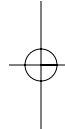
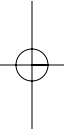
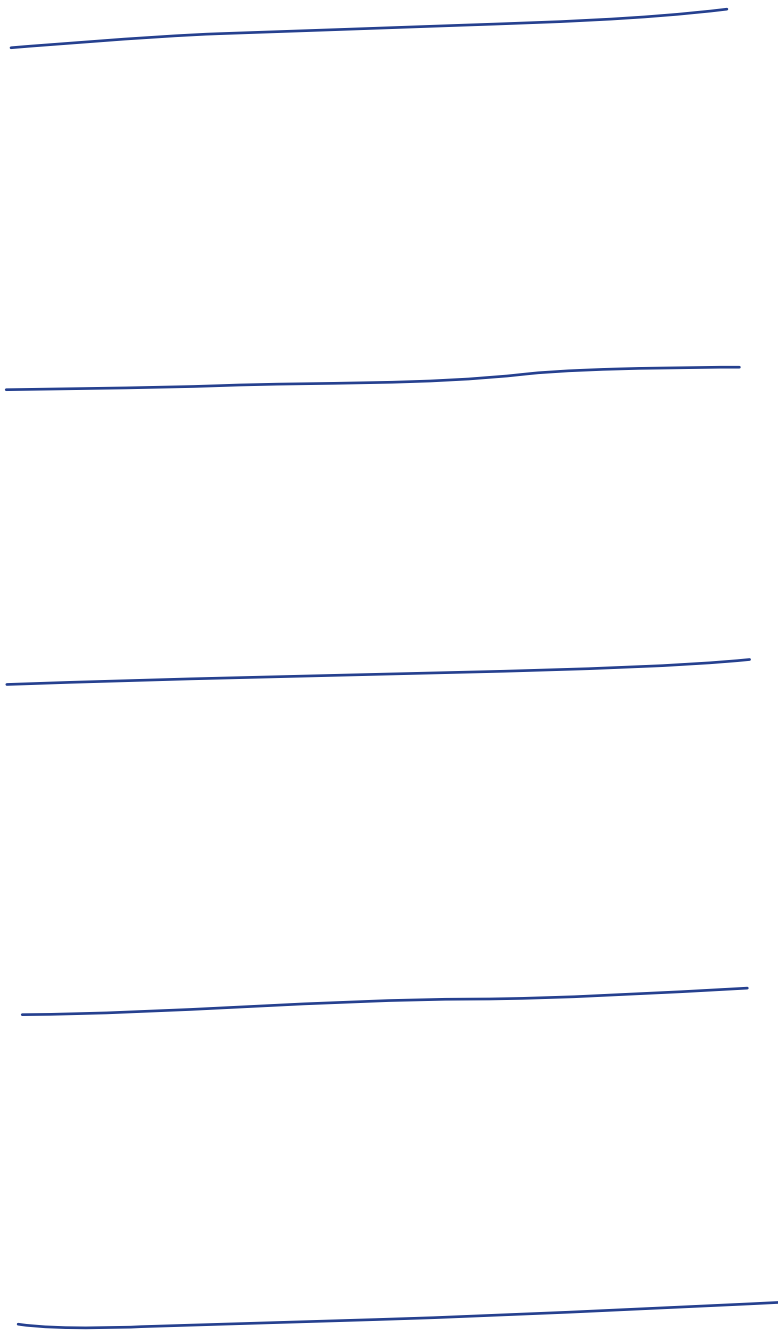
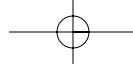


Focus Study on Funding, Management and Operation of European Research Networks

> analysed by network hierarchy //

TERENA REPORT > / MAY, 2004





Focus Study on Funding, Management and Operation of European Research Networks

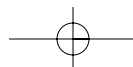
analysed by network hierarchy

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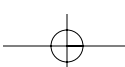
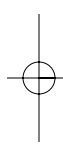
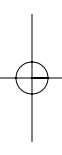
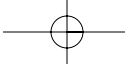
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Executive Summary //>

> Introduction

This report presents the results of a focus study carried out in spring 2004 to complement the information collected in the annual TERENA Compendium of NRENs. This focus study was funded under the COM-REN project of the EU's Fifth Framework programme on research networks.

The objective of the focus study was to examine a selected number of features of research networks in Europe in more depth than had been possible in the context of the Compendium. In particular, the study was intended to look at funding levels and trends in funding, analysed across the levels of the network hierarchy.

The main data collection was by means of a questionnaire distributed to selected European NRENs. The design and execution of the survey was carried out with the advice and active participation of TERENA Compendium Review Panel. The draft questionnaire was refined as a result of testing with some of the NRENs represented on the Review Panel. This resulted in an improved and simplified design. Further, an extra section was added to the questionnaire to cover multiple domain issues since these are closely related to the organisation of the network hierarchy. It was apparent that NRENs were a source of valuable information in this area and that this would enhance the analysis by network level.

> Response and Follow-up

The questionnaire was circulated to 28 NRENs of the EU member states and the EEA. This choice was made to limit the total number of respondents in a survey which was anticipated to involve a substantial follow-up programme. The questionnaire was lengthy but easy to fill in. However, it must be acknowledged that the information being sought is not necessarily easy for NRENs to supply, since it involves a financial breakdown of both their own and external costs which has not previously been requested. It is therefore understandable that four NRENs, under pressure of work, were unable to respond. Nevertheless, the 24 NRENs who eventually responded by the end of April formed a very satisfactory sample, providing a good distribution in terms of country population and network budget.

The follow-up to the questionnaire comprised 54 questions of clarification to 17 countries. In the event, the majority of these could be handled by email rather than by telephone or face-to-face interviews.

Results 1: Analysis of Funding, Management and Operations by Network Level

The initial sections of the questionnaire looked at the current situation of the NRENs, broken down by network level. The network hierarchy used was the same as that used in the main Compendium, namely:

External:	international and commodity Internet links
Backbone	NREN core
Access	links from the backbone to the client institutions
Regional	regional or metropolitan networks
Campus	client institution LAN

The analysis of these factors displayed a consistent pattern. At the campus level, responsibility was almost always with the user institution. At the external and backbone levels, it was predominantly with the NREN, although there was a substantial amount of co-funding. At the access and regional levels, the picture was very mixed, with the NRENs, user institutions and regional bodies all involved.

It was clear from the responses that NRENs have almost no detailed information about expenditure at the campus level. Hence, this survey, which was directed exclusively at the NREN contacts, is unable to provide any reliable data on this particular item. However, the frequent occurrence of performance bottlenecks at this level is evidence of under-investment by some institutions.

The sources of funding and the levels of expenditure at the other levels were fully analysed on the basis of cost breakdowns from 22 countries. The average annual expenditures at the external and backbone levels were €2.72 million and €5.10 million respectively. In those countries (14 and 8) which reported at the access and regional levels, the average expenditure was €1.84 million and €3.26 million respectively. The individual figures are included in the text of the report.

A separate analysis was carried out at the external level in order to determine the costs of general Internet connectivity as well as connections to other research networks. This revealed that the costs of Internet connectivity were, on average, about 60 per cent of the costs of international research connectivity, although there were large differences between countries.

User contributions to the external or backbone costs were found in two-thirds of the countries. The average contribution is substantial, amounting to 28 and 37 per cent of the external and backbone costs respectively.

Results 2: Current Trends

The survey looked at changes in all of the above factors that had either occurred during the last year or were expected during the coming year. Exactly half of all countries reported some significant changes over this three-year period. The majority of year-on-year variations in expenditure were associated with one-off capital programmes. These resulted in expenditure variations of up to 60 per cent in some cases.

It was difficult to discern any strong trend in recurrent expenditure. It was either stable or perhaps rising slightly. This is consistent with the general picture which has emerged through previous Compendium surveys, which demonstrate that there are very substantial increases in bandwidth year-on-year within roughly constant total expenditure.

There were some changes of responsibility. A few NRENs were given an increased role at the regional level. There were changes to the level of user contributions in two countries: one an increase, the other a decrease.

Results 3: Multiple Domain Issues

A number of issues are known to be associated with multiple domains, and these are similarly associated with the hierarchy of network levels, especially where these are separately managed and funded. It is also expected that these will become increasingly significant as grids and e-science enter production. There was, therefore, a section of the questionnaire inviting NRENS to give details of their experiences in the last year, under the headings of performance bottlenecks, security, premium services, end-to-end services, and other.

The majority of countries reported performance bottlenecks. These were most frequent at the campus and access levels. This is consistent with the evidence from the SERENATE studies in 2003. As noted above, there were many reports that these were due to under-investment by some user institutions.

Similarly, the majority of countries reported denial-of-service attacks and other security incidents. The main problems were worms and viruses, other deliberate attacks and spam. It was often reported that the existence of multiple domains made it more difficult to diagnose and resolve such problems. Co-ordination between the network management at the different levels was also time-consuming. A further factor was the lack of sufficient, trained network staff at the user institutions.

The responses on premium and end-to-end service showed many similarities and these were consequently analysed together. Many NRENs have experience in offering these services on a limited scale, particularly through deploying videoconferencing and multimedia. There were also reports on IPv6 and the high-bandwidth research user. These services are demanding and stressed the network; frequently, this revealed performance weaknesses which had not been visible to the general user. Diagnosing and eliminating these weaknesses was again a difficult and lengthy business. The detailed engineering of multiple domains was often a source of such difficulties, for example, through differing technologies, and they were again associated with issues of diagnosis and co-ordination.

A full analysis of the multiple domain issues is included in the main text.

Results: Two Wider Issues

In two countries, it was reported that some network bottlenecks were due to the high cost of telecommunications. This had been reported previously in the SERENATE studies in 2003 on Eastern Europe. Neither of the two countries are among the ten recent accession states. Hence, it must be concluded that this phenomenon is also present, but perhaps not as widespread, in Western Europe.

In two countries, it was reported that some performance bottlenecks were the result of a charging policy, under which user institutions paid a connection fee related to the bandwidth of their connection. This is evidence that some institutions are unwilling, or unable, to fund an adequate network at for their members.

> Scope and Limitations of the Survey

This was the first survey of its type and it has resulted in much new and significant information. It represents a benchmark which could be used as a starting point for future studies.

There were three principal limitations in this study. Firstly, the number of countries included in the survey was limited, as explained at the outset. Secondly, no meaningful information was collected on expenditure at the campus level. Thirdly, trends were assessed only over a three-year period centred on the current year. Any or all of these aspects could be addressed more fully in future surveys. It is clear that obtaining information about campus network expenditure will require much greater investigative effort.

1 Introduction }

This report presents the results of a focus study carried out in spring 2004 to complement the information collected in the annual TERENA Compendium of NRENs (see <http://www.terena.nl/compendium> for more information). This focus study is funded under the COM-REN project of the EU's Fifth Framework programme on research networks.

The objective of the focus study was to examine a selected number of features of research networks in Europe in more depth than had been possible in the context of the Compendium. In particular, the study was intended to look at funding levels and trends in funding, analysed across the levels of the network hierarchy.

The methodology of the study is described in chapter 2. The main data collection was by means of a questionnaire distributed to the European NRENs. This was supplemented by follow-up contacts with the correspondents.

The main body of the results of the study is presented in chapters 4 through 7. These start with coverage of the current situation, as of early 2004, with regards to the funding, management and operational responsibilities, broken down by network level. This is followed by trends in these areas over a three-year period. Chapter 7 looks at the issues of multiple network domains, which are closely linked to the network hierarchy. These are particularly significant for the high-performance connections which are becoming increasingly important with the growth of e-science and grid-based projects. In this context, multiple domains are known to give rise to a variety of problems. The study therefore covered the level of occurrence of these problems and their affect on network performance.

The conclusions of the focus study are reported in chapter 8. Where applicable, we have compared our results with those of earlier studies. However, most of the observations of this study represent new data not previously collected, which are presented here for the first time.

2 Methodology ~

~ 2.1 Extension of TERENA Compendium Work

The focus study was conceived from the outset to be an extension of the existing COM-REN work and the annual TERENA Compendium of NRENs. In a number of areas, it was therefore natural and efficient to use the same procedures:

- data collection via an electronic questionnaire;
- distribution to TERENA NREN correspondents;
- wherever possible, use of the same terminology and definitions as the main compendium;
- oversight of the design and execution of the study by the Compendium Review Panel.

~ 2.2 Design and Testing of the Questionnaire

The first drafts of the questionnaire were subject to a period of testing and review by the Compendium Review Panel. As a result of the comments and experiences of the testers, the design of the questionnaire was substantially modified. The particular changes to the design were as follows:

- addition of more explanatory text to the questionnaire to promote more consistency in the answers and to make the form easier for the respondents to complete;
- laying out the sections relating to trends in funding in a very clear way, thus making it faster to complete, especially for NRENs whose circumstances were stable;
- expanding the section on funding of external links to distinguish between connections to the general Internet and to other research networks;
- expanding the section on multiple network domains and improving the classification of related issues.

The questionnaire was tested twice with the members of the Compendium Review Panel. This resulted in five completed returns as well as a considerable number of comments and suggestions. There were also a number of follow-up emails and telephone calls during this process. There were two outputs from this phase. The first is the final version of the form, which is included as Annex I. In addition, the response provided by one NREN was so comprehensive that it was possible to adapt this as a 'sample answer' which was placed on the TERENA website for reference by other NRENs during the full survey.

~ 2.3 Response Levels and Follow-up

The Compendium Review Panel approved the design of the questionnaire for distribution and it was then sent to the TERENA NREN correspondents of 28 European countries. These

correspondents had been alerted by email about ten days previously about the focus study and to expect this questionnaire. Responses were requested by the end of March.

In the event, responses were returned over a period that went well beyond this deadline. This was not surprising in view of the workload of many NRENs and the fact that the questionnaire requested a breakdown of expenditure figures which would not necessarily be immediately to hand within the NREN. Eventually, 24 completed questionnaires were returned, from the following countries:

Belgium	Croatia	Cyprus
Czech Republic	Denmark	Estonia
Finland	Germany	Greece
Hungary	Ireland	Italy
Latvia	Lithuania	Luxembourg
Malta	Netherlands	Norway
Poland	Portugal	Slovakia
Spain	Switzerland	United Kingdom

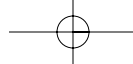
These countries comprise the bulk of the EU member states including the recently acceded countries, plus Croatia, Norway and Switzerland. There is a balanced distribution of countries by population, income and size of NREN.

Upon receipt, the questionnaires were analysed and the initial results tabulated. At the same time, a list of clarification questions was compiled. These were reviewed by the survey team, and a list of agreed follow-up questions was sent out to the correspondents. It turned out that the majority of these clarifications were straightforward, indicating that the questionnaire had been well understood on the whole. It also made it possible for this follow-up stage to be handled by email without the need for any interviews. In all, a total of 54 follow-up questions were sent out to 17 countries. In addition to these follow-up questions, the survey team also contacted the four member states who had been unable to provide responses, in an attempt to obtain 100 per cent coverage.

~ 2.4 Structure of the questionnaire

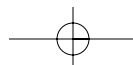
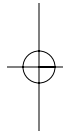
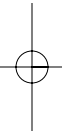
The text of the questionnaire is included as Annex I. It was structured as follows:

- A covering letter giving the background and purpose of the focus study. This also referenced the 'sample answer' available on the TERENA website;
- A note on the definition of the levels of the network hierarchy. This followed that used in the TERENA compendium;
- Section A, which covered a number of funding and managerial issues, by network level. Specifically, it requested information on who is responsible for funding research networking (A1), current levels of funding (A2), sources of funding (A3) and funding of external connectivity (A4);
- Sections B and C, which requested information on operational and managerial responsibility, by network level;
- Section D, which addressed issues of multiple domains. These issues are already significant for research networking; they will be of increasing importance in the future with the growth of grid



technology, premium services, optical networking and hybrid networks. They are naturally linked to the question of multiple managerial responsibility for the various network levels. Information was requested specifically in four areas: performance bottlenecks, security, premium services and end-to-end services;

- Sections E and F, which were designed to collect information on trends in funding and management responsibilities. Section E covered changes over the preceding 12 months whilst section F covered expected changes over the following 12 months. Both sections used identical classifications to those employed in sections A, B and C for the current situation;
- Space for general comments was given at the end of the questionnaire.



3 The Network Hierarchy >

The network hierarchy that was used in this study was the same as that used previously in collecting data for the TERENA Compendium. Five network levels are defined as follows:

- External: This comprises the international connections to other research networks (most commonly via GÉANT) and connections to the general Internet;
- Backbone: The core of the national research and education network;
- Access: Those connections linking the LAN of a client institution to the backbone network;
- Regional: In many countries, the geographic reach of the research network is achieved up by a combination of a core plus a number of regional networks or MANs (Metropolitan Area Networks);
- Campus: The LAN of the client institution.

This is an established description of the network hierarchy and one which is familiar to the correspondents. It should, however, be borne in mind that these distinctions are not clear-cut in many cases and that correspondents will have used their judgement in completing the questionnaire.

4 Funding of Research Networking -/

-/ 4.1 National Responsibility for Funding

The initial section of the questionnaire, section A1, asked who, in each country, was responsible for funding the various network levels in the current financial year. (If figures for the current year were not available, correspondents could use figures from the previous year. Throughout this report, we shall simply refer to all such figures as ‘current year’.) In replying to this section, some countries gave the names of the relevant bodies, whilst others indicated the general source of funding. Initially, some countries omitted identification of the EU as a source of funding, since the contribution is channelled via DANTE rather than the NRENs. This has been corrected in this and subsequent tables.

The table below summarises the responses.

Network level	National government	Regional government	Local government	User institutions	EU	NREN	Other
external	13			10	23	8	2
backbone	13			8		8	
access	7	1		16		5	
regional	8	2	2	12		2	2
campus	1			24			

Summary of 24 responses

Table [4.1-1]. Types of body having responsibility for funding research networking, by network level

The numbers indicate the number of replies from a country for each category. In most countries, a number of bodies share responsibilities for funding and this means that the total numbers across the table may add up to more than 24.

In many cases, countries reported multiple sources of funding for a single network level, as shown in the table below.

Network level	Countries with single funding source	Countries with multiple funding sources	% multiple
External	1	23	96
Backbone	19	5	21
Access	15	7	32
Regional	7	10	58
Campus	23	1	4

Summary of 24 responses

Table [4.1-2]. Number of countries having single/multiple bodies with responsibility for funding research networking, by network level

It is possible to make some further observations on these responses:

- Responsibility for funding the campus level, in the vast majority of cases, rested solely with the user institutions. There is only one exception reported;
- At the external level, all countries except one are part-funded by the EU via DANTE. The number of countries that reported multiple sources, not counting the EU, was seven. At the backbone level, the number was five. Despite the multiple funding sources, NRENs seemed to have good oversight at both these levels;
- Where regional networks or MANs were reported, the majority were multiply-funded. A significant number of the funding partners were bodies over which NRENs often lack oversight, such as regional and local government and consortia of user institutions. To a lesser extent, this also applied to the access level;
- The 'other' sources referred to in Table [4.1-1] were neighbouring NRENs in respect of a short-haul non-GÉANT interconnection, and other partners in MAN consortia.

-/ 4.2 Current Funding Levels

Section A2 covered expenditure in the current financial year, by network level. The individual responses are shown in Table [4.2].

Country	External	Backbone	Access	Regional	Campus	Total
BE	3.60	4.40				8.00
CH	1.70	6.10		0.20		8.00
CY	0.50	0.10	0.10			0.70
CZ	2.00	1.80	1.60			5.40
DK	1.60	2.10				3.70
EE	0.38	0.47				0.85
ES	3.48	11.59				15.07
FI	1.20	4.50				5.70
GR	4.60	4.50	3.70		2.00	14.80
HR	2.15	3.56	0.81		2.35	8.87
HU	2.90	2.50	2.00			7.40
IE	6.20	3.50	1.00	1.00		11.70
IT	2.80	14.00	10.50	5.00		32.30
LT	1.17	0.67	0.41			2.25
LU	0.65	0.27	0.74			1.66
LV	0.48	0.06	0.02	0.01	0.01	0.58
NL	6.00	14.00	3.00	3.00		26.00
NO	2.80	8.90	0.70	0.10	0.50	13.00
PL	4.70	13.20				17.90
PT	1.30	0.70	1.20			3.20
SK	1.04	0.51	0.03	0.12		1.70
UK	8.50	14.76		16.67		39.93
Average	2.72	5.10	1.84	3.26		

Table [4.2]. Current expenditure on research networking, by network level (€ million)

The NRENs were able to provide comprehensive figures for expenditure at the external, backbone and access levels. However, they noted that they had incomplete information at the regional, and especially, at the campus level. Two countries were unable to provide detailed figures of expenditure at any level. Nevertheless, these figures provide a representative sample of expenditure both by larger NRENs (16) with annual budgets over €3 million, and by smaller NRENs (6) with budgets under €3 million.

Some observations can be made about these responses:

- Most NRENs said that they were unable to give any figures for expenditure at the campus level. Where given, most of the amount referred only to the NREN contribution. No reliance can therefore be placed on the figures at this level, and hence no average is quoted;
- Expenditure on external connectivity is, on average, about 50 per cent of the expenditure on the backbone. However, for the smaller NRENs, it is often much higher than this, exceeding the backbone expenditure in a number of cases;
- Where regional networks exist, expenditure at this level is substantial in comparison with the backbone level;
- The total expenditure figures were calculated as the sum of the expenditures at all network levels. These were compared with the total NREN expenditure reported in the 2003 TERENA Compendium. The accounting basis, in particular, the attribution of overheads, is different, and

hence, these figures were not expected to be exactly comparable. However, in the case of four countries, the discrepancies were sufficiently large to merit more detailed follow-up; these were all due to one-off capital programmes.

-/ 4.3 Sources of Funding

Section A3 covered sources of funding in the current year for each of the network levels. Countries were asked to give figures for the proportion of funding from each source. The principal sources of funding were identified as user institutions, local government, regional government, national government, the EU and other. A summary of the responses is given in Table [4.3-1].

Network level	User institutions	Local government	Regional government	National government	EU	Other
external	28			49	22	1
backbone	37		1	60		2
access	61		1	38		
regional	47	12	11	28	2	
campus	88	3	1	8		

Summary of 24 responses

Table [4.3-1]. Per centage of funding from various sources, by network level

It is possible to make some observations on these responses:

- Funding at the campus level is usually single source, usually by the user institution itself;
- User contributions to the external connectivity (average 28 per cent) and to the backbone network (average 37 per cent) are substantial in most countries. In eight countries there was no user contribution at these levels;
- The funding at the regional/MAN level shows the greatest variety and mixture of funding sources.

-/ 4.4 Funding of External Connectivity

Section A4 looked, in more detail, at the funding of external connectivity. Three types of external connectivity were identified. These were connectivity to other research networks (e.g., via GÉANT), national connectivity to the general Internet and international connectivity to the general Internet. Respondents were asked to give information on the expenditure in the current year and on the sources of funding. The results of this section are summarised in Table [4.4-1].

