high levels of education. Broadband generates employment through innovation and productivity gains, but productivity gains can also lead to a fall in employment levels. The effects can differ between different industries and geographical areas, and the research team highlights the fact that improved access to high-speed broadband can paradoxically run the risk of benefiting the groups, sectors and regions that "need it the least" - highly-educated labour, which is qualified in use of information and communications technologies, the services industry and other sectors with highly-qualified personnel, as well as already densely-populated areas and the outskirts of major towns.

Positive effects on employment occur primarily in sectors needing qualified labour. Access to broadband tends to supplement qualified labour, while it replaces unqualified labour with more routine tasks. The research team's own examination, with the help of Swedish data, shows that there is a certain positive correlation between access to high-speed broadband and the number of companies and workplaces, and between mobile data speeds and the number of workplaces in a municipality. No positive impact on employment was found, but a negative correlation between access to broadband with a speed of at least 10 Mbit/s and total employment was identified. This was the case especially outside larger towns. One hypothesis is that this depends on the fact that development of the broadband infrastructure leads to unqualified jobs disappearing outside larger towns. Similarly, the studies showed a weakly negative correlation between income levels and access to broadband at a speed of at least 10 Mbit/s. This can also be interpreted to be the result of a shift towards more qualified labour, primarily in towns.

Negative impact on the economy if goals for fast broadband are not achieved

As mentioned, there is relatively extensive literature on the effects of broadband in general. Research on the effects of higher broadband speeds is not as comprehensive. It is clear that both the supply and the demand for higher data speeds is increasing, and that certain areas of use that fill an important socio-economic function require high data speeds. As the figure shows, different services need different speeds and qualities.

New applications and services will require very fast broadband. At the same time, the research team highlights that it costs more to develop super-fast broadband, especially in sparsely-populated areas. Several studies indicate positive effects of greater broadband speeds on GDP, but the extent of these effects has not been clearly proven. A study conducted in cooperation with Chalmers University of Technology, ADL and Ericsson does, however, show the positive effects on GDP growth and household incomes. The research team writes that there is support for the hypothesis that the effects of broadband follow an S-curve, where the positive effects increase more rapidly after a certain level of broadband speed, but that the marginal effects can also be expected to decline after a certain level.

The research team has attempted to quantify the consequences of different speeds. However, there is little evidence regarding the effects of higher broadband speeds at the high levels Swedish now has, and the results can only be regarded as an indication. A rough estimate has been made of the status of broadband access by 2020 as forecast by the Swedish Post and Telecom Agency. According to this forecast, 99.5 per cent of all households and workplaces will have access to broadband at a speed of at least 30 Mbit, and 94.5 per cent will have access to at least 100 Mbit. The estimate indicates that the total contribution to GDP growth will be around SEK 10 billion (or 0.25 per cent of GDP) until 2020.

A scenario has also been created for a 5 per cent higher coverage rate with broadband of at least 100 Mbit, compared with the Swedish Post and Telecom Agency's forecast (that is 99.5 per cent). Such a scenario would, in the short term, lead to a further increase in GDP of between SEK 310 million and 1.6 billion by 2020, alongside the previous rough estimate of SEK 10 billion.

The scenario would lead to an estimated 3000 extra jobs (presumably temporary), increased household incomes and approximately 400 new companies. However, the research team points out that these estimates are very uncertain. In the long term, there would be possible productivity gains among companies, and efficiency gains in public sector activities. Innovative capacity is growing in regions where faster broadband is available.

In the long term, the impact on employment is expected to be neutral, but there may be a transition towards more qualified tasks, more highly educated labour and certain industrial sectors. Paradoxically though, there is a risk that improved access will benefit the groups, sectors and regions that "need it less".

An estimate has also been made of a development at a lower level compared to the Swedish Post and Telecom Agency's forecast. According to this scenario, 94.5 per cent of the population would have access to 30 Mbit/s and 89.5 per cent to 100 Mbit/s by 2020. A development in this direction would lead to a fall in GDP growth of between SEK 750 million and 3.7 billion, compared to the development in the Swedish Post and Telecom Agency's forecast. With such a scenario around 600 new companies would fail to be established. Fewer job opportunities would be created (approx. 5000). The research team points out that the differences between the various scenarios as a whole, at the national level, is not strikingly great, even though the differences between the scenarios may be expected to increase in the long term (the benefits have only been estimated until the year 2020). One explanation as to why the differences are not greater is that one can assume that the

increase in coverage will primarily occur in sparsely-populated areas, where the economic effects of expansion are often smaller.

Based on these – admittedly very rough – estimates, the researchers consider that a large increase in public funds cannot be justified. Firstly, the established positive effects are not sufficiently large and, secondly, it is uncertain what effects expanded support would have on the actual development of the broadband system. It is, at any rate, clear that the negative effects of a reduction in support would be greater than the positive effects of an increase in support.

Positive economic effects of mobile telephony

There is fairly extensive international literature about the economic effects of mobile telephony and mobile communications. The research area has shown strong links between, above all, mobile penetration (measured in terms of share of the population) and GDP. In Sweden, however, penetration is, in principle, complete, in terms of the number of users, and coverage in some form, even though there are areas that lack satisfactory coverage, and there is a lack of methods and data to enable evaluation of the benefits of further mobile coverage.

Difficult to examine the economic effects of robustness

The field of reliability and robustness is not an established research area, and there is no common view of what needs to be examined and how. Nor is the reliability of the networks followed up in the same way as, for example, access to broadband and data speeds, which means that there is a lack of data here. It has therefore not been possible to make a quantitative assessment of the consequences of robustness.

Several potentially positive social effects of broadband

The social and societal effects of broadband have not been as well researched as the economic effects.

On the basis of earlier research, the research team has identified several potentially positive, and some negative, social and societal effects. The research mainly indicates that access to broadband helps to increase equal opportunities and inclusion. At the same time there are studies that suggest that broadband can reinforce social divides. The technology favours more highly qualified individuals, companies, regions and sectors, and can therefore lead to exclusion or widening the gap between different groups.

Previous research has shown that the internet can serve as a platform for greater political and social commitment, but there is fairly little evidence to prove this. The research team, examined the relationship between broadband speed and participation in the general elections of 2010 and 2014. There was a significant correlation, primarily between access to broadband at speeds of at least 10 Mbit/s and increased voter participation. The research team stresses that continued research is needed to examine alternative interpretations and models for this correlation, but it nevertheless considers that the study indicates that broadband can have a positive impact on democracy and commitment to social issues.

On the basis of international research, the research team can see that broadband potentially has major effects on health and access to healthcare, in particular among older people. In this context, broadband quality and speed will presumably be of relatively great importance. Likewise, the research indicates that broadband has a major potential effect on learning and education. The research can identify positive effects on learning in the form of stimulation and access to information and applications. However, negative effects on learning also exist, on account of distraction and involvement in unproductive activities. According to the research team, the mixed results probably depend on the fact that the education system and tuition have not been adapted to increased broadband access.

According to the research team's own examination, there is a correlation between test results in Swedish compulsory schools and access

to broadband. Broadband (primarily mobile), with higher speeds, was positively associated with the results of national tests, primarily in mathematics, but also in English in year 9. However, the corresponding correlation with Swedish was negative. The research team points out that education is an area in which very fast broadband can come to be of particularly great importance.

Negative environmental effects in the short term, positive effects in the long term

The environmental effects of broadband have not been as well-researched as the economic effects either.

Broadband can affect the environment at three levels. Firstly, there are direct effects relating to manufacturing, distribution, management and waste management of physical ICT equipment. These directs effects often have a negative impact on the environment and consist, for example, of increased energy consumption and CO2 emissions.

Secondly, broadband has what is known as enabling effects. These are, on the whole, positive for the environment and involve the development of other products and services in a way that is favourable to the environment. They may include smart electricity grids, more efficient transport or de-materialisation in the form of listening to music digitally, video conferences and distance work. Empirical evidence also shows that access to faster broadband increases the likelihood of teleworking.

Thirdly, there are systemic effects, which means that behaviours change. Broadband facilitates information, for example, about current energy consumption or how "green" a product is, which can lead to changes in consumer behaviour. The systemic effects, have the greatest environmental impact, but are at the same time the most difficult to measure.

The conclusion of the research team is that the positive effects of broadband are probably greater, and potentially a lot greater than the negative effects, but that the positive effects take longer to materialise

and are more uncertain and more difficult to prove. Optical fibre is the most energy efficient, while mobile technologies are the least energy efficient. Higher data speeds lead to greater energy consumption. IT infrastructure, and in particular mobile networks, are at the same time becoming more energy efficient over time, which means a rapid reduction in energy consumption per user.

The research team's own study using Swedish data showed a clear, but weak correlation between mobile data speed and driving. In other words, better mobile internet could lead to more driving. On the other hand, there are much clearer links between access to broadband at speeds above 10 Mbit/s and reduced driving outside cities. In the cities, they also found considerable negative effects on driving in connection with access to broadband at speeds above 100 Mbit/s. These negative effects compensated more than adequately for the increase in driving that was identified in connection with mobile data speeds.

Very large potential effects in the long term

An overall reflection on the Chalmers study is that well-developed and fast broadband already has positive economic effects today. Furthermore, broadband has a very extensive potential positive effect, both measured in purely economic effects and effects on, for example, health and social participation. The study also shows that the transition can, in the short term, lead to a number of negative effects. The immediate effects of greater access to broadband and broadband speeds may be negative for the environment, and the results in the field of education are mixed. A pattern that recurs is that many of the positive effects are greatest in the services sector, or around densely-populated areas or towns, and among households and individuals with high education levels. The research team highlights that access to broadband tends to replace unqualified labour with tasks of a more routine nature. Improved access to very fast broadband can therefore - paradoxically enough - involve a risk, at any rate initially, of favouring the groups, sectors and regions that "need it less".

Several results indicate that the truly extensive, positive, effects will only emerge after a period of transition. An adaptation of activities, processes and organisations, as well as education and practice are needed before the benefits can be generated. At the same time, the research shows that these processes are neither permanent nor uniform, and that they can be influenced. As expressed by the research team, broadband is a necessary, but not a sufficient condition to enable Sweden to make use of the possibilities that digitisation offers.

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