

# TERENA Compendium

of National Research and Education Networks in Europe

> 2006 Edition



# Contents

Introduction	4		
Summary of Key Findings	6		
<b>1 Basic Information</b>	<b>11</b>	<b>5 Services</b>	<b>59</b>
1.0 NRENs that have Responded to the Questionnaire	11	5.1 Overview	59
1.1 Legal Form of NRENs	13	5.2 Network Operations Centres	60
1.2 Major Changes in NRENs	15	5.3 Performance Monitoring and Management	61
<b>2 Users/Clients</b>	<b>21</b>	5.4 Authorisation and Authentication Infrastructure	61
2.1 Overview	21	5.5 Security Incident Response	66
2.2 Connection Policies	25	5.6 Bandwidth on Demand	66
2.3 Access Capacity for Different Categories of Users	27	5.7 Grid Services	67
2.4 Number of Connections to Universities and Bandwidth	28	5.8 IP Telephony	70
2.5 Percentage of Schools Connected Through the NREN	31	5.9 Videoconferencing	71
<b>3 Network</b>	<b>33</b>	<b>6 Tasks, Staffing and Funding</b>	<b>73</b>
3.1 Overview	33	6.1 Staffing	73
3.2 Core Capacity on the Network	34	6.2 Total Budgets, 2005 and 2006	76
3.3 Expected Change in the Core Capacity in Two Years' Time	38	6.3 Income Sources	80
3.4 Core Network Size	40	6.4 Expenditure by Category	82
3.5 External Connectivity: Total External Links	42	<b>APPENDICES</b>	<b>85</b>
3.6 Dark Fibre	46	1 Alphabetical List of NRENs	85
3.7 Cross-border Dark Fibre	47	2 Glossary of Terms	87
3.8 Routers and Switches	47		
3.9 Number of PoPs and Managed Links on the Network	48		
<b>4 Traffic</b>	<b>49</b>		
4.1 Overview	49		
4.2 Traffic in 2005	52		
4.3 Traffic Load	54		
4.4 IPv6	57		

# Introduction

Since the publication of the first edition of the Compendium in 2001, it has grown into a sought-after and authoritative source of reference for all those who take an interest in the development of research and education networking. The information contained in the Compendium has continued to grow in variety and dependability, even though caution in interpreting the data remains essential.

This year's edition is the second that has been published as part of the GN2 (GÉANT2) project and that has benefited from the input from activity leaders in that project. Like last year, an attempt was made to aggregate data for groups of NRENs and to look at and partially explain multi-year trends. This year, summarised information is provided in a number of 'overview' sections at the start of each chapter, whilst the more analytical and explanatory texts are at the end of each chapter. Throughout the Compendium, analytical or explanatory text has been highlighted.

Some of the trends have again been summarised in the 'Summary of Key Findings.'

The production of the 2006 edition was overseen by a Review Panel composed of the following people: Marko Bonač (Slovenia), Sabine Jaume-Rajaonia (France), Mike Norris (Ireland), Esther Robles (Spain) and Lars Skogan (Norway). Input was also received from a number of Activity Leaders in the GN2 project, from the TERENA Technical Staff, the Secretary General and the Executive Committee. Maarten de Jong, who was recruited for this project as a Data Analyst, was responsible for reminding NRENs, handling requests for information and clarification and for preparing the tables and graphs.

Collecting data of this type typically requires the involvement of a number of people from each NREN, as well as careful checking by NREN staff. TERENA wishes to express its gratitude to all those in the NREN

community who contributed to the gathering, submitting, clarifying and double-checking of the data contained in this publication.

The Compendium consists of two parts: the basic information as submitted by the individual NRENs (available on the Web at <http://www.terena.nl/compendium>) and this publication.

Most tables and graphs first show the EU and EFTA<sup>1</sup> countries and then other countries in Europe and North Africa. A list of all those countries is given in section 1.0. Data are usually presented in alphabetical order by the English-language name of each country. An alphabetical list of NRENs included in the Compendium is in Appendix 2. This year, for the first time, countries from outside of Europe were asked to provide some basic data, in the form of responses to a mini-questionnaire. In a few cases, information from these questionnaires has been included for illustrative purposes. The full data can be found on the Web. Note that unless otherwise specified, the data describe the situation at or close to the 31 January, 2006.

It is hoped that this sixth edition of the Compendium will prove to be at least as valuable as the previous ones. Feedback is again invited and is key to the future development of the Compendium!

Bert van Pinxteren  
TERENA Chief Administrative Officer

---

<sup>1</sup> The EFTA countries are Iceland, Norway, Switzerland and Liechtenstein. Liechtenstein is serviced by SWITCH (Switzerland) and not counted separately in this Compendium.

In a number of places in this document, reference is made to the SERENATE studies. The SERENATE project was an Accompanying Measure in the Information Society Technologies programme of the Fifth Framework Programme and was supported as such by the European Union. The summary report, 'Networks for Knowledge and Innovation', ISBN 90-77559-01-9 is available from the TERENA Secretariat and on the Web, at <http://www.serenate.org/publications/d21-serenate.pdf>.

The SERENATE studies have been succeeded by EARNEST. The EARNEST studies run from March 2006 to August 2007 (see <http://www.terena.nl/activities/earnest/>).

## Summary of Key Findings

Unless otherwise specified, all NRENs have been asked to provide data that describe the situation at or close to the 31 January, 2006.

### Legal Form

The most common model in the EU and EFTA countries is an NREN which is a separate legal entity. This separate legal entity is controlled by the research and education community which itself is (largely) government funded. It is important to note, however, that several other models exist. In the other countries, there is a greater variety.

NREN development requires the commitment of all major stakeholders, such as funders and users. A governing model that allows the participation of these stakeholders would seem to be the most appropriate; such a situation can be achieved a number of different ways.

NRENs that can operate with a certain amount of independence from their respective governments may have certain advantages, such as easier decision-making procedures and the ability to offer staff attractive terms of employment. This may help to explain why this model is more common in countries where research networking has developed over many years and is now well established.

### Users/Clients

In the period 2003 – 2006, NRENs in the EU states have shown a steady increase in the number of universities connected at **Gigabit speeds**.

The SERENATE study<sup>2</sup> recommended the promotion of Gigabit networking services. Gigabit connections can be seen as a necessary, though by no means sufficient, condition for a university to engage in high-end research and learning programmes.

The Compendium data suggest that the SERENATE recommendations on Gigabit networking are being followed in many countries. It seems that fibre optic technology is allowing NRENs to leap-frog immediately to much higher capacities. Gigabit Ethernet is being introduced by many less developed NRENs and thus seems to make it possible, for the first time, to quickly address an important aspect of what was termed the ‘digital divide’ in Europe in the SERENATE study.

There is clear evidence that the connection of **secondary and primary schools** to the Internet via NRENs and also the provision of support and application services to schools is high on the agenda in many countries. The commitment by EU heads of government in Lisbon in 2000 to making Europe ‘the most dynamic and competitive knowledge-based economy in the world’ by 2010 is a common factor underlying these activities.

In a number of countries, the percentage of coverage of connected schools is either 100% or close to it. In many countries, connections to schools are funded centrally through ministries of education. The percentage of connections is expected to rise sharply in some countries because implementation of schemes to connect most or all schools has just started.

### Network

The overall trend is that there is considerable **growth** year on year. In 2006, all but three of the EU/EFTA NRENs have a capacity of at least 1 Gb/s; the most common capacity is 10 Gb/s or a multiple of this and eleven NRENs operate at this capacity.

We have data from nineteen additional NRENs. In 2006, seven of these operated at 1 Gb/s and one had a capacity of 2.5 Gb/s. What is interesting to note here is that these NRENs have made a larger jump than the EU/EFTA NRENs, thus skipping one or more of the network development stages that the EU/EFTA NRENs experienced.

---

<sup>2</sup> SERENATE summary report, p.5

The Compendium shows that for most NRENs that are part of the GN2 project, the **external link** to GÉANT is by far the most important in terms of capacity. Often NRENs also have peering arrangements at neutral Internet exchanges and many also have connections to commercial ISPs, but these do not have the same capacity as those to GÉANT. The situation is obviously different in the countries that are not part of GN2 project.

There are indications that more and more NRENs are switching over to **dark fibre**. There is a steady increase in the number of NRENs that currently have at least two-thirds of their backbone as dark fibre. This seems to be the technology of choice for NRENs that are planning to upgrade their networks now or in the near future.

As a new development, a number of countries already have or are planning to install **cross-border dark fibre links** directly from one NREN to a neighbouring NREN. The Compendium provides an overview of these links.

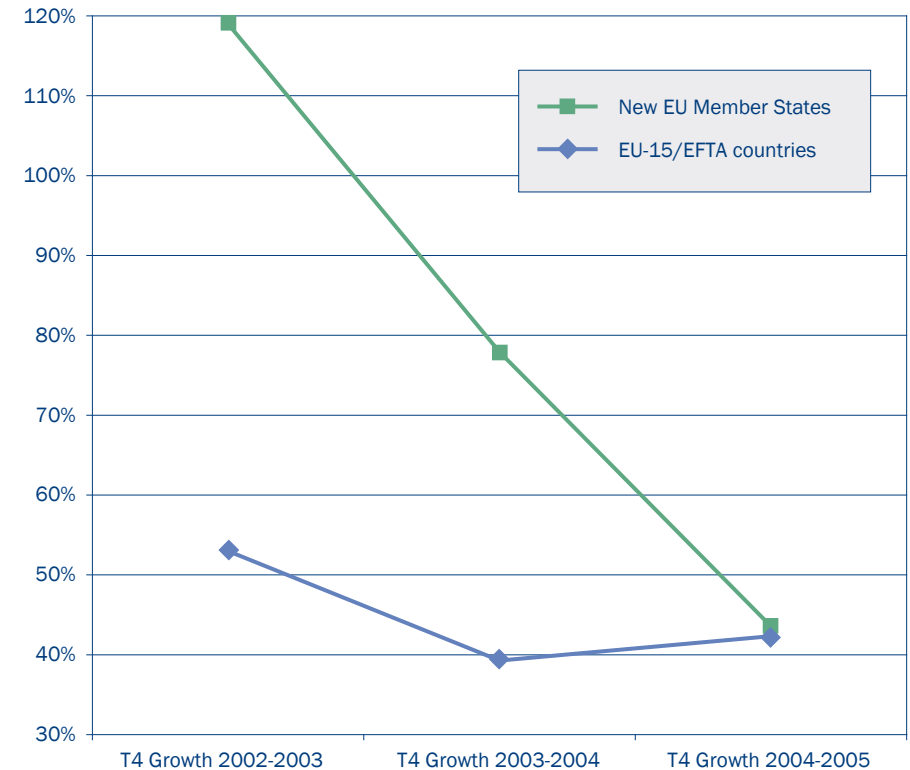
## Traffic

The 2005 edition of the Compendium showed a significant distinction between the growth rates in the new EU member states and in non-EU/EFTA countries. The growth rates in the 'new' member states were clearly higher than those in the 'old' EU member states. As is clear from the new data, the growth rates have now converged.

As stated last year, it seems that in the EU, traffic is now determined more by (changes in) user demand, than by limitations in network capacity. In the 'Other' group of countries, this is probably not yet the case.

The lower growth rate for the EU/EFTA countries that was evident when comparing 2002/2003 to 2004/2005 now seems to have stabilised. It is difficult, if not impossible, to predict what the future will bring – new Grid applications, for example, may change the picture. However, in that case,

**Inbound External Traffic (T4) Growth in the 'Old' and 'New' EU Member States, 2002 – 2005**



growth will be driven by demand rather than by changes in network capacities. In addition, changes in technology may change the picture.

The level of **NREN traffic with the general Internet**, as distinct from inter-NREN traffic, is quite uniformly high. The overall average proportion across all NRENs in the survey is approximately 75%. However, the spread between NRENs is considerable, ranging from just under 30% for RHnet (Iceland) to more than 90%, for example, for ULAKBIM (Turkey).

A single metric was derived for the level of congestion in each network element from the subjective levels reported by NRENs. The overall picture is the same as in 2005: in EU/EFTA countries, NRENs report relatively little congestion in those parts of the network within their domain of responsibility. Uniformly, they see no serious congestion on external circuits, virtually none in their core networks and little in the MAN or regional network. Any serious congestion, they report, is largely confined to access networks or, to the campus LANs of connected institutions.

The ‘Other’ NRENs report that most congestion is on their external connections. In those countries, the restrictions imposed by low-capacity external connections mean that constraints at the campus and other levels are less apparent. It is to be expected that these constraints will surface as soon as the problems at other levels have been solved.

The uptake of **IPv6** seems to be slowing down. On the one hand, the proportion of universities that have some form of IPv6 connectivity has increased, at least in the EU/EFTA area. The growth in IPv6 traffic on the GÉANT backbone has peaked, at least for the time being. It seems that institutions are adopting the connection, but are not using it.

## Services

Services are receiving more attention from NRENs. There are a few trends that can be noted from the data:

- More users have come to expect reliable, high-capacity Internet connections. NRENs are doing more to provide such connections and to provide assistance in case of problems. One way of doing this is through the ‘PERTs’. These now exist in roughly half of the NRENs. In cases where a PERT does not exist, an NREN is able to call upon the central GÉANT PERT.

- There is an increased need for an authorisation and authentication infrastructure (AAI) in the NREN environment and many NRENs are working to develop such an infrastructure. However, the work is by no means complete. Currently deployed AAI’s have very different capabilities, ranging from simple username/password-based authentication systems to sophisticated middleware for granting or denying access to resources.
- There is a renewed and increasing interest in the Public Key Infrastructure (PKI) area.
- Many NRENs are now introducing or have introduced eduroam, a facility that provides roaming access for users to wireless networks.<sup>3</sup>
- A related area is that of security incident response. The figures indicate that in this area, there is still a large gap between the EU/EFTA countries and the other countries in the region.
- Approximately 25% of the NRENs are currently offering a bandwidth on demand service; approximately the same percentage is planning to introduce it in the next two years, with a significant percentage of NRENs still in doubt.
- Grid services are currently running in most NRENs – several others are planning to introduce such a service. There has been a clear increase of interest over the past year. A striking element in the responses is that the adoption of Grid technology has widened beyond the initial high-energy physics and biomedical communities. All disciplines seem to be well represented.
- Several NRENs have introduced IP Telephony services on their network; however, the scale and types of implementation vary widely, depending on different national situations.

---

<sup>3</sup> eduroam is a registered trademark of TERENA. See also <http://www.eduroam.org>.



- Videoconferencing is now part of the day-to-day collaboration activities in universities and research centres. 85% of the NRENs in the EU/EFTA countries currently offer such a service.

## Funding

NREN budgets may fluctuate from year to year, because investments can vary considerably. NRENs have many different tasks and are organised in different ways. Some NRENs provide services only to the research or education communities in their country. Others provide additional services, for example, they administer the country-code top-level domain or they connect others who are clearly outside of the research or education communities. There are also other reasons why comparisons are difficult:

- Funding for regional and/or metropolitan area networks is handled differently in different countries;
- In some countries, clients pay for their line to the nearest NREN PoP, in others the NREN pays for this;
- Some spend a large part of their budget on connecting primary and secondary schools, while others do not.

When comparing current budget data with data from previous editions of the Compendium, it becomes clear that NREN budgets tend to be stable over time. There are fluctuations from year to year, depending on whether or not an important investment takes place during that year. But on the whole, the trend is that budgets stay relatively stable and that NRENs are able to deliver more bandwidth and more services for roughly the same amount of money.

The situation is different for the less developed NRENs. New possibilities for significantly upgrading international bandwidth (for example under the GN2, EUMEDCONNECT or SEEREN projects) seem to act as a catalyst for increased national NREN budgets. A case in point is CERIST of Algeria.

For 2005, it has received extra funding for a major upgrade of its backbone and of the access network. It could be that this increase has, in fact, been stimulated in part by the improved international connectivity that has become available to CERIST through the EUMEDCONNECT project.

However, in these countries, a modest increase in budget leads, in many cases, to a great leap in traffic. Often there is not yet a commensurate increase in services.