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NORDUnet

10 April 2001

NORDUnet in 2001

Reply to a Mandate from Kontaktgruppen of the Nordic Council of Ministers

1. NORDUnet's tasks

NORDUnet is a common function of the networks for research and education in the Nordic countries, in the following called Nordic *NRENs*. They have chosen to organise their international connections in common instead of each having to operate own international connections. NORDUnet therefore operates more as a common department of the Nordic NRENs and less as an external service provider.

Historically, the Internet started among universities, and research networks have since existed in parallel with the commercial Internet, in the following called the *commodity Internet,* and today a worldwide system of networks for research and education exists besides the commodity Internet.

The network traffic of an institution within research and education therefore consists of traffic with other research and education institutions in the world, *research traffic*, and traffic with sites on the commodity Internet, *commodity traffic*. The research traffic requires a higher *service quality* to allow development and piloting of new applications before they can be introduced into the commodity Internet.

The Nordic NRENs give full networking services to their institutions. They not only interconnect institutions for research and education but they also connect the institutions to the commodity Internet, such that an institution gets all its networking needs satisfied by an NREN. This is similar in the rest of Europe, but different in the USA because of different regulations there.

The amount of network traffic of the connected institutions has increased by a factor 2 every year since networking was introduced, and there is no sign of slowing down of this growth.

NORDUnet's tasks may be summarised as follows,

    a) Interconnect the Nordic NRENs into a common platform
    b) Increase the value of the funds used for Nordic NRENs
    c) Connect the Nordic NRENs to the rest of the world
    d) Act as a framework for Nordic network collaboration
    e) Represent the Nordic NRENs in international collaborations

a) Interconnect the Nordic NRENs into a common platform

NORDUnet provides an infrastructure for collaboration within research and education in the Nordic countries. This infrastructure also constitutes a Nordic platform for collaboration with the rest of the world. A Nordic country is small on a world scale and cannot have world class specialists in all fields of research. However, by pooling of
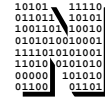
resources, which is particularly advantageous in the Nordic area because of the homogeneity of the countries and the excellent traditions of Nordic collaboration, one may compensate for the size drawback.

Technically, the intra-Nordic infrastructure is dimensioned with the same capacity as a Nordic NREN to assure there are no barriers (bottlenecks) between the Nordic institutions on the networks.

b) Increase the value of the funds used for Nordic NRENs

NORDUnet increases the value of the funds used for the Nordic NRENs in two major ways. One is by sharing specialist knowledge, which has assured that the Nordic NRENs are maintained at an advanced level relative other NRENs in the world. The other is by exploiting the "economy of scale" in the purchase of capacity because NORDUnet acquires bandwidth and commodity Internet services for the sum of the Nordic NRENs. Furthermore, commercial providers regard NORDUnet as a valuable partner in network development, and they consider NORDUnet an important reference customer. Responses to NORDUnet calls for tender therefore frequently offer substantial price reductions in return for access to NORDUnet's experience, or the possibility to use NORDUnet for publicity.

c) Connect the Nordic NRENs to the rest of the world

The connection to *the rest of Europe* is realised as a connection between NORDUnet and the European research network backbone TEN-155, and soon Géant. NORDUnet's connection has capacity similar to a large European country because a Nordic country has more international traffic, compared to its size, than a large country. There are several advantages for the Nordic NRENs of connecting via NORDUnet. One is the economy of scale, because the cost sharing agreements in TEN-155/Géant favour large capacity; another is that the intra-Nordic system extends this capacity into each Nordic NREN (except Iceland). A connection to TEN-155/Géant gets 50% economical support from the European Commission; furthermore, discussions are under way about support to the intra-Nordic system[1]. As a result of the intensive use of networking in the Nordic area NORDUnet is the second largest user of the European backbone, surpassed only by Germany.

The connection to *the USA* is NORDUnet's external connection with the highest capacity, because the traffic with the USA is about 4 times larger than with Europe. The USA traffic consists of both research and commodity traffic due to the importance of the American commodity Internet. The connection to the USA was first set up in 1988 as a dedicated transatlantic link to NSFnet and carried mainly research traffic, as the commodity Internet was not yet there. After the termination of NSFnet in 1996 and with the appearance of the World Wide Web, the commodity traffic became increasingly important, also because most American universities were connected only to the commodity Internet. So, NORDUnet's dedicated links were supplemented by connections in Stockholm to the commodity Internet with the result that at the end of 2000 only a third of the capacity was on dedicated transatlantic links. In this way the lower price for connection to the

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[1] Such support existed during the previous TEN-34 European backbone but was terminated in 1999.

commodity networks could be exploited. In 2001 the USA system will be totally renewed. The new system will have dedicated transatlantic capacity only for research traffic, whilst all the commodity traffic will be carried over connections in Stockholm to a commodity network.

NORDUnet is directly connected to the Internet2 network Abilene and connected to the other American research networks at the STAR TAP in Chicago. The STAR TAP is a NSF funded interconnect facility for research networks from all over the world. NSF contributes to the cost of the intercontinental links to the STAR TAP, in the case of NORDUnet by 320,000 USD/year. The support is given after peer evaluation of the collaboration possibilities a link will give. It was recently reviewed and the support to NORDUnet was maintained.

The connection to *research networks in countries outside Europe and USA* is made via the STAR TAP where NORDUnet meets research networks from Canada, South America, the Far East, and part of Russia.

For historical as well as geographic reasons NORDUnet has direct connections to *research networks in the CEE countries* Estonia, Poland, Ukraine and Russia. These networks use NORDUnet in the same way as the Nordic NRENs, and they pay NORDUnet for the cost of the resources they consume, thus making the arrangement cost-neutral for NORDUnet. The service is attractive for the countries because of the price and the service quality.

Connection to *the commodity Internet* is made in two ways. The preferred way is by *peering,* which means an interconnection without exchange of money. Peering capitalises on the investments in the Nordic NRENs and NORDUnet. The alternative is a payable subscription to a commodity provider. Unfortunately this is the case for commodity traffic with the USA where the market positions are such that NORDUnet must pay for a connection. During recent years these payments have been NORDUnet's single largest expense, but the competition has now driven down the prices so much that they will be less dominating in the future.

d) Act as a framework for Nordic network collaboration

For many years now NORDUnet has been a natural forum for collaboration between the Nordic NRENs. Such collaboration comprise e.g. network security, new and advanced network protocols, and video conferencing, not to forget the NORDUnet conferences that gather hundreds of experts from the Nordic countries. Also, when the NORDUnet Board realised a need for a coordinated Nordic effort to develop advanced network applications NORDUnet proposed and helped start up the Nordunet2 project.

e) Represent the Nordic NRENs in international collaborations

NORDUnet has formal collaboration agreements with Internet2 in the USA, the Canadian Canarie organisation, SingaREN in Singapore, and the Russian ministry of education, and less formally expressed agreements with a dozen others. NORDUnet acts as one focal point for international contacts and thereby makes the Nordic NRENs visible and attracting collaboration partners. NORDUnet represents the Nordic NRENs in the Géant/TEN-155 Policy Committee, in the STAR TAP Advisory Committee, in the

Abilene International Task Force, and in ad hoc committees around the European Commission. As a detail it should not be forgotten that the representations also saves people time and travel costs for the Nordic NRENs. NORDUnet is regularly visited by delegations from research networks in the world. Among the more distant, Japanese delegations have visited twice and Singapore once during the last two years.

2. NORDUnet today

It is generally recognised that NORDUnet and the Nordic NRENs give services to the users in research and education that are among the best in the world.

NORDUnet has given the Nordic NRENs worldwide visibility.

A fact that substantiates this is the NSF support to NORDUnet mentioned above. Another is the wish by NRENs in the Baltic countries to connect to Géant via NORDUnet, yet another is Russia's ministry of education's reliance on NORDUnet as international provider for its universities. Funding bodies, like the European Commission, also rely on NORDUnet as an enabling facility for collaboration in the Baltic region. Also, the providers regard NORDUnet as an attractive customer because the publicity value and collaboration benefits.

3. Perceived problems

a) It has been argued that NORDUnet were too expensive.

To get this discussion on a firm footing the diagram below shows the yearly contributions to NORDUnet by each of the Nordic countries since 1994, when NORDUnet was organised as a Danish A/S.
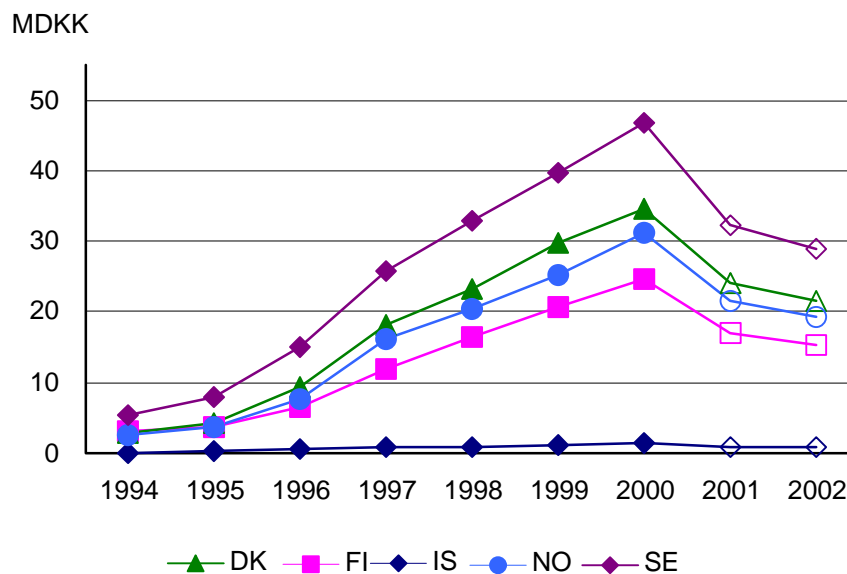
The data for 2001 and 2002 are budget estimates.

During the same period the capacity of the network has increased by about 1000 times.

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NORDUnet

The cost of NORDUnet is the product of two opposing developments, one is the yearly doubling of the demand for capacity, and the other is the decrease of the capacity unit price. This decrease is caused by the combined effect of intensified competition in the market and of technological advances, where the latter gives spectacular increases in the amount of capacity one may get out of a given investment. A manifestation of these factors is the decrease of NORDUnet's expenses in 2001 and 2002 that occur even with a doubling of the demand each year. Until 2001 the unit prices decreased by about 40% per year which, combined with the demand doubling, gave a cost increase of about 20%/year[2].

The absolute level of the cost may be assessed in different ways.

Based on data from a recent call for tender the price for a 2.5G port to the European Géant backbone network is expected to be about 30 MKKK/year. In this comparison it should be noted that NORDUnet gives a 2.5G service that includes full access to the commodity Internet, whilst Géant does not have a connection to the American commodity Internet. Such connection is NORDUnet's largest cost element.

NORDUnet's cost may also be related to the situation of the end user. It is estimated that the Nordic NRENs altogether have up to 1 million users. Assuming this number, NORDUnet's cost per end user is less than 100 DKK/year, an amount that is comparable to the cost of the electricity needed for the end user's computer. The cost per end user has decreased continually during the last years.

NORDUnet buys services according to the rules for public tendering. The fast decreasing prices advocate frequent tendering to benefit from the lowest price available at any moment. However, there is limit to how frequent one may issue a tender because a change of provider generates extra costs for the provider as well as for NORDUnet, a cost NORDUnet must pay in the end. The provider must amortise an initial investment over a shorter period, and NORDUnet must pay for an overlap period between the old and the new provider. As a compromise NORDUnet now generally applies a contract period of 2 years. This means that NORDUnet's cost level has cycles; immediately after a new tender they are the lowest, whilst at the end of the 2 year period they most probably are higher than the best obtainable price at that time (even after possible renegotiations during the contract period). In 2001 NORDUnet was at the end of such a cycle, and after a call for tender it obtained a decrease in the unit cost of USA services by a factor 4.

Finally, the technical system for research and commodity traffic with the USA has changed over time from using the same system for both, into a separation that allows independent dimensioning of the capacity for each and thereby avoiding that requirements from one generate unnecessary costs for the other.

b)   It has been argued that NORDUnet's service level were too high.

NORDUnet gives the service quality that the Nordic NRENs demand. It does not set an own specific "NORDUnet service level". During the years it has proved important for the

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[2] The year 2000 was particular difficult for NORDUnet because the main expense was paid in US dollars which then was 30% higher valued than at the time the contracts were made.

NRENs to have a NORDUnet service level comparable to the national service quality to avoid bottlenecks between the users.

The demands by the research traffic and by the commodity traffic are different because the advanced high bandwidth research applications, that are essential for the development of the Internet and piloting of new services, need a larger ratio between capacity and load than does the commodity traffic. However, this does not imply that the service level for the commodity traffic can be degraded to e.g. a usual commodity "modem access" level. There are two reasons for this, one is that most American universities may be reached only via the American commodity network (a situation which is different from Europe), so there is some research traffic also over the commodity network connection. The other is that the accumulated cost of wasted time at a computer waiting for response, may easily exceed the cost of maintaining a usable service quality because of the large number of users, thus making it is more economical overall to invest in NORDUnet.

4. Changes

NORDUnet has continuously adapted to the dynamic environment in which it operates by keeping to its tasks and being pragmatic in its solutions. The main element of NORDUnet's strategy is therefore pragmatism and, together with the Nordic countries' funding authorities understanding of the need for networking, it has been one of the major reasons that NORDUnet is able to maintain its good services and its leading position among research networks.

NORDUnet operates with a minimum of staff, but this has meant that some areas of coordination between the Nordic NRENs have not been optimally addressed. It was the case for applications development where NORDUnet as a consequence proposed the Nordunet2 project, which is now managed by specialists outside NORDUnet. However, Nordunet2 contains little basic network technology development; such activities are carried out by the Nordic NRENs themselves without much coordination or collaboration.

NORDUnet should therefore consider extending its activities by also coordinating network technology development among the Nordic NRENs, as it would benefit from the pooling of (brain) resources. It would mean changing NORDUnet somewhat in the direction of an Internet2 organisation. It will require more staff in NORDUnet, and thus added cost, but it is well in line with NORDUnet's task of increasing the value of the funds used for networking in the Nordic countries.

5. Conclusion

An analysis of NORDUnet's tasks, its costs and services has not revealed causes for major changes. It has demonstrated that NORDUnet's strategy of pragmatism has worked well in the dynamic world of networking and telecommunications. Recent technological developments and increased competition in the market have created an advantageous situation where NORDUnet can fulfil its purpose without continuing budget increases.