

The Case for National Research and Education Networks (NRENs)

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Introduction

There is a general perception in the research and education community that National Research & Education Networks (NRENs) are special and provide services and support unavailable elsewhere. From time-to-time counter views have been voiced generally from outside the community. This paper provides a short history, an assessment of the current role of European NRENs and explores the case for their continuation.

History

In the 1970's research and education networking existed only as small ad-hoc arrangements to meet local needs. These were the times of non-inter-working proprietary operating systems and communications protocols.

Around the end of the 1970's the activities in some countries started to gel into more organised projects exploring how to integrate the existing ad-hoc facilities into a common set of standard ways of working that could be used on a national or even international basis. The underlying technology that supported these networks was copper wire, owned and operated by monopoly suppliers willing to lease circuits. The cost of leasing a circuit seemed directly linked to the amount of revenue that the line might generate if it had been used for telephone calls and consequently was very expensive.

Whilst big financial institutions with a very limited set of applications could commission specialist software to meet their needs, providing the means to encourage innovation across disparate research and education sectors around Europe was an entirely different matter. It was clear that the commercial providers were very good at delivering telephone services but unprepared to deliver advanced data networking services.

Many governments recognised the importance of providing their academic communities with good data network services and were willing to provide some funding towards the development. This led to the initiation of projects and teams that would work on integrating the disparate components in a way that would bring about pervasive inter-working between systems. By 1985, these activities gave birth to eight dedicated organisations in Europe and by 1990 the number had risen to fifteen.

Serious computing power was only available in specialist centres. The computers of this period were large machines, housed behind glass and guarded by the operators in an air-conditioned and clean environment. Access to the centres was either by visiting in person or using some dialup link with modems and terminal adapters.

Whilst researchers and other users wanted remote access to these computers, engineers and scientist recognised the benefits of being able to transfer data between machines. Networking technology was relatively slow and simple. If one was sufficiently motivated, with the help of some programming skills, simple

components and a soldering iron one could enable computers in the lab to exchange data. Bearing in mind that off the shelf modems operated at 300 baud (0.3kbps) file transfer over a telephone line was an excruciatingly slow business.

Several pioneering European data networks that developed in the research and education community were based on X.25 supporting a raft of applications including those implemented to the coloured book standards¹. In the US they were based on Network Control Program (NCP) & Unix-to-Unix Copy (UUCP).

What was common to both sides of the Atlantic was the innovative and pioneering spirit in the research and education community that led to rapid advances which would ultimately find their way to commercial and public networks.

In the UK, the JANET network initially operated at speeds of 9.6 kbps and by the early 1990's had reached 8 Mbps which was the fastest X.25 network in the world at the time. Along with the underlying transport systems, application protocols for terminal access, file transfer and electronic mail were supported to provide a range of useful services to the users. What had developed out of necessity layed the foundations for what has become an effective and enduring model for serving the demanding requirements of the research and education community.

The combination of knowledgeable users having the skills and ambitions was the key to making working solutions in a world where the telecommunications monopolies could see little economic reasons for developing such services.

Whilst it takes advanced laboratories and huge resources to develop the current range of networking components such as 40 Gbps optical interfaces, optical switches and massive routers, the NRENs are still at the leading edge of integrating these devices into pervasive end-to-end services that are capable of meeting the needs of education and researcher users.

The question some people have been asking is: "why is this approach of using NRENs still needed when industry is capable of delivering Internet services to the general public".

The remainder of this paper details some of the unique features of the NRENs.

¹ Wikipedia has an article on the coloured books
URL: http://en.wikipedia.org/wiki/Coloured_Book_protocols

The European NREN model

In many respects, Europe has become a world leader in research and education networking. One of the enabling factors has been the way in which Europe has organised itself. The organisational model of a single NREN per country with co-ordination and collaboration at the continental level has been the key to success. The European model is being copied in other world regions.

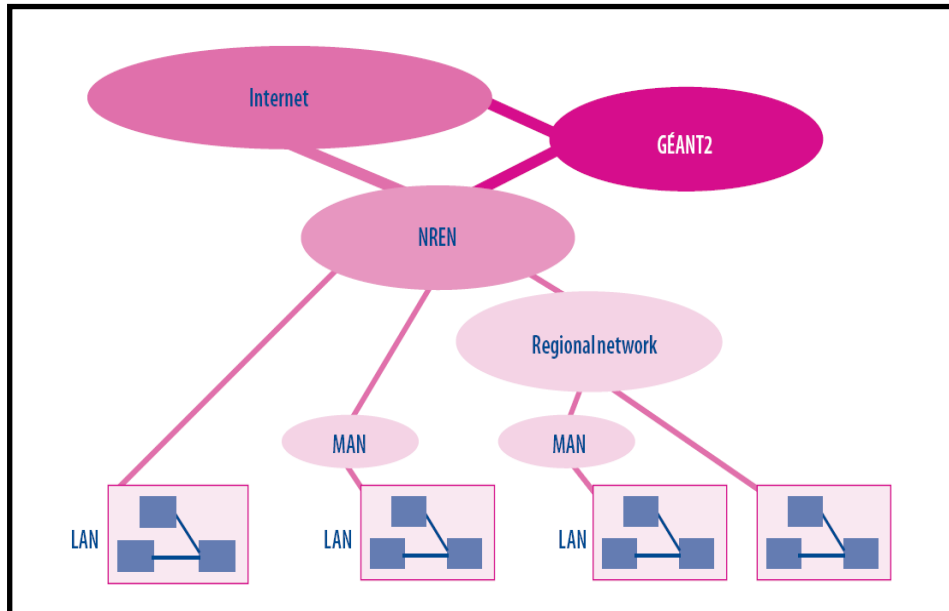


Figure 1: Structure of research & education networks in Europe²

Closest to the researchers, teachers and students is the Local Area Network (LAN) at the site or campus where they work. The LAN is the responsibility of the institution: the research institute, university, school etc. The local staff providing network connectivity and related services at the campus level play a crucial role in the networking chain. The local technicians are in a good position to understand the needs and aspirations of the users and help them to develop and use networked services. They also provide an information bridge or conduit to other members of the support chain responsible for other levels of the network.

At the national level there is the network that connects the local networks of the research institutes and institutions of higher education in a country. This level is the responsibility of the National Research and Education Networking organisation (the NREN) of that country. In some countries, campus networks are not connected directly to the national research network, but via Metropolitan Area Networks (MANs) or regional networks.

At the international level connectivity between the European NRENs is provided by the GÉANT2 network managed by DANTE on behalf of the NRENs. Connectivity to research and education networks on other continents is also provided by DANTE, however some NRENs have their own links to key destinations. In addition the concept of using Cross-Border-Fibres commissioned or operated by NRENs is becoming more prevalent between European NRENs.

² Innovation, Integration and Deployment (EARNEST Summary Report), 2008
URL: <http://www.terena.org/activities/earnest/docs/20080429-final-report.pdf>

Connectivity to the commercial Internet takes place both at the NREN level and, to a limited extent, at the GÉANT2 level.

This model has led to the development of a community of staff dedicated to cooperating and working together for the common good of the whole research and education community. There is evidence that the availability of cost effective and leading edge NREN network services enables and even encourages technological spill-over into the commercial sector which ultimately benefits society as a whole^{3,5}. Conversely, the absence of such facilities hampers such development and even excludes countries from advances that could help their economic development.

NREN Characteristics & Services

It is clear from such studies as SERENATE⁴ and EARNEST^{5,6} that research and educational users make high demands for advanced network services not generally available in a pervasive way on the commercial market. These pre-commercial developments often find their way into the competitive commercial ISP networks some years after they enter common usage in the NRENs.

Some specific benefits that can be attributed to the NRENs:

- *The NREN community has pioneered the development and use of hybrid networking technology in which general IP traffic and high bandwidth (10 & 40 Gbps) light paths may be supported on a single infrastructure and not interfere with one another. Ultimately this will lead to dynamic bandwidth on demand being available to all who need it, particularly those engaged in E-Science.*
- *Pan-European Performance Enhancement and Response Teams (PERTs) are being put in place. The PERTs will investigate and correct problems in the pan-European infrastructure to ensure an optimal end-to-end application performance for the end users. It is unlikely that support will be available end-to-end across commercial networks in the near future.*
- *A confederation of trusted federations is being built to support pan-European Authentication and Authorisation between community users, resources and the development of dynamic Virtual Organisations which are needed to support collaboration between geographically distributed teams. These Authentication and Authorisation Infrastructures will have local management, the level of granularity and control that the community requires and will be federated at the European level.*

³ REANNZ Value Proposition "Underpinning New Zealand's future economy", REANNZ, June 2008
URL: <http://www.karen.net.nz/assets/Uploads/Publications/REANNZ-Value-Proposition.pdf>

⁴ SERENATE Final Report, 2003
URL: <http://www.terena.org/publications/files/SERENATE-FINAL.pdf>

⁵ Innovation, Integration and Deployment (EARNEST Summary Report), 2008
URL: <http://www.terena.org/activities/earnest/docs/20080429-final-report.pdf>

⁶ Report on Researchers' Requirements (EARNEST Sub-Study), 2007
URL: <http://www.terena.org/activities/earnest/docs/20080204-researchers-requirements.pdf>

- *NRENs are in a position to undertake applied research along with members of its own constituency in a way the commercial concerns would find difficult. This has allowed the development of national and international testbeds and pilot services many of which result in production services.*
- *Advanced NRENs stimulate innovation in the research and education community and bring forward technological advances. These developments eventually find their way to commercial ISPs and benefit the public at large. NRENs are consequently an important asset for technological advancement, economic growth and prosperity in their country.*
- *The NRENs are part of the research and education community and hence close to the constituency that they serve. They are generally independent of specific suppliers and solutions and are trusted by the community to deliver good high quality services at an economic price.*
- *Almost all national telecommunications infrastructures were monopolistic providers of infrastructure. Many studies including that conducted as part of SERENATE demonstrate the high pricing structure that follows from such a situation. The community has worked with the European Commission, national governments and alternative suppliers to counter the damaging effects of such market conditions. These actions have had beneficial effects for the market as a whole. Whilst not completely solved, these activities have contributed to the lowering of barriers in the digital divide. The principle of solidarity amongst European NREN community members has brought about inclusion of these disadvantaged regions whilst maintaining a fair balance of cost sharing.*
- *NRENs have been able to bring the benefits of collective buying power to the universities by procuring networks and services on a national basis. This provides savings for the community and hence the country as a whole. The same is true on an international basis where DANTE has been able to procure international connectivity on behalf of all European NRENs.*
- *Individual institutions or indeed countries may find it difficult to become a serious player on the international stage. Being affiliated to the NREN community and representing it on the international level gives them recognition and hence the ability to actively participate.*
- *The independence of NRENs is a valuable asset for advising in the development of national policy on education, research and IT. NRENs occupy a position of trust in this respect and are called on to provide guidance uninfluenced by the pressures and demands of commercial business. Many NRENs are recognised as being a pool of expertise that is an asset to its country.*

Why it is reasonable to provide explicit justification for the NRENs?

From time-to-time there have been discussions within the NREN community about the special position that NRENs occupy. Whilst for the reasons stated earlier in this paper it might seem clear to many that NRENs are a force for general or public good, it would be complacent for any organisation not to consider its *raison d'être* and be in a position to justify its existence. Furthermore, NRENs are generally users of public money (directly or indirectly) so it is essential that they are open and accountable for its use and are able to demonstrate the value and justification for such funding.

If NRENs only provide the same services as are readily available on the commercial market and NRENs are more expensive than the commercial market, then there is a clear case for them to disappear. This is currently not the case. NRENs provide innovation and end-to-end services not generally available in the commercial market and are still the source of much Internet development.

Despite the above, it is possible that at some time in the future, the position and value of NRENs might be questioned. Scrutiny could come from several quarters and might raise the following potential issues:

Source

Potential Issues

- | | |
|--------------------------------|--|
| • Funding Bodies | • Need for NRENs when commercial ISPs exist
• Need for central funding |
| • Telecommunications Regulator | • Position with regard to scope of service
• Data collection and retention |
| • Commercial Operators | • Possible distortion of market |
| • Government | • Need for NRENs when commercial ISPs exist
• Need for central funding
• Possible distortion of market |

The remainder of this paper examines these potential issues.

Addressing Questions and Issues

- What is the need for NRENs when commercial ISPs exist?

NRENs came into being at a time when networked data communications were not generally provided by the commercial sector. The NRENs and research users' community became adept at developing the necessary communication protocols and finding innovative ways of using the network to support education and research. This situation is perpetuated today. Although leading edge industrial research leads to new high-speed and advanced components, much of present day Internet innovation is still undertaken within the education and research community. Commercial ISPs do not have sufficient motivation to reach the level of innovation needed by the education and research community.

Whilst it is true that some commercial organisations (for instance Google) offer "free-services", institutional integration and management will have a significant cost⁷. NREN provided services may be more economic than using "free-services".

- Why is there a need for central/government funding of NRENs?

It seems reasonable that network users should be prepared to make a contribution for the production services they use. As a result of their short term funding constraints, user institutions find it more difficult to provide funding of innovation and the large periodic investments needs to fund the step improvements in the network when there is a change in underlying technology.

Application of the principal/agent theory and transaction costs, suggest that a hybrid funding model may be beneficial^{8,9}. Users pay a fair contribution to the production services costs, whilst government takes the longer term view funding innovation and upgrade.

Most European NRENs follow a hybrid model of funding to some extent.

- Regulatory position of NRENs

NRENs offer their services to the well bounded and closed community of education and research users. Sometimes equally well bounded and related groups are added to the core education and research community if there is an identifiable benefit in doing so. The community using the NREN network is thus a well bounded closed-user-group. NRENs are not in the business of providing public services and hence should not be regarded as a public network operator.

It makes good sense for NRENs to adopted best industry practice in the operation of their networks despite being a non-public network operator.

There are arguments that making NRENs register as public network providers, with the administrative requirements it imposes will change the very nature of NRENs and detract from their innovative and pioneering capabilities.

⁷ The Launch of Google™ Apps at USC: Determinants, Decisions, and Deterrents
URL: www.internet2.edu/presentations/fall08/20081015-googleapps-bellina.pdf

⁸ Networks for Knowledge and Innovation, A Strategic Study of European Research and Education Networking, SERENATE Summary Report, TERENA, December 2003
URL: www.terena.org/publications/files/SERENATE-FINAL.pdf

⁹ REANNZ Today An analysis of advanced networking in New Zealand, REANNZ, June 2008

- Regulatory requirements for data collection and retention

The costs of putting in place facilities to meet the requirements of the European Data Retention Directive¹⁰ are not yet known. Estimates have been made in several papers including an extensive technical evaluation undertaken by the Faculty of Computer Science University of Vienna, Austria¹¹. The precise cost cannot yet be accurately predicted. The expectation is that the administrative and financial burden would be high and detrimental to education and research.

- Possible distortion of the market

The NRENs operate a network for a closed user group that have advanced requirements to support their research and education users. These requirements are not generally satisfied by commercial offerings from ISP. The NRENs do not compete with commercial ISPs, but offer a different level of service in parallel with them.

It would be beneficial for both NRENs and ISP to develop collaborative links and work together of developments for the future. Indeed the SERENATE¹² study made two major recommendations in this respect:

National governments should be aware that research and education networking in their country, and in particular their National Research and Education Network organisation (NREN), is an asset for economic growth and prosperity. It is a source of innovation and provides fast and widespread technology transfer to society and industry. Promoting such technology transfer should be an explicit goal of NRENs.

NRENs and industry should ensure that collaboration between research teams in industry and teams in universities and publicly funded research centers can be supported effectively.

SERENATE
Study into European Research and Education Networking As Targeted by e-Europe
Summary Report, TERENA, December 2003

¹⁰ Directive 2006/24/EC of The European Parliament and of The Council
<http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2006:105:0054:0063:EN:PDF>

¹¹ The EU Data Retention Directive 2006/24/EC from a Technical Perspective
G. Stampfel, W. Gansterer, M. Ilger, K. Stark, Department of Distributed and Multimedia Systems
Faculty of Computer Science, University of Vienna, Austria, October 2007

¹² Networks for Knowledge and Innovation, A Strategic Study of European Research and Education
Networking, SERENATE Summary Report, TERENA, December 2003

Conclusions

It can be demonstrated that the NRENs do indeed occupy a special position outside of the commercial Internet market. They operate as not-for-profit organisations serving a closed user group consequently there is a case for them to be designated as non-public networks.

NRENs are still the source of much Internet innovation much of which will spill-over into the commercial Internet for the benefit of society in general.

National governments should regard their NRENs as a national asset to be fostered and supported by central contributions to a hybrid funding model. In this way they will benefit industry and ultimately their citizens generally.



Figure 2: European NREN members of TERENA

Epilogue

There has long been debate regarding the use of public funds to drive innovation with particularly important contributions from Francis Bacon¹³ (1561–1626) and Adam Smith¹⁴ (1723-1790). There are philosophical arguments for the use of public funds to support science and innovation and there are equally compelling arguments against such use of public funds. More recently, the Organisation for Economic Co-Operation and Development undertook an analysis that is published in *The Sources of Economic Growth in OECD Countries*¹⁵ which seems to disprove Smith's assertions. No matter which side of the argument eventually proves to be accurate a common theme emerges. Innovation and hence progress is best driven when individuals and organisations take ownership of the problems to be solved.

It is commonly accepted that we now live a knowledge society in which many people value the pursuit of intellectual achievement as equally important to the pursuit of wealth. When we talk of ownership, we should therefore consider intellectual attainment as equally valuable as the creation of monetary wealth.

An NREN is almost always a not-for-profit organisation with a proportion of staff being part-of or very closely related to the research and education community. Many NREN staff are proud to be part of the community which they serve and can be highly motivated by the positive way in which their work can provide benefits that support academic advances. There is a level of "ownership" found in NRENs which is a major driver to their success. It is unlikely that such ownership could ever exist if the development of research and education networks was left to commercially motivated organisations.

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¹⁴ An Inquiry into the Nature and Causes of the Wealth of Nations, Adam Smith, 1776
URL: <http://www.econlib.org/LIBRARY/Smith/smWN.html>

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