



Information Society
Technologies

Report identifying issues related to the geographic coverage of European research and education networking

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Executive Summary

The topic of this report is the current state of research and education networking in wider Europe. It focuses on geographic variations and in particular on the digital divide between the most developed and least developed National Research and Education Networks (NRENs). A major part of this report is based on a comprehensive survey of NRENs in "Neighbouring Countries" carried out in spring 2003.

The geographic coverage of this report is the "Neighbouring Countries" of the European Economic Area, which for the purposes of this report are defined as the ten countries (Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia and Slovenia) that plan to join the European Union on 1 May 2004 and eight other European countries (Albania, Bosnia and Herzegovina, Bulgaria, Croatia, FYR Macedonia, Romania, Serbia and Montenegro, and Turkey).

The concepts of equal opportunities for researchers and of the digital divide are central to this study. Equal opportunity is the goal, but we have found that in Europe today there is a significant digital divide and that there is a real risk of "research exclusion".

Research network provision

The survey reviewed the current standard of research network provision in the Neighbouring Countries. There is a great variation between countries. Several accession states have research networks of a high standard. Elsewhere there are some countries with no effective research network at all. Most lie somewhere in between. It should be emphasised that no country is entirely free of problems and, equally, there are none without some positive aspects.

Overall, fourteen of the eighteen countries reported major problems either at the international, national or LAN level. From the detailed responses it is clear that the lack of low-cost high-speed lines is seen as the major obstacle to improving research network provision. This is due to a lack of competition and the continuing dominance of the (ex-)monopoly telecommunications operators. The situation is similar to that in EU countries ten years ago. However, some of the fourteen countries have succeeded in taking the opportunity to acquire dark fibre and this has enabled them to leapfrog and rapidly develop quite an advanced network. Those who have not succeeded yet in doing this lag behind, especially in the development of their backbone capacity.

Some conclusions derived from this study

Firstly, the digital divide exists in research networking in Europe and to such a level that, if uncorrected, will prevent the goal of equal opportunities for researchers being attained.

Secondly, in the countries most affected by the digital divide the case for effective government support for research networking still needs to be made. This is an area where the European Commission, national governments, TERENA and the NREN community all need to play their part.

Thirdly, looking to the future, we conclude that research exclusion is a real risk in most of the Neighbouring Countries and that this will obstruct attempts to build the European Research Area. Many national governments are aware of the risks of information exclusion and recognise the need to follow the lead of eEurope in building an Information Society. Far fewer perceive the dangers posed by the digital divide in research networking and the need to close this gap.

Proposed steps to achieve equal opportunities for research and education

First, we do see an opportunity to make major strides towards diminishing the digital divide. If an NREN can get access to dark fibre, then it can, within the same budget, immediately upgrade the network capacity by as much as a factor of 100. In a monopoly situation it is not easy to get access to dark fibre; however, we have found examples where this has been done successfully.

Secondly, there is wealth of testimony to the fact that participation in joint projects has been helpful to the NRENs in Neighbouring Countries. These are joint projects with other NRENs from all parts of Europe that often, but not always, have been supported by EU funding. This should be continued and

extended to cover the new countries. For these countries, a small amount of funding could make a large difference.

Finally, the survey shows that the European Union has already proved to be very influential in persuading governments in Neighbouring Countries that are accession states or aspire to EU membership to commit to the Information Society. Therefore the EU could be equally persuasive in showing the importance of research networking. Specifically, the EU should help drive the further liberalisation of telecommunications and in particular help to persuade national governments that NRENs should get access to dark fibre. The EU could also support the investments in research and education infrastructure inside accession countries through other measures (e.g. Structural Funds).

1. Introduction

This report presents a review of the national education and research networks in the wider Europe, and, in particular, of the extent to which they are capable of providing equal opportunities for researchers.

The report reviews the extent of the digital divide in research network provision between the European Economic Area (EEA) which is comprised of the fifteen European Union (EU) states and three of the European Free Trade Area (EFTA) states on the one hand, and the ten accession states that will join the EU on 1 May 2004 together with Albania, Bulgaria, Bosnia and Herzegovina, Croatia, FYR Macedonia, Romania, Serbia and Montenegro, and Turkey, on the other hand. We will refer to this second group as the "Neighbouring Countries". This review is based on a survey of the present state of research networking in the Neighbouring Countries carried out in spring 2003. The National Research and Education networks provided a considerable amount of material for this review.

The current report covers the policy and funding environments for the networks, the availability and cost of infrastructure, the availability of trained staff and specific problem areas within the research network itself. This is analysed and a number of conclusions are drawn. Finally, a number of recommendations are made for practical steps to help close the digital divide.

2. Equal Opportunities for Researchers

It is part of the vision of the European Research Area that researchers throughout Europe, irrespective of location, will be able to contribute fully to its high-quality research activities. This represents equality of opportunity for researchers, and increasingly, advanced research networks such as GÉANT and the national research networks are playing a key role in achieving this.

Consider first the ideal circumstances. There are a number of factors that come together to create these. A researcher would have: a well-equipped university or institute; good computing and LAN facilities; an environment in which these are maintained up to date; access to information resources, both physical and digital; the ability to participate in national and international collaborations; the ability to take part in network-demanding research. The latter type of research is typified by Grid applications, although it could equally well require videoconferencing and multimedia communications as computing- or data-intensive scientific applications. It also goes without saying that these are likely to be found in a society which is itself IT-literate and Internet-aware, that is to say, one in which the Information Society is firmly established.

Broadly speaking, most countries of the EEA provide many examples of this ideal environment. Even here however, the reality sometimes falls short of the ideal. The ideal research network is both pervasive and leading edge; that is, it provides researchers with the full range of advanced networking facilities, whatever their location. Even within an advanced country this is hard to achieve. There are always "difficult to connect" sites and often, despite significant expenditure, there can remain significant differences in research connectivity, especially bandwidth and last-mile connections.

In Neighbouring Countries the situation is far more mixed. In some instances, the network facilities available to researchers do approach the ideal. But this is very much the minority, and in many areas the network facilities fall far short.

The key concept here is that of exclusion. When there are whole communities, regions or countries where a digital divide exists then they are unable to participate in the modern network-enabled society. There are useful parallels to be drawn with the *eEurope* programme for making progress towards the Information Society. One of the express aims of *eEurope* is to avoid a "two-speed Europe" or any form of "information exclusion" as the Information Society develops. Equally it should be the aim of the research networking programmes to avoid a two-speed Europe for researchers or the growth of "research exclusion" as research activities become more and more founded upon the use of advanced computer and communication networks.

The potential risks of a growing digital divide for researchers has been highlighted in a report produced under the auspices of the International Committee for Future Accelerators in early 2003. Whilst this addresses the concerns of the High-Energy Physics community, the scenario it describes is relevant to many other research communities as well. The HEP community, as is now well known, collaborates on a global basis and in this report they have been able to draw on detailed evidence from around the world. In their main conclusion they state that "[our] essential concern is that Digital Divide problems will delay or prevent physicists in less economically favoured regions of the world from participating effectively, as equals, in their collaborations". To avoid this, "high-performance networks are required, in all regions where the physicists and engineers are located".

3. The Geographic Divide

In this report we examine the digital divide in research networking on a geographic basis. Geographic factors have been well recognised for some time as potential causes of a digital divide in the Information Society. Generally, regions that are remote, sparsely populated or poorer are the last to acquire the necessary infrastructure. The cost of building the infrastructure is higher (both *per capita* and as a percentage of GNP) and the return on investment is less, due to the lower economic activity. However, these are exactly the regions that have more to gain from adopting the Information Society. Further, the situation is not self-correcting but self-reinforcing. This has led over the years to many initiatives at a local, regional or national level aimed at alleviating this. This is often tackled at a regional level, and, for example, the RISI (Regional Information Society Initiative) programmes of the EU were a coherent approach towards encouraging and accelerating a fruitful development of the Information Society on a regional basis. Many of these regional programmes showed considerable success and have been continued with local or national funding in some 35 regions of the European Union.

3.1. Research Exclusion within Europe

In this report we look at the provision of research networking and the consequent issues of research exclusion and equal opportunity for researchers. We look at this at the national level, and also at the level of groups of countries. This is not of course to say that significant differences do not exist at local or regional levels, but the comparative data are available principally at the national level.

We start by looking at some data that illustrate features of the digital divide in research networking between, broadly speaking, the EEA countries and Neighbouring Countries (Table 1). This data comprised of, firstly, two indicators chosen by eEurope that relate to research networking, namely the international connectivity and national backbone speeds for the NREN. It also includes the NREN budget (normalised by population) and finally the figures for GDP per capita and GERD (Gross Expenditure on Research and Development) per capita, where available. These figures give an indication of the inputs (the size of the economy, the research budget and the amount allocated to research networking) and the outputs (research network capacities).

We also show the average figures for three groupings of these countries. Firstly, EEA: these are the fifteen EU member states plus the three EFTA members Iceland, Norway and Switzerland. Secondly, the ten accession states that will join the EU in 2004, namely, Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia and Slovenia. Thirdly, the other European countries: these are the three other accession states, Bulgaria, Romania and Turkey, plus a number of Balkan countries for which networking or survey data is available: Albania, Bosnia and Herzegovina, Croatia, FYR Macedonia, and Serbia and Montenegro.

Country	NREN Total International Bandwidth (Mb/s)	Typical National Core Bandwidth (Mb/s)	NREN budget per 1 million inhabitants (MEUR)	GDP per capita (EUR)	GERD per capita (EUR)
Austria	1,240	1,000	0.73	25,073	451
Belgium	4,122	5,000	1.12	24,170	474
Denmark	8,122	620	0.37	32,873	677
Finland	8,277	2,500	1.56	25,316	853
France	5,475	2,500	0.45	23,442	504
Germany	9,366	10,000	0.49	24,596	610
Greece	1,244	310	0.82	11,553	79
Ireland	3,742	310	3.86	26,646	322
Italy	7,464	7,500	0.69	20,123	209
Luxembourg	200	1,000	6.69	45,844	
Netherlands	38,976	10,000	2.05	24,962	504
Portugal	624	1,250	0.59	11,430	87
Spain	3,887	2,500	0.42	15,162	143
Sweden	10,122	10,000	1.92	27,992	1058
United Kingdom	8,819	10,000	0.70	25,836	481
Iceland	155	1,000	1.36	27,810	673
Norway	8,110	2,500	2.65	33,490	604
Switzerland	4,110	1,000	1.70	27,750	940
Average EEA:	6,892	3,833	1.57	25,226	510
Cyprus	34	34	0.78	18,460	27
Czech Republic	4,509	2500	1.12	13,280	62
Estonia	155	100	0.47	9,820	26
Hungary	2,488	2500	0.67	11,880	31
Latvia (LATNET)	42	100	0.76	7,710	11
Latvia (UL DoIT)	26	100	0.42		
Lithuania	157	155	0.81	8,730	
Malta					
Poland	2,500	620	0.09	9,210	28
Slovakia	1,500	1000	0.34	11,060	23
Slovenia	450	10	2.28	15,970	147
Average accession countries	1,186	712	0.77	11,791	44
Albania					
Bosnia and Herzegovina		2	0.07		
Bulgaria					
Croatia	622	620	2.35		
FYR Macedonia	2	2	0.03		
Romania	155	34	0.12		
Serbia and Montenegro	4	155	0.14		
Turkey	465	155	0.21		
Average other Neighbouring Countries	250	161	0.49		

Table 1. NREN international bandwidth, national core bandwidth, NREN budget per 1 million inhabitants and GDP and GERD per capita for European countries.

(Source: TERENA Compendium 2003 (except GDP and GERD))

This table shows quite significant differences between the average values for the three groups of countries. There are also some striking variations within the groups. However, whilst it shows us, for example, that the average bandwidth is much lower in the accession states than in the EEA group and much lower again in the other Neighbouring Countries, of course it does not tell us what an individual researcher experiences and whether the lower bandwidth is in fact a limitation on exploiting the network. Published data of this type is scarce, but one relevant source are the figures for network congestion, again from the TERENA Compendium 2003.

These figures are shown below, this time only for the three country groupings. They do suggest quite strongly that the lower bandwidths in these country groupings are in fact associated with increased congestion.

Country Grouping	International Connections	National Backbone	Campus-NREN Interconnect	LAN
EEA	1	0	9	8
Acceding states	2	11	21	5
Other Neighbouring Countries	39	21	34	0

Table 2. Research network congestion by country grouping: average percentage of NREN client institutions experiencing high congestion at a particular level of the network hierarchy. (Congestion can be experienced at more than one level.)

(Source: TERENA Compendium 2003)

3.2. Monitoring, Benchmarking and Indicators

Indicators and benchmarking have an important role to play in measuring progress over time towards defined goals. The eEurope 2002 Action Plan, for example, has made significant use of benchmarking. As part of this plan 23 key indicators were defined and have been used to measure the progress of countries towards the Information Society. This formed the basis for an annual benchmarking report, which has been published for each of the years 2000, 2001 and 2002. As noted above, one indicator (no. 4) referred to research networking, within the set of indicators on the "Faster, cheaper Internet".

These benchmarks and indicators were originally devised for the fifteen EU member states. It is interesting to note that when the accession states came to adopt these indicators, they felt it necessary to enhance the set (now called eEurope+) with the addition of extra indicators covering "Putting in place the basic building blocks of the Information Society". In other words, there was recognition amongst these states of a pre-existing digital divide.

In the field of research networking, it should be noted that TERENA has been monitoring a comprehensive set of indicators over a period of some years. These are published annually in the TERENA Compendium of National Research and Education Networks. In fact, the figures for the research network indicator in the benchmarks related to the eEurope 2002 Action Plan were provided each year by TERENA. TERENA intends to continue the publication of the Compendium, which is widely recognised as a valuable activity. Further extension of the monitoring should be considered (for example, to user-oriented measures such as those being introduced by SLAC¹ and others).

The question has been raised in the course of this study as to whether some additional indicators and benchmarking, specifically aimed at measuring the progress of NRENs in Neighbouring Countries towards closing the digital divide, should be added. At this stage it is felt that the current set of TERENA indicators is probably already sufficient to enable these NRENs to set their own targets in comparison to some other NRENs. On the other hand, the analysis of the survey below has shown that there would be merit in putting together a checklist of items, mainly from existing sources, which these NRENs could make use of internally. This is discussed further in the final section.

¹ Stanford Linear Accelerator

4. Survey of Issues Facing Research Networking in Neighbouring Countries

4.1. Introduction

As seen from the previous section, there is only limited information to be gained from the published indicators as to the status of and issues facing research networking in Neighbouring Countries. A survey of the national research and education networks was therefore undertaken. The methodology of the survey was as follows. Each NREN was sent a letter and a questionnaire. The letter explained the purpose of this work item within the overall SERENATE programme. It asked the respondents to provide a general description of their NREN. Where available, they were provided with a copy of the country profiles prepared for the SERENATE report on the development of the regulatory situation², in which case they were able just to update the NREN section. They were also asked to describe the problems which they faced and to make suggestions for how these could be tackled. The questionnaire was designed to cover this part of the enquiry but respondents were free to add their own comments. A copy of the questionnaire is attached as Annex II.

The list of NRENs contacted extended beyond the set of accession states to include a number of other countries from southeast Europe. This was natural because the NRENs of these countries are in regular contact with other European NRENs, either as members of TERENA or through CEENet, and also because they are now involved, particularly through the SEEREN project, in the EU-supported research networking activities.

The NREN profiles are attached as Appendix I. The questionnaire responses are described in detail below.

4.2. Survey Results

4.2.1. Issues in network provision

The first section of the questionnaire was designed to find out which levels of the network hierarchy (local, national, international etc.) were seen as presenting the greatest problems in providing a comprehensive research and education networking infrastructure. Respondents were also invited to provide examples to illustrate the nature of the problems.

Six levels of network hierarchy were indicated: end-user equipment, LAN, access network, metropolitan network, national backbone and international connectivity. Of course, there can be some overlap between these categories, especially at the metropolitan level.

The summary of results received from the eighteen countries is shown in Table 3. Where respondents indicated levels of priority these are mentioned in the table.

Overall, it was found that a significant number of NRENs reported problems at the LAN, national, and international levels and we will comment on those in more detail in this section.

LAN issues. These fell into two categories. In some instances, obsolete LANs at universities were not being replaced. In other countries, however, the issue arises because university locations are highly dispersed across a city rather than being located together in campus structures. In such cases the building of the university LAN is dependent on a very large number of cross-city links which can only be obtained from an expensive telecommunications operator that has a (de facto) monopoly.

In most countries access links are mainly provided by the incumbent operator. Many NRENs reported significant discrimination, meaning that they are not able to obtain access under the same conditions as the incumbent operator provides to its own Internet customers.

² SERENATE deliverable D7 "Report on the expected development of the regulatory situation in European countries relevant for the SERENATE project"

Country	End-user equipment	LAN	Access network	Metropolitan network	National backbone	International connectivity
Bulgaria					Yes	Yes
Cyprus			Yes		Yes	Yes
Czech Republic			Minor		Minor	Minor
Estonia		Yes (4)	Yes (1)	Yes (3)	Yes (2)	
Hungary	Minor (1)					
Latvia	-	-	-	-	-	-
Lithuania			Yes (1=)	Yes (1=)	Yes	
Malta						Yes
Poland					Yes (1)	
Romania			Yes (1)		Minor	
Slovakia	Yes	Yes				
Slovenia		Yes	Yes		Yes (1)	Yes
Turkey		Yes (3)			Yes (1=)	Yes (1=)
Albania					Yes	Yes
Bosnia and Herzegovina				Yes	Yes	Yes
Croatia	Yes	Yes				
Macedonia, FYR	Yes (4)			Yes (3)	Yes (2)	Yes (1)
Serbia and Montenegro		Yes				Yes (1)

Table 3. At which level(s) in the network hierarchy are significant problems found?

National backbone issues. The majority of these instances involved a telecommunications monopoly which limited affordable bandwidth to quite low levels (from 10 Mb/s down to 64 kb/s). Most NRENs affected reported high levels of congestion. Congestion was also reported by one NREN on its 155 Mb/s and 622 Mb/s links.

International connectivity issues. This level presented significant problems. Firstly, there are some countries without a connection to GÉANT. Secondly, some countries had a GÉANT connection but it was very restricted in bandwidth, resulting in congestion. Finally, some NRENs had sufficient international bandwidth but the costs were felt to be excessively high. In nearly every case in the last two groups, the existence (or persistence) of a national monopoly was seen as the principal cause.

The problems of such low international and national bandwidth were noted by one respondent as inhibiting full use of the network by the academic and research community, as follows:

"The speeds [of the national backbone] range from 64 kb/s to 1 Mb/s for most organisations. These speeds do not allow the introduction of new generations of services and the problem is propagated to the end-user, irrespective of the quality of networking at the campus level."

"We do not have the [international] capacity required to participate or collaborate in advanced services projects or application projects requiring high-speed bandwidth, and this hinders research and academic activity."

4.2.2. Policy, funding and economic environment

The second section of the questionnaire was designed to find out to which extent the establishment and continued development of the NREN had been affected by factors such as the level of support by government

and other bodies, the level of funding, the telecommunications infrastructure, and shortages of skills.

Respondents were asked to answer a multi-part question, as follows:

Are you affected by the following problem; if yes, can you illustrate the problem by some numbers/data or stories, and do you see a possible solution?

1. *Lack of awareness by politicians and decision makers of the importance of the NREN for research, education and general development of the country.*
2. *Lack of awareness by university chancellors and directors of research institutes of the importance networking and NREN services.*
3. *Lack of awareness by researchers and professors of the importance of networking and NREN services.*
4. *Lack of funds for computers, networking equipment and functioning of NREN.*
5. *Shortage of appropriate infrastructure in the country.*
6. *High prices of the telecommunication infrastructure.*
7. *Shortage of managerial skills in your NREN.*
8. *Shortage of technical competence and skills in your NREN.*

It was not expected that all NRENs would be affected in the same way and this can be seen from the summary of replies from the eighteen countries shown in Tables 4 and 5.

Country	Lack of Government support	Lack of University Support	Lack of Researcher awareness	Lack of NREN Funding
Bulgaria	Yes			Yes
Cyprus	Yes			Yes
Czech Republic				Yes
Estonia	Yes			Yes
Hungary	Some			Some
Latvia	-	-	-	-
Lithuania				Yes
Malta				Yes
Poland	Yes			Yes
Romania	Yes	Minor		Yes
Slovakia	Some	Yes		Yes
Slovenia		Yes		Yes
Turkey	Some	Some		
Albania	Yes	Yes	Yes	Yes
Bosnia and Herzegovina	Yes	N/a	N/a	Yes
Croatia	Yes			Yes
Macedonia, FYR	Yes (3)	Yes (4)	Yes (5)	Yes (1=)
Serbia and Montenegro				Yes

Table 4. Summary survey results by country indicating problem areas in the policy, funding and economic environment (part 1).

Country	Lack of national infrastructure	High cost telecoms	Shortage of managerial skills	Shortage of technical skills
Bulgaria		Yes		
Cyprus		Yes		Yes
Czech Republic				
Estonia	Yes	Yes		Yes
Hungary		Yes		
Latvia	-	-	-	-
Lithuania	Yes	Yes	Yes	Yes
Malta				
Poland	Yes	Yes		
Romania		Yes	Yes	Yes
Slovakia		Yes		
Slovenia		Yes		
Turkey	Yes	Yes		
Albania	Yes	Yes		
Bosnia and Herzegovina	N/a	N/a	N/a	N/a
Croatia		Yes		Yes
Macedonia, FYR		Yes (2)	Yes (1=)	
Serbia and Montenegro	Yes	Yes	Some	Yes

Table 5. Summary survey results by country indicating problem areas in the policy, funding and economic environment (part 2).

Where respondents indicated levels of priority these are mentioned in the tables. Some respondents interpreted the questionnaire as asking only for the top priority to be identified, and in these cases there could be other problem areas not recorded.

Of course the answers from the respondents follow their own subjective judgment, and different NRENs will have different standards for what is to be considered adequate. If one NREN identifies an area as a problem area and another does not, then that does not necessarily imply that the situation in the first country is worse than in the second country in absolute terms.

It is perhaps not surprising that almost all NRENs claimed to be limited by funding. However, there were some interesting differences in emphasis. Two NRENs identified shortage of funding for staff as most significant. Two others identified difficulties in funding equipment as particularly important (for high-bandwidth equipment and for LANs, respectively). Finally, one country was just starting its NREN development and foresaw the need for more staff as this development would come on-stream.

Nearly all NRENs identified the high cost of telecommunications as an issue. This was mentioned by a number of respondents as a major factor in creating budgetary pressures.

There were many NRENs that experienced problems in the lack of awareness and support at government level. In a few cases, this could be summed up by the statement that "deeds, not words" are required. In a number of other countries, government awareness is very much focused on the ideas of the Information Society and its benefits for each individual citizen, and this sometimes leads to a failure to understand the full significance of research networking. Many respondents also found that it was necessary to re-fight the battle to justify NREN funding each year, although this is probably not unknown amongst NRENs in EU member states either.

Several respondents reported significant difficulties in recruiting, and especially in retaining, NREN technical staff. In many cases arrangements for training and additional funding through project work are used to alleviate this.

4.2.3. Telecommunications infrastructure

The next section of the questionnaire was intended to find out what infrastructure, especially fibre, was available and whether the national telecommunications company (former monopoly) or ISPs had hindered, or attempted to hinder, the development of the NREN.

Only two NRENs reported experiencing problems from local ISPs, but six NRENs reported significant obstruction on the part of the monopoly (or ex-monopoly) telecommunications operator. This obstruction frequently occurred "behind the scenes" and in most cases the respondents requested that their answers be regarded as confidential.

The responses to the section on the availability of fibre were largely inconclusive. Very often the response was along the lines of "Yes, in principle, but not in practice". However, there are a few NRENs in Neighbouring Countries that, through persistence and local circumstances, have been able to obtain a fibre infrastructure. This has even proved possible, by government action, in the presence of a formal monopoly. Moving to dark fibre offers a real opportunity to make big strides in closing the digital divide. It is an important development which all countries should study carefully.

4.2.4. Connection of schools and libraries

This section of the questionnaire was designed to find out to what extent NRENs are already connecting schools and public libraries, and if not, whether they are willing in principle to do so.

The responses showed that in four countries the NREN is already engaged in this activity. In two cases this is limited to a small number of connections so far, but the other two NRENs have undertaken the networking of essentially the whole school system. A further seven NRENs are willing to undertake this activity and in one case this has reached the planning stage.

One NREN that already supports schools networking commented on the benefits it has seen:

"It substantially increases the number of network connections that we support, and in a small country this brings significant benefits of scale. Also, it is good for promoting the spread of the Information Society and this will benefit us through raising new generations of university students who are already Internet-aware. It also raises the standing that the NREN has with the government, but the downside is that they see the schools network as the most important thing that we do and tend to see the research networking activities as a somewhat expensive luxury."

4.2.5. How the EU can help

In this section of the questionnaire NRENs were asked whether they believed that the European Union could or should help to close the gap between the least and most developed NRENs, and if so, what suggestions they would put forward to help achieve this.

There was universal agreement among the respondents that the European Union could play a very positive and valuable role. Indeed, many correspondents noted that many EU projects have contributed to this already. There were very many individual suggestions as to what the EU might do in future. Broadly, these fell into four categories:

1. Set minimum standards for NREN development.

The first issue for some countries is to establish the NREN and to fund it on a sustained basis. One respondent suggested that *"EU documents related to higher education [should make] the existence of the NREN a mandatory condition for membership in the EU academic community"*. Others suggested that a minimum NREN capacity (155 Mb/s was suggested) should be defined.

2. Set minimum standards for the establishment of the Information Society.

A number of NRENs supported this, on the grounds that this was an essential part of spreading awareness of information and communication technology and of the Internet among their user communities. In some cases they noted that real progress towards the Information Society lags behind official statements. One respondent commented that, despite recent government and parliamentary declarations, *"it seems that up to now there has been no adequate adoption of short- and mid-term strategies, coherent, synchronised and concrete programmes and actions and allocated funds for development of the Information Society"*.

In the context of both these suggestions, many NRENs pointed out that their countries aspire to EU membership and hence specific EU recommendations on convergence and harmonisation have a powerful influence on government actions and priorities.

3. Joint projects.

Many respondents emphasised that joint projects, and specifically EU-assisted projects, had been helpful in developing their NREN capabilities and that they would like to see these continue. GÉANT was mentioned by some respondents, but there was general agreement that all forms of exchange – ideas, knowledge, and experience – were beneficial.

One respondent commented on the benefits of the EU-assisted projects for regional connectivity as follows: *"There are two main benefits. The first is the actual provision of connectivity into the region. The second is that it has helped us get other funds from other sources."*

4. Funding.

Many respondents were acutely aware that their costs for national and international connectivity are very high, both in absolute terms and relative to national income. They also saw the digital divide as requiring an exceptional effort if the gap is to be reduced and eventually closed. Hence respondents saw that EU funding could be of great value in many contexts, for example:

"The European Commission has to do something to close the gap between most and least developed NRENs. The participation of most and least developed NRENs in common EU projects is only one possibility. They also could establish specific funds for projects for only the least developed countries, which are still not a member of EU but which are "in front of the EU door". The specific criteria for determination which countries are [in this category] should be defined and only these countries would be able to apply for these projects. These countries will be responsible for the realisation of the project. The most developed countries would participate in these projects as advisers, monitors and evaluators or in some other way but the majority of financial resources have to be ensured for the least developed NRENs. The position of the managers of the least developed NRENs in that case will be different than in common projects with the most developed NRENs. They will be leaders of the projects and as leaders of the EU projects the managers of the least developed NRENs also will increase their abilities."

"The EU should establish specific funds for the least developed NRENs in EU countries (or regions) and non-EU countries. Goal should be to lower the existing digital divide through specific programmes or projects like GÉANT, and Grids."

"Provide extra funds for international connectivity, encourage local governments and financially support [the building of the] internal network."

4.2.6. How TERENA can help

This section of the questionnaire asked the same question with respect to TERENA that had been asked about the European Union, namely whether TERENA could or should help to close the gap between the least and most developed NRENs, and if so, what suggestions respondents would put forward.

There was again agreement among the respondents that TERENA could play a very positive role, and its current activities are highly valued. There were numerous suggestions as to how TERENA might help. Some examples are:

1. Promote knowledge transfer. The following quote is typical of support for this type of activity:

"TERENA is very important for all NRENs and its role could be to support all activities that increase the abilities (services and capacity) of NRENs as well as technical support. TERENA also could (alone or with some partners) co-ordinate activities between the most and the least developed NRENs. The specific and very important activities of TERENA are training and increasing the knowledge and abilities of the NREN's staff members."

2. Many NRENs noted that they had difficulties in taking advantage of TERENA conferences, projects, workshops etc, due to their own lack of funds:

"Unfortunately countries of the less developed NRENs are not all members of TERENA due to rather high membership fees. So they are not [able to] articulate their problems and needs through TERENA GA. Also in spite of the good TERENA technical programs it seems that very few less developed NRENs participate."

"[TERENA should] provide low-price conferences, workshops, technical courses etc."

"TERENA could learn from CEENet, which is much appreciated as an organiser of technical, managerial and policy workshops for eastern European and Asian countries, which it does with a very small budget and with a good understanding for the situation in least developed countries."

4.3. Overall Comments on Questionnaire Results

The response to the questionnaire was very satisfactory. Nearly all NRENs contacted made a return and in most cases a very generous number of comments were added to the form. A meeting was held during the TERENA Networking Conference in Zagreb in May 2003, which was attended by representatives of eight of the countries involved in the survey; although this meeting was not limited to the questionnaire, there was a very full discussion of the issues raised by the questionnaire.

It is very apparent, both from the returns and from the discussion, that there is a great variability in the state of research networks in Neighbouring Countries and the consequent scale of the digital divide. In four countries, research networking is of a high standard on most measures, to the point where the digital divide has been very significantly reduced. On the other hand, there are one or two countries where there is effectively no research network and quite a number of others where the limitations of the network are seen to severely inhibit the research community.

5. Conclusions and Recommendations

5.1. Conclusions

A Digital Divide exists

The first conclusion is that a digital divide in research networking in Europe exists and that, broadly speaking, it affects most of the eighteen Neighbouring Countries. The depth of the digital divides varies very greatly from country to country. We can note first that there are four countries in the Neighbouring Countries group with a high overall standard of research networking. Amongst the significant reasons which might have helped achieve this are: good support for research networking at government and other levels, access to dark fibre where necessary, and a history of participation in joint European projects. However, in the majority of countries that we are considering the standard of research networking falls very far behind that of the EEA countries.

The consequences of this digital divide are serious. The international research community is moving rapidly to adopt Grid-based research and other forms of collaborative e-science. In future, only those researchers with access to a high-capacity research network will be able to take part. This style of research work is predicted to be adopted in most other areas of research as well. The countries without an adequate research network will suffer from "research exclusion".

Access to dark fibre is vital

Access to dark fibre enables the NREN to upgrade the capacity of the national research backbone and the capacity of the access links 100- or 1000-fold without significantly increasing its spending on the infrastructure. At the present moment this is the main step that could be taken in Neighbouring Countries to close the digital divide.

It seems that in most Neighbouring Countries the fibre is already laid. The problem is that in a near-monopoly situation the owner of the infrastructure (that is the incumbent operator and in many cases also the electricity distribution company or railway company) is not willing to lease dark fibre. Acquiring a dark-fibre infrastructure is not easy in these circumstances, but it is encouraging to see the example of those countries that have already been able to go down this route, for example Poland, the Czech Republic, Slovakia and Serbia and Montenegro. This shows that it is possible, and it is certainly worth pushing for. A potential role exists for the European Union here, since the legacy of the monopoly telecommunications operators is still very evident, to an extent which is clearly hindering the NRENs from making progress. At the same time, comments made in the survey show that governments aspiring to eventual EU membership attach a lot of weight to EU expectations.

The case for research networks still needs to be made

National NRENs accept that it is principally their own responsibility to persuade their governments and others of the need to establish research networking in their country and to fund it on a continuing basis. However, by increased contact with the international NREN community they can better share experiences on how to do this effectively. In this context, the members of the SEEREN project have already given serious consideration to the task of achieving long-term sustainability of the national networks and have produced a useful "road map" or checklist detailing the steps towards this goal. This of course covers much more than just winning support. This is potentially of great value to other NRENs in Neighbouring Countries, and indeed more widely. It would be a very valuable outcome if this was written up as a document of general advice on achieving sustainability.

The lack of awareness of the importance of research networking revealed by the survey, sometimes at government level, sometimes at academic level, is a matter for concern. It is particularly disturbing that sometimes it is thought that the general-purpose Internet or the advent of the Information Society will solve the problem. As already noted, without a high-capacity research network, research exclusion is inevitable. Research networking is not the same thing as the Information Society. Relying on the Information Society as a substitute for research networking will prevent the future research community taking part in major international research projects. However, creating a research network will stimulate and accelerate the Information Society.

The whole discussion of tackling the digital divide in research networking presupposes that a country already has an effective NREN. Experience of other world regions shows this is not always the case and the results of

the survey confirm that this applies in Europe as well. This can be a source of great frustration to the networking community within these countries. One respondent went as far as to suggest that the European Union should make the existence of an effective NREN a condition for any EU funding. Problems are also known to exist where the NREN is not formally established as an independent body. This can lead to several NREN-like bodies in the same country, but with indistinct responsibilities. Furthermore, the existence of several NRENs makes services more expensive because the necessary economy of scale is not achieved.

Participation in joint projects

The survey has shown universal agreement on the value of participating in joint projects. In this context, it may be noted that NRENs in the Neighbouring Countries often have substantial numbers of good technical staff and that this is potentially a valuable resource for these projects to draw on.

As far as other types of joint activities are concerned, the perspective of the NRENs in the Neighbouring Countries has changed over time. Previously a common pattern was for these activities to comprise visits by experts and advisers. Now, it is seen as more valuable to take a more equal role in projects, conferences, etc. However, funding is still a very significant problem for some countries. This means, for example, that even raising the annual TERENA membership fee is a problem. The same is true for travel costs for junior staff. This appears to be one area in which small amounts of funding could be applied to very good effect.

5.2. Recommendations

Role of politicians

Many countries have good reason to be grateful for the vision of politicians who saw the importance of information technology, networks and research for economic prosperity. These include Al Gore in the United States, Carl Bildt in Sweden, Heinz Riesenhuber in Germany, Wim Deetman in the Netherlands and many others. Many European countries have also benefited from the coherent programmes of the European Union and the committed support of a number of members of the European Parliament over a period of many years. Politicians in Neighbouring Countries should wake up to this and ensure that the necessary resources and support are made available for an advanced research network programme in their own countries.

Role of national governments

Where an NREN does not yet exist, the national government should help set one up and ensure that it is recognised inside and outside the country as the single official NREN. Governments should ensure that there is adequate funding allocated to the NREN and should also ensure that there is adequate funding for their university and research institutions for their networking facilities. This should include the university's payments to the NREN if there is "user charging". In telecommunications markets, governments must fight the forces that, despite official liberalisation, in practice keep old-fashioned monopolies alive. As a particular example in the regulation area, governments should force owners of fibre infrastructure to make this fibre infrastructure available to the NRENs at cost-related prices.

From 2004 onwards, accession countries will be eligible to receive Structural Funds to help regions whose development is lagging behind. One of the projects chosen by governments should be investment in its NREN, especially investment in communications infrastructure such as optical fibre.

Role of management of universities and research institutes

Management must reserve adequate funds in their budgets for information technology and networking facilities. These are essential in order to avoid falling behind other institutions at home and abroad. University and research management should lobby their governments, politicians and the media on behalf of research networking, in particular highlighting what their country is missing compared to others. They can do this individually but better still they should join forces to form an action group. In many countries, this sort of pressure has been the beginning of a successful research networking infrastructure.

Role of researchers and teachers

The role of the end-users of research networks is crucially important. Unless they argue forcefully for good networking facilities, it is unlikely that the problems will be taken seriously. They should lobby widely and explain that they cannot do their work properly unless they have the facilities that their counterparts in other countries have. Every country has researchers and university professors who are well-known figures; they can be effective leaders in a campaign to change the situation.

Role of NRENS

NRENS should both lobby and act as a source of information. They should establish close links with government departments, universities and other NREN client institutions, with telecommunications suppliers, and with other NRENS. They should monitor the situation in their own countries, regarding both the capacity of the research networks and the telecommunications market, and compare the status with other countries. NRENS should be pro-active and look for opportunities such as dark fibre.

Role of European Union

It should be acknowledged that the European Union has already acted on some of the questions that were originally envisaged to be dealt with by this study. In particular, the SEEREN project has begun the process of connecting a number of southeast European countries to GÉANT. The role of the contractor NRENS in this project should be equally acknowledged. This experience of partnership has been highly valued by all the countries involved.

The EU should accept the overall responsibility to reduce and ideally to eliminate the digital divide among the EU member states in research and education networking, and hopefully also help other European countries in this respect. To achieve this, the relevant institutions of the European Union should do the following:

Firstly, monitor annually the state of the digital divide in Europe and find measures suitable for reporting progress. The main metrics could be (a) the availability and cost of key elements in the telecommunications infrastructure market and (b) the functionality and performance of NREN services. Continued financial support from the European Commission to the production of the TERENA Compendium would make a contribution to this action.

Secondly, in relation to the connection to GÉANT of countries that are least developed in terms of their internal research networking organisation and structure: the European Union has an exceptional influence at such times, and the European Commission should insist on minimum standards for the country's NREN to achieve in order to make the connection worthwhile.

Thirdly, making clear that research networking is an important part of the Information Society. Neglect of the Information Society can lead to information exclusion; neglect of research networking can lead to research exclusion. As governments have to be active in stimulating the development of the Information Society in general, they have to be involved in sustained support of research networking. Again, the responses to the questionnaire have made clear how influential the European Union's views are in the Neighbouring Countries.

Finally, we believe that the influence of the European Union could be very helpful in enabling NRENS in Neighbouring Countries to make progress towards acquiring a dark fibre infrastructure. It is essential that these governments are awakened to the consequences of a growing digital divide, to the present obstacles faced by their NRENS in advancing the national research networks, and to the importance of their assistance in enabling them to build the new infrastructure.

Role of TERENA

The survey responses have shown that the established TERENA activities in this area are highly appreciated. These include the Compendium of National Research and Education Networks, papers, staff visits, transfer of expertise within task forces etc. TERENA is also involved in ongoing discussions with NRENS in the accession states and in the SEEREN project in order to tailor its support activities. TERENA should continue to expand its support for the least developed European countries.

TERENA also has a very important role in providing monitoring information on the provision of research networking throughout Europe. In conjunction with the NRENs, it should continue this function and seek to expand the scope of this monitoring activity to include user-oriented information.

Annex I - NREN Profiles

The information sources for these profiles are, firstly, original descriptions provided by the NRENs, secondly, the NREN section of the country profiles of SERENATE deliverable D7, including updates provided by the NRENs, and, thirdly, the 2003 edition of the TERENA Compendium of National Research and Education Networks.

Albania

NREN name: Albanian Academic Network

Abbreviation: ANA

Visiting address:

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Phone: +355 4 362968

General e-mail address: inima@inima.al

Website:

The Albanian Academic Network (ANA) is in a transitory phase. The network is in the process of creation. Thus, at the moment there is no inter-institutional academic network backbone in Albania, except for a few isolated cases of inter-institutional links. Instead, institutions are connected separately to the Internet, usually via dialup to private ISPs.

The Institute of Informatics and Applied Mathematics (INIMA) managed the old metropolitan network in Tirana (a project of the United Nations Development Program (UNDP), 1985-1993). INIMA formally continues to manage the state computer network (by decision of the government in 1996). There is no legal entity and no permanent official site for ANA.

By joint decision in May 2002, the Ministry of Education and Science and the Academy of Sciences of Albania created a Managerial Board (co-chaired by the Minister of Education and Science and the Chairman of Academy of Sciences) and a Technical Board with representatives from the main academic institutions. The role of these Boards would be to organise and co-ordinate actions for the creation of ANA.

Bosnia and Herzegovina

NREN name: Academic and Research Network of Bosnia and Herzegovina

Abbreviation: BIHARNET

Visiting address: Obala Maka Dizdara 2, 71000 Sarajevo, Bosnia and Herzegovina

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Phone: +387 61 226717, + 387 33 663 693

General e-mail address: biharnet@biharnet.ba

Website: <http://www.biharnet.ba/>

BIHARNET was established as the academic and research network of Bosnia and Herzegovina in 1998. It is a legal entity set up in February 1998 by the University of Banja Luka, the University "Džemal Bijedić" in Mostar, the University of West Mostar, the University of Sarajevo and the University of Tuzla. The BIHARNET network was intended to be the backbone of the communications infrastructure dedicated to meet the needs of the Internet users from the educational, research and cultural sphere in Bosnia and Herzegovina. These universities also established the BIHARNET Centre, which was responsible for managing the network. Subsequently the new universities in Srpsko Sarajevo and Bihac also became members of BIHARNET.

The original funding for BIHARNET was provided by the government of the Republic of Slovenia as a donor project that finished at the end of 1999. However, due to political and economic reasons the funding of BIHARNET was not continued, despite a viable network and organisation being in place. The network is currently not operational due to lack of funding to cover the connectivity costs.

In June 2001, the ministers for education and science from both B&H entities (Federation of B&H and Republic of Srpska) and the representative of the Ministry of Education of the Republic of Slovenia signed an agreement regarding the financing of BIHARNET. Under this agreement financial recourses for the reactivation and regular work of the network were to be provided in the B&H entities' budgets. However, this had not been implemented yet when the ministries changed after the elections. A few months ago new ministers were appointed and it is hoped that they will finally complete the process.

The configuration of BIHARNET at the end of 2002, when the network was switched off, comprised nodes in Banja Luka, Bihać, Bijeljina, Foča-Srbinje, Lukavica, Mostar, Sarajevo, Tuzla and Zenica. The basic construction of a BIHARNET network node consisted of a Cisco 3640 router with corresponding capacity (of at least six ports) and modems on leased lines for user connections. International connectivity was by a 2 Mb/s link to the Slovenian academic and research network ARNES. This then allowed access to the pan-European network TEN-155 and subsequently to GÉANT.

Institutional connections to BIHARNET were usually leased lines except where their equipment was located at a BIHARNET node, in which case connection by Ethernet was possible. Depending on the need, available equipment, distance and the quality of the telephone lines, local connections via leased lines could have a capacity of 2 Mb/s. The usual alternative was 1 Mb/s (on one telephone twisted pair). In fibre-optic connections, the transmission capacity could be 10 Mb/s or more. The communications equipment located on the institutions' sites, such as modems, telephone line and router, were owned by them, though, as a rule, they were operated by the BIHARNET Centre.

BIHARNET was directly connected to the BIHNET network (a commercial network) via the Ethernet segment BIHIX (Internet exchange). No direct access to the BIHARNET network via dialup lines was provided. However, institutions connected to the network could provide their users with this service on their own, subject to the Rules for the Use of the BIHARNET network and its services.

The main problem related to BIHARNET is that it is established at the state level whilst the financing of education, research and culture institutions in B&H is organised at other levels (entity and cantonal). All these institutions recognise the need for a good academic and research network but nobody in government feels responsible for its sustainability, because a Ministry of Education at the state level does not exist. This does not mean that anybody in government contests the need for B&H to have an NREN. On the contrary, all prime ministers and ministers express support for the NREN. As a result of this policy, BIHARNET still exists as legal body but currently without the financial resources for connectivity, normal work and development.

Bulgaria

NREN name: Information Society Technologies Foundation

Abbreviation: IST Foundation

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Phone: +359 2 9492126

General e-mail address: rossitza@ist.bg

Website: <http://www.ist.bg/>

The prototype of the first Bulgarian research network (established as a volunteer association of universities and research departments) started operating in 1988. Mainly through various international projects, at the end of 1995 the external connection capacity of the academic network consisted of two 64 kb/s circuits to Amsterdam and one satellite 64 kb/s channel Sofia-Vienna, providing services to twelve cities in the country.

In the beginning of 1997, the Ministry of Education and Science (MES), which was one of the main contributors to the network, ceased its funding, and consequently the academic network lost its external connectivity. At the end of 1998, MES established a legal entity called UNICOM-B, which survived till December 2001. Its major technical node was based at the Bulgarian Academy of Sciences (Central Laboratory for Parallel Processing) and it still links around 50% of Bulgarian universities and all research institutes of the Academy. It peers with commercial ISPs at both the Sofia and Varna Internet exchanges but, unlike some NRENs in the region, is not involved in management of the national top-level domain.

During 2002, the NREN's legal statute was put under review. This created difficulties for the acceptance of funding and participation in international projects. However, the technical infrastructure remains operational, linking four cities (Sofia, Plovdiv, Varna and Rousse), with external connectivity provided via a 6 Mb/s link to the Greek NREN GRNET.

On 16 December 2002, a two-year project agreement was signed between the Bulgarian Ministry of Transport and Communications, the ICT Development Agency, the United Nations Development Program (UNDP) and the Ministry of Foreign Affairs of Bulgaria for a joint initiative aimed at the re-establishment of the national research network in Bulgaria. According to the project, the ICT Development Agency acts as a main counterpart on behalf of the Bulgarian government, while UNDP carries the formal administrative responsibility for the project bureau. The project is focused on the creation of a sustainable model for the development of the research network in Bulgaria after the end of the two-year project period via the creation of a not-for-profit entity.

The NREN was legally re-established on 31 March 2003. It is called the Information Society Technologies (IST) Foundation and is a not-profit entity acting in public favour. The Managing Board includes representatives from the Ministry of Transport and Communications, the United Nations Development Program (UNDP) local office and the ICT Development Agency, which are so far the major sponsors of the network.

The structure is open to other sponsoring partners and their interests will be protected via designated places on the Foundation Board.

The IST Foundation is managed by a CEO, appointed by the Board Members. There is also a Board of Experts, whose role is to propose projects to the Board of Directors and to give technical recommendations.

The organisation will serve all universities and research departments in Bulgaria. This is formalised through specific contracts for providing capacities and networking services at preferential (non-commercial) prices. At the end of October or beginning of November 2003 the external connection will be upgraded initially to 18 Mb/s and gradually to 34 Mb/s by October 2004 within the framework of the SEEREN Project (financed by European Commission). Six new regional centres were also added to the network: in the National Military University (Veliko Tarnovo), in the Academy of Economics (Svishtov), in the Aviation Faculty of the National Military University (near Pleven), in the Technical University (Gabrovo), in the University of Shumen and in the Trakia University (Stara Zagora).

Croatia

NREN name: Croatian Academic and Research Network - CARNet

Abbreviation: CARNet

Visiting address: Josipa Marohnica bb, Zagreb 10 000, Croatia

Fax: +385 1 616 5615

Phone: +385 1 616 5616

General e-mail address: office@carnet.hr

Website: <http://www.carnet.hr/>

The Croatian Academic and Research Network (CARNet) was created in 1991 as a project of the Ministry of Science and Technology of the Republic of Croatia. In 1995 the Government of the Republic of Croatia issued a decree founding the CARNet institution. Besides 40 employees, CARNet has about 70 external associates, and the employees of several institutions and companies participate in various project teams. The most important CARNet partners are the University Computing Centre (SRCE) and the Faculty of Electrical Engineering and Computing in Zagreb.

CARNet's members are the institutions from the science and higher-education system, comprising the universities and their respective faculties, other institutions of higher education and the scientific and research institutes. Today, 169 institutions at 236 locations in 27 towns in Croatia are connected to CARNet. The access network reflects the fact that the universities in Croatia are distributed throughout the country rather than being campus-based. This results in an access network with a large number of connections at a wide range of speeds. Some 59 institutional links run at speeds of 100 Mb/s or more. At the other end of the scale, there are some 160 connections at 2 Mb/s, with a smaller number of links at intermediate speeds.

The CARNet infrastructure is based on ATM and Ethernet technologies. The speed on the core network is 155 Mb/s, although work has just started on the "Gigabit CARNet" project which will increase this to 622 Mb/s and 1 Gb/s. CARNet is connected to international networks through GÉANT, at 622 Mb/s.

CARNet manages the Internet domains of the Republic of Croatia (i.e., the top-level .hr domain) and registers the domains within this, in accordance with the authority acquired in 1993 from the IANA organisation. CARNet's DNS service takes care of the organisation and maintenance of the national domain Internet space, i.e. it registers and activates the secondary domains within the top-level .hr domain.

Having recognised the need for a national centre for the prevention and remedy of problems related to computer network security, in 1996 CARNet founded a Computer Emergency Response Team (CERT). One of the basic tasks of CARNet's CERT is co-ordination in the process of solving computer security incidents in which at least one party involved is from the Republic of Croatia. The task of CARNet CERT is also to work permanently on improving the level of computer security among the Internet users in the Republic of Croatia. CARNet also provides a PGP service which allows finding public keys of other users, publishing one's own public key, and exchange of keys with similar systems in the world.

Another CARNet service is the Croatian Internet Exchange (CIX), which was founded in September 2000. Technically, CIX represents a unique point which connects communication channels between its users - commercial and non-commercial ISPs as well as academic and private computer networks in Croatia. Organisationally, CIX is a not-for-profit service of CARNet to other users of CIX. A CIX member can be any ISP in Croatia, a non-commercial network providing its services on the territory of Croatia or a private network providing its services to legal and physical entities on the territory of Croatia.

In addition to providing the full range of normal Internet services, CARNet promotes education in the application of information technology as one of the key areas in establishing an Information Society. It does this through a series of educational projects, the educational centre Edupoint, the Cisco Networking Academy, an education programme for system engineers and by organising Internet conferences. CARNet also runs a number of projects in co-operation with institutions from the academic community and external partners with the aim of popularising information technologies.

CARNet also provides multimedia services. Its Media-on-Demand server offers multimedia facilities produced by CARNet (various projects and events), as well as contents that are produced within the Croatian academic and research community. The Media-on-Demand service also provides its users with solutions and advice for the

application of multimedia technologies. Finally, CARNet continuously provides its members with a room videoconferencing service intended for distance lecturing, events (conferences, seminars, symposia, round tables, etc.), and professional meetings for the needs of the academic community.

Cyprus

NREN name: University of Cyprus

Abbreviation: CYNET

Visiting address: Kallipoleos 75, Lefkosia 1678, Cyprus

Fax: + 357 22756082

Phone: + 357 22892131

General e-mail address: agatho@ucy.ac.cy

Website: <http://www.cynet.ac.cy/>

There is only one university in Cyprus and it is responsible for running the NREN, CYNET. With a core capacity of 34 Mb/s, the network connects all university institutions and some other educational establishments. Usage is doubling or tripling every two years and it is planned to expand capacity accordingly. CYNET runs the router for Cyprus' Internet exchange and also manages the national top-level domain .cy. More generally, the university computer and networking department plays an important role in Cyprus by advising the government on information and communication technology issues.

90% of CYNET's budget comes directly from the government and the rest from users, based on bandwidth. 60% of expenditure goes on transmission capacity and 20% on staffing.

Its 34 Mb/s link to the GÉANT network is supplied via GRNET of Greece, and additional external capacity is supplied by CYTANET, CYTA's ISP operation, who also supply the domestic links.

Czech Republic

NREN name: CESNET, Association of Legal Entities

Abbreviation: CESNET

Visiting address: Zikova 4, CZ - 160 000 Prague 6, Czech Republic

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General e-mail address: info@cesnet.cz

Website: <http://www.cesnet.cz/> <http://www.ces.net/>

From being a relatively low-capacity network in the early 1990s, CESNET has today developed into a modern network (CESNET2), with a backbone core capacity of 2.5 Gb/s reaching all major entities within the national research and education network. Thirty-one universities and 229 hospitals, schools and libraries are connected to CESNET, where the universities account for approximately 95% of all the generated traffic. Through the 31 university connections almost 200,000 students, professors and other staff members have connection to the network. At the moment CESNET is not connecting primary and secondary schools to CESNET2, due to a government decision to that effect. Primary and secondary school connections to the Internet are directly managed by the Ministry of Education, Youth and Sports. The network topology consists of multiple rings, which ensures redundancy for each PoP. Today 95% of the network provided by CESNET consists of fibre connections and the rest are microwave links. Based on the competitive telecommunications market, CESNET is using different suppliers for leased lines and interconnections.

Overall the Czech national research and education network has not encountered any significant regulatory problems/obstacles regarding the development and maintenance of the network. CESNET has five international connections at the moment, one 1.2 Gb/s connection to GÉANT, which is only used for research traffic, one 622 Mb/s (800 Mb/s since October 2003) connection for commodity traffic, one native IPv6 connection at 155 Mb/s to 6NET, and one 2.5 Gb/s to NetherLight for testing lambda services. The fifth connection is a 1 Gb/s line to the Slovak NREN SANET. In addition to these five international connections, CESNET also has a national dual connection (2 x 1 Gb/s) to NIX.cz (the Neutral Internet Exchange of the Czech Republic).

CESNET uses mainly the following companies for providing leased-line services and capacity for the national network: Czech Telecom, Aliatel, Self Service, Sloane and CD-Telekomunikace. The highly competitive telecommunications market also means that it is no problem for CESNET to get capacity; the biggest problem is in the "last mile" connectivity.

When CESNET needs a new connection point or an increase of capacity in existing connections, this is done through a public tender, where interested providers can submit their offer. This gives CESNET the right to choose the best offer and thereby get the best combination of price and capacity.

As to the future, CESNET estimates that the capacity required will be 10 Gb/s for the next two years or so, and up to 40 Gb/s in a five-year timeframe.

Since all public universities already are connected to the network, CESNET is not expecting an increase in the number of connected entities; however, they are working on making it possible for technology parks, research institutions and other industrial research departments/entities to connect to the network on special conditions.

Today there are around fifteen small private universities in the Czech Republic, which are not connected to CESNET. Instead they have themselves chosen to use commercial suppliers for their Internet connections. The CESNET budget for 2002 is approximately 11 million euro and can roughly be divided as follows: salaries and office cost 23%, hardware and software 29%, transmission of data 38%, and other 10%.

Estonia

NREN name: Estonian Educational and Research Network

Abbreviation: EENet

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General e-mail address: eenet@eenet.ee

Website: <http://www.eenet.ee/>

The Estonian Education and Research Network (EENet) is a governmental non-profit organisation established in August 1993 by the Ministry of Education and is today a public institution operating under the administration of the Estonian Ministry of Education and Research. Currently there are about six thousand hosts in the national network and it extends to every county in Estonia. EENet's main task is to offer Internet connection (permanent links) as well as additional services. In addition EENet manages the Estonian top-level domain (.ee).

The EENet is built with Tallinn, Tartu and Haapsalu as centres of a "three-star" network connecting to all major cities in Estonia and with a 155 Mb/s connection from Tallinn to Stockholm to the GÉANT network. The current capacity of 155 Mb/s available through the GÉANT network is enough for the time being, but in 3-5 years' time it is estimated that the capacity should be 600 Mb/s to 2.5 Gb/s. The split between international and national traffic is currently around 50/50, whereas four years ago the split was around 60% for international and 40% for national; due to the fact that more webpages are becoming available in the national language, the national traffic has been and still is growing faster than the international traffic.

During 2002, EENet switched from using Eesti Telecom for leased-lines services for the backbone topology to mostly using Eesti Energia for leased lines, as that company has entered into the leased-line market with very attractive prices.

As of March 2002, 208,000 persons were registered as users of EENet, which includes different kinds of students as well as staff. 600-700 customers have a permanent connection to EENet, whereas the rest uses various kinds of dialup/radio connections.

Besides the already connected entities, EENet estimates that around 1500 entities that are not connected would qualify for connection, but for these entities the price of getting connected and obtaining the equipment necessary to make the connection possible is a major obstacle.

Overall the Estonian national research and education network has not encountered any significant regulatory problems/obstacles regarding the development and maintenance of the network. The regulator ENCB intervenes in the setting of prices for leased lines, but EENet is sceptical about the ability of the regulator to ensure lower rates, e.g. through interconnection regulation. The only major regulatory obstacle that EENet has had is related to the power limits in radio networks regarding transmission effects.

At present EENet uses the 2.4 GHz ISM band, where there is no licensing or regulatory obligations while in addition the equipment to be used in this frequency band is also fairly cheap, compared to equipment for other frequencies - according to EENet. EENet would also like to use more powerful transmitters using the 3.5 GHz band, if they could afford to buy the necessary equipment.

When a license is needed for a specific frequency band or for operating a network, the procedure can be described as relatively slow - but the price for obtaining the specific license is also relatively low.

The EENet budget for 2002, of approximately 1.15 million euro, can be divided as follows: salaries and office costs 25%, hardware and software 15%, transmission (leasing lines) 60%.

Hungary

NREN name: Hungarian Academic and Research Network Association

Abbreviation: HUNGARNET

Visiting address: NIIF-HUNGARNET, Victor Hugo u. 18/22, H-1132 Budapest, Hungary

Fax: +36 1 350 6750

Phone: +36 1 450 3060

General e-mail address: hungarnet@niif.hu

Website: <http://www.hungarnet.hu/> <http://www.niif.hu/>

The Hungarian academic and research networking community started network development in the late 1980s under the National Information Infrastructure Development (NIIF) Program. Early in the 1990s HUNGARNET, the Hungarian Academic and Research Network Association was established. The national network of NIIF/HUNGARNET is serving almost 700 institutions and today the user community comprises roughly 600,000 users.

The backbone network has a capacity of 2.5 Gb/s and is configured in a star with Budapest in the centre. In addition, some links outside the core star structure have 155 Mb/s or 34 Mb/s connections to different points in the star network. Cross-connections between the major regions provide redundancy in the topology.

Each of the connected institutions has one or more connections, either directly to the backbone, or through metropolitan networks. High-capacity connections are between 100 Mb/s and 1 Gb/s, medium-access capacities are around 2 Mb/s, and the low-end capacity access levels are 256 kb/s.

As far as development, operation, and management of the network is concerned, there is close co-operation between HUNGARNET and the NIIF Program managed by NIIFI.

HUNGARNET and NIIFI jointly provide access for related communities to a wide range of national and international network services, operate HBONE, the community's country-wide private 2.5 Gb/s backbone network, and provide 2.5 Gb/s international connectivity to the entire community consisting of practically all Hungarian research, development and education institutes, libraries and other public collections. No commercial entities are connected to the network.

HUNGARNET is controlled by its General Assembly and has its own President, Executive President, and Vice Presidents (Presidential Board).

The NIIF Program is controlled by the Program Committee and managed by NIIFI, under the umbrella of the Ministry of Education. The Program Committee consists of high-level representatives from, among others, the Ministry of Education, the Ministry of Informatics and Communications, the Hungarian Academy of Sciences, the Ministry of Cultural Heritage, the Ministry of Welfare, and the Hungarian Science Foundation.

Funding for academic and research networking in Hungary comes from the state budget through the Ministry of Education, while financial management is provided by NIIFI.

The permanent core staff within NIIFI, serving the HUNGARNET community, and taking care of the NIIF Program, consists of about two dozen members.

In cases where NIIF/HUNGARNET deploys leased-line capacity from 64 kb/s to 2.5 Gb/s there are several providers able of providing these capacities. MATAV, Vivendi and PanTel are considered to be the three major players that can provide high-speed capacities.

Today NIIF/HUNGARNET has subcontracted MATAV, Vivendi, PanTel, Novacom and GTS for leased-line services. Procurement is always by open tender. In general, NIIF/HUNGARNET does not have any serious regulatory problems.

NIIF/HUNGARNET has only one international connection, the 10 Gb/s GÉANT connection, which uses DWDM technology (upgraded from 2.5 Gb/s to 10 Gb/s in October 2003). For the future, NIIF/HUNGARNET expects the capacity needs to be around 10-20 Gb/s on a three-year perspective and 20-40 Gb/s in a five-year timeframe.

The NIIF/HUNGARNET core budget for 2002 was approximately 6 million euro and could roughly be divided as follows: salaries and office costs 10%, hardware and software 18%, transmission of data 60%, other 12%.

Latvia

In Latvia there are two research networks, which both will be described in detail below.

1.

NREN name: LATNET Department of the University of Latvia, Institute of Mathematics and Computer Sciences

Abbreviation: LATNET

Visiting address: Institute of Mathematics and Computer Sciences, Raina Boulevard 29, 1456 Riga, Latvia

Fax: +371 7820153

Phone: + 371 7211241

General e-mail address: latnet@latnet.lv

Website: <http://info.latnet.lv/En/>

The academic network LATNET is a separate unit of the Institute of Mathematics and Computer Sciences at the University of Latvia. The Institute was established in 1959 and is now the leading research institution of Latvia in mathematics and computer science. The main research directions of the Institute are system modelling and design, telecommunications, Internet technologies and their applications, theoretical investigations in mathematics etc. The Institute houses the graduate (master) studies in computer science at the University of Latvia, attracting approximately 200 students.

LATNET was founded in 1992 and soon expanded its network to all higher-education institutions throughout the country. To achieve this goal LATNET also took part in the international projects supported by the European Commission (Baltbone-1, Baltbone-2, Baltic Information Infrastructure Pilot Project BIIP etc.).

Today, LATNET offers all forms of Internet connections - dialup, leased lines, Ultra DSL, ISDN, fibre-optical, microwave, radio links etc., as well as Web presentation (hosting, homepage creation etc.). LATNET was the Latvian pioneer of wireless Internet and in co-operation with LATNET Serviss Ltd. was successful in implementing wireless access to the Internet in Latvia. As a result, a Latvian radio network was built with the central nodes of wireless access in the capital Riga and in 25 of Latvia's regions.

LATNET is very active in various projects concerning Internet content development in Latvia. It compiles a catalogue of Internet sites in Latvia and maintains the portal www.lv.

LATNET has participated in various international projects related to information technology and to presenting databases on the Internet. For example, the projects ICTIN (supported by the World Trade Organisation UNO), LinkGuide, INSIGHT and INTACCOMP (COPERNICUS programme), EASYCRAFT etc. Currently LATNET participates in GÉANT as the national research network of Latvia.

LATNET also investigates the possibilities of implementing new telecommunications technologies in business and everyday life. It studies e-commerce and e-business applications in Latvia. LATNET has been working on Internet content for a long time and, for example, has established an online gallery of Latvian art (www.gallery.lv), an initiative that was possible thanks to good and long-term contacts with Latvian professional artists. The most recent achievement in the modern application of Internet technologies is the e-shop Ambersea that offers art to customers worldwide; see <http://www.ambersea.lv>.

The LATNET staff counts three Ph.D.'s, 17 M.Sc.'s and other university graduates, most of whom are further educated via various courses organised by international corporations.

LATNET is a member of the international organisations RIPE NCC, TERENA, CEENet and ICANN.

Turnover in 2002 was about 1.1 million euro. LATNET's budget for 2002 was approximately spent as follows: 30% on salaries and office costs, 30% on hardware and software, 40% on transmission/data communications.

2.

NREN name: Department of Information Technology, University of Latvia (UL)

Abbreviation: LANET

Visiting address: Aspazijas b5, 1057 Riga, Latvia

Fax: +371 7 222 620

Phone: +371 9 269 305

General e-mail address: contact@lanet.lv

Website: <http://www.lanet.lv/>

The formation of LANET was an initiative of the government of the Republic of Latvia and the German Federal Republic. The Ministry of Education of Latvia had the responsibility for the formation of LANET. The institutions in Germany that provided concrete help were the University of Münster and DFN. The computer network has been given the international name LANET- Academic Network of Latvia.

Simultaneously in 1992 the Finnish company "OY International Business Machines AB" (IBM) undertook an "academic initiative". Within the framework of this initiative a mainframe computer IBM-4381 including software was installed at the University of Latvia. Some individuals and several organisations have also contributed to the development of LANET.

LANET was initially based on FDDI, later on ATM and as of 2003 a transition to GE has started. LANET is managed by the IT department of the University of Latvia. All LANET staff are employees of the University of Latvia. LANET is funded by that university (80%) and by the government (20%). LANET and global Internet connections are provided to non-profit academic institutions or its users without charging costs.

Most local networks of Latvian research institutions, the University of Latvia (30% of students in Latvia study at that university), the Latvian Academy of Sport Education, the Latvian Academy of Music, the Ministry of Education, local networks, and some University of Latvia dormitory networks are served by the backbone network of LANET. Most of these connections, including dormitory connections, are at a speed of 10 Mb/s to GE. There are only 140 student rooms in dormitories connected to LANET right now, but the connection of dormitories to the network continues. This is important for the E-studies project. Wireless connection inside buildings has begun. In total 3000 work stations are connected to LANET. It is possible for LANET users to connect to LANET using VPN or dialup connections.

The LANET connection is sufficiently fast and can provide its users with QoS, which is important to LANET users, because at the moment active work on the formation of an E-studies program has started and the usage of videoconferences and streaming media has become necessary.

There are more than twenty buildings connected to LANET. They are located in different places in Riga and surrounding areas within a 10 km radius. The connections form a star with the centre in the main node. Leased (dark fibre) optics, Lattelekom Ethernet service and leased lines are used for these connections. There is a tendency to migrate to GE, which is realised via leased lines. Concerning broadband connections, there is a tendency to provide connected workstations with QoS. This is especially important, because the University of Latvia has started developing and widely using E-studies, videoconferences, streaming and other modern network applications in its activities.

The LANET connection to the global Internet is 50 Mb/s with a guaranteed rate of 23 Mb/s. The LANET connection to GÉANT is 3.5 Mb/s. LANET's connection to other networks in Latvia (via the Internet exchange LIX) is 2 x 100 Mb/s.

Lithuania

NREN name: Lithuanian Academic and Research Network

Abbreviation: LITNET

Visiting address: Studentu Str. 48A – 101, LT 3031 Kaunas, Lithuania

Fax: +370 37 300643

Phone: +370 37 300641

General e-mail address: info@litnet.lt

Website: <http://www.litnet.lt/>

The academic research network of Lithuania (LITNET) is an association of academic research institutes and other non-profit organisations, where the members use, manage and develop the LITNET network. The highest governing body of LITNET is the LITNET Board, whose structure and regulations are supervised by the Ministry of Science and Education in Lithuania. It is also the Ministry of Science and Education that financially supports LITNET.

LITNET is a national network, which interconnects all major Lithuanian cities and local education and research institutions, schools etc. The main goal of LITNET is to provide advanced and high-quality Internet services to all kinds of educational establishments in Lithuania. Due to these restrictions of the use of LITNET, service is only available for:

- higher education and colleges
- research institutions
- medical research
- national and local libraries
- primary and secondary schools
- national and local museums.

All fifteen universities in Lithuania are connected to LITNET and over 320 entities are connected through a permanent connection, either directly or through regional networks; almost 100,000 students are given Internet access through LITNET.

The LITNET core network can be described as a star-network, with Kaunas as the centre. Between the five major connection points in the core network the capacity is 155 Mb/s, whereas minor connection points have a 4 Mb/s or 1 Mb/s connection capacity.

LITNET has two international connections: one through GÉANT which operates at 155 Mb/s and one through Delfi Internet at 4 Mb/s. LITNET expects the access capacity to be upgraded to 622 Mb/s in the first half of 2003 and furthermore to upgrade this capacity several times within the next few years.

The LITNET budget for 2002 is approximately 3.2 million euro, which can roughly be divided as follows: salaries and office costs 10%, hardware and software 23%, transmission of data 57%, other 10%.

FYR Macedonia

NREN name: Macedonian Academic and Research Network

Abbreviation: MARNet

Visiting address: Univerzitet "Sv. Kiril i Metodij" Bul. Krste Misirkov b.b., 1000 Skopje, FYR Macedonia

Fax: +389 2 114 308, or +389 2 116 370

Phone: +389 2 129 068

General e-mail address: postmaster@marnet.mk

Website: <http://www.ukim.edu.mk/voizgradba.html>

The Macedonian Academic and Research Network (MARNET) was founded in 1994 by Decision of the University Board as an organisational unit within the Ss Cyril and Methodius University and endorsed by the Ministry of Science. At the same time the Statute of MARNet came into effect determining the goals, management and organisational structure as well as the financing of MARNet.

The overall direction of MARNET is provided by the Council of MARNet. The Council consists of sixteen members who come from academic institutions, other research organisations, Macedonian Telecommunications and certain ministries of the government. Under the Council two further bodies have been established, the Management Board and the Technical Board. Between them, these three bodies are responsible for the management of MARNet.

Although MARNet's initial technological infrastructure was predominantly based on the existing university computer network of the Ss Cyril & Methodius University, it was envisioned that MARNet's mission should extend beyond the functionality and boundaries of this network and that it should develop into the national academic and research network. Therefore it was also supposed to, and actually does, manage the .mk country code top level domain, to plan, develop, implement and manage the communication infrastructure backbone in the country, and to attain and maintain international and Internet connectivity for its users. MARNet is also representing the country through membership of international networking organisations.

MARNet has grown to a focal point where other academic institutions obtain their connectivity to Internet (the St. Clement of Ohrid University in Bitola, National University Library in Skopje and the University Library in Bitola). Other governmental institutions, several ministries, the national statistics agency as well as the offices of the government have also acquired their Internet connectivity through MARNet. At present MARNet connects two of the universities in the country. The third, the University of Southeast Europe in Tetovo, is not yet connected (it obtains its Internet connectivity through a satellite link to British Telecomm). However, since that university's representative has recently been included in the governing bodies of MARNet, it is expected that peering shall be established in the near future.

It is customary that research institutes affiliate themselves with universities, so connectivity for them is also provided through MARNet. Hence, today MARNet serves a community of around 70,000 people, approximately 60,000 of them in the academic sector and 10,000 in governmental and library institutions. It is expected that when MARNet is sufficiently resourced by the recruitment of additional staff and additional financing by the government is obtained, connectivity for secondary and primary schools will also be provided. This will increase the number of users by about 72,000 when secondary schools are connected and by another 270,000 when primary schools are served.

The organisation is supported financially by the government (the Ministry of Education and Science) and member institutions in the following way: Internet connectivity is provided by a local ISP (MTnet) and paid for by the government (45,000 euro a year), while the national connectivity costs are covered by the connecting members themselves (6,500 euro a year). The connecting parties also cover the expenditures for the procurement and maintenance of equipment, while on the NOC site there is existing equipment of the network of the university in Skopje and a certain quantity is provided by donations. The aforementioned ministry also covers the fees for the membership in international networking organisations (TERENA, CEENet) which amounts to 7,500 euro a year. It is planned in the near future that this model should be changed in such a way that extended funding from the government shall be provided and that the members of MARNet shall be charged on the basis of the services offered. The services for the public, such as the domain registration under the .mk top level domain, will also be charged for.

It is important to stress that although MARNet has been in existence for almost a decade, it still does not have a separate legal status (it is a subdivision of the University in Skopje), despite continuous effort that has been put by the management structures to establish a positive environment where MARNet could achieve legal and financial independence. These circumstances have been strongly influenced by the fact that at the time MARNet was founded, it was based on the communications infrastructure of the university computer network of the Ss Cyril & Methodius University and it was put into operation by the endeavour of the academics coming from this university.

Many of the staff who support the operation of MARNet, both managerial and technical, are not formally employed by MARNet. For example, technical duties are most often done by collaboration between the employees at the NOC and technical staff at the connecting institutions and hence scheduled on a time-permitting basis. This has a negative effect on efficiency. This is why the management structures are putting in a great effort to design an organisational structure with a legal identity as well as to obtain funding for the recruitment of full-time staff.

Malta

NREN name: University of Malta - Computing Services Centre

Abbreviation: CSC

Visiting address:

Fax: (+356) 21343397

Phone: (+356) 32903004

General e-mail address: csc@um.edu.mt

Website: <http://www.csc.um.edu.mt/>

The NREN is still in its infancy with the necessary structures still being set up. The NREN functions are currently being carried out, using existing resources, by the Computing Services Centre of the University of Malta, the same organisation that handles university campus network services.

The University of Malta is the only university in Malta and comprises around 8000 students and 1000 members of staff. The Computing Services Centre within the university is responsible for the IT infrastructure of the university and it services several other research and education organisations, including Junior College, the Malta Council for Science and Technology, the Mediterranean Academy of Diplomatic Studies and the International Maritime Law Institute.

The Computing Services Centre also provides operations and technical support to the Malta Internet Foundation. That foundation was set up by the university and is responsible for the top-level Internet domain for Malta (.mt) and also for the Malta Internet Exchange.

Malta was recently connected to the GÉANT network and currently has a 20 Mb/s connection.

Work is ongoing to set up the necessary structures to be able to serve other local research and education entities that may require access to GÉANT and to upgrade the GÉANT connection in order to meet these requirements. Further funding and personnel would be needed to develop and sustain NREN operations. It is hoped that these will become available once the necessary structures are put in place.

Poland

NREN name: Poznan Supercomputing and Networking Centre

Abbreviation: PSNC

Visiting address: 10 Noskowskiego Str., 61-704 Poznan, Poland

Fax: +48 61 8525954

Phone: +48 61 8582001

General e-mail address: office@man.poznan.pl

Website: http://www.man.poznan.pl/

In 1992 the Committee for Scientific Research in Poland started a programme for building an information infrastructure for the Polish scientific community. It resulted in the creation of twenty-two Metropolitan Area Networks and five High Performance Centres. Metropolitan Area Networks with their own fibre infrastructure have connected all universities and all institutes of the Polish Academy of Sciences. In order to create an effective environment for collaboration and applications development for science, the Polish Scientific Network has been developed. Today the network is called POL-34/622, based on the fact that it is operating at 622 Mb/s in the core backbone. Currently the backbone infrastructure is mostly based on leased channels (SDH and lambda) from the Railway Telecommunications Company.

The Polish research community has its own fibre infrastructure within the academic Metropolitan Area Networks and to become independent from external suppliers it has started in 2001 its own project called PIONIER. The PIONIER project is aiming at building fibre-optic cables and using DWDM infrastructure (10 Gb/s and 40 Gb/s lambdas) connecting all MANs in Poland. The research community today already has put in 2,500 km of fibres out of the 5,000 km planned.

Until the PIONIER network is fully deployed there is a migration to a 10 GE backbone connecting sixteen Metropolitan Area Networks, which will be the basis for further migration to a fully optical infrastructure with a multi-lambda network.

In January 1998 the Poznan Supercomputer and Networking Centre (PSNC), which operates and manages the POL-34/622 network and the Poznan MAN, received a license from the Secretary of Communications for operator activity in the field of data transmission and access to the Internet. This networking/telecommunication activity of PSNC on Polish territory is based on registration in the Office of Telecommunications Regulation (OTR); to operate the research network, PSNC had to apply for a telecommunications license and become a formal operator, which also meant that they afterwards it did not have any regulatory problems in relation to the telecommunications regime. The same regulations applied to other MAN operators in Poland. Since 2001, the new regulations do not require licences for network operator activities in Poland, but registration is still required.

There are 715 university locations connected to the POL-34/622 network and more than 1.4 million students are connected. Besides universities, also research institutions, R&D institutions, libraries, hospitals and other public and governmental institutions are connected to the network.

The international connectivity for the POL-34/622 network is provided by DANTE via the GÉANT network; the connection between POL-34/622 and the GÉANT PoP in Poland is 2.5 Gb/s. The GÉANT connection is based on Packet-over-SONET directly to the GÉANT PoP in Poznan. A second international link has been established to the SPRINT network via a local provider, with a capacity of 310 Mb/s based on ATM. The link to the GÉANT network is dedicated for research traffic and the link to the SPRINT network is for commercial traffic. This split of traffic is due to the funding, where the international capacity for the research community is funded by the State Committee for Scientific Research, while the commercial link is funded by the users of this link.

Regarding future capacity, PSNC is planning to increase their international capacity to 10 Gb/s in 2003 and probably migrate to 40 Gb/s and multi-lambda connection within five years.

The PSNC budget for 2001 was 7.8 million euro, which roughly can be divided as follows: salaries and office costs 30%, hardware and software 10%, data transmission 50%, other 10%.

Romania

Two separate organisations run academic networks in Romania. They used to be a single organisation, and have been split so that each is answerable to a different Ministry. They continue to work closely together.

1.

NREN name: Romanian National Research and Development Network

Abbreviation: RNC

Visiting address: Research Institute for Informatics, Bd. Averescu 8-10, Sector 1, Bucharest 71316, Romania

Fax: +40-21-224.10.84

Phone: +40-21-224.26.18, +40-21-224.07.62

General e-mail address: net-admin@listserv.rnc.ro

Website: <http://www.rnc.ro/>

RNC (Romanian National Computer network) is run by the National R&D Institute for Informatics, and is a member of TERENA. Half its income comes directly from the government and half from users and other sources. In addition to providing connectivity to six universities and over 100 other educational institutions, it offers a full range of Internet services on a commercial basis, manages the .ro top-level domain and acts as Local Internet Registry for IP addresses. It is also involved in the Internet exchanges for Bucharest and Romania. 70% of its operating budget is spent on transmission facilities and 10% on staff.

The network topology is mainly a star based on Bucharest, supplemented by direct links between other major cities and additional links among the many academic institutions in Bucharest. Core backbone capacity is 100 Mb/s, with a total capacity of 2000 Mb/s x km. Both internal and external capacity are expanding rapidly, by a factor of 10 or 20 in two years.

2.

NREN name: Office for Administration and Operation of Data Communication infrastructure "RoEduNet".

Abbreviation: RoEduNet

Visiting address: Splaiul Independenței 313, Rectorat, R506-507, Cod 77206, Bucharest, Romania

Fax: +40-21-4101639

Phone: +40-21-4101639

General e-mail address: support@roedu.net

Website: <http://www.roedu.net/>

RoEduNet is the data communication infrastructure of the Ministry of Education and Research. RoEduNet's network structure consists of seven Network Operation Centres (NOCs) located in the major university centres of Romania: Bucharest, Galati, Iasi, Tg. Mures, Cluj, Timisoara, Craiova. The network topology is similar to that of RNC, supplemented by spurs from each of these major centres to surrounding counties. The connection speed is 34 Mb/s for Cluj, Iasi, Timisoara and 8 Mb/s for Galati, Tg. Mures, and Craiova, with an 8 Mb/s backup ring. RoEduNet also has Points of Presence in every county's capital city (40 in total), each connected to the closest NOC by a 2 Mb/s link. RoEduNet also operates Gigabit, ATM and FastEthernet metropolitan area networks in Bucharest, Cluj and Iasi respectively. Core network capacity in Bucharest is 1 Gb/s.

RoEduNet has local exchange connections with all major ISPs in Romania and a 155 Mb/s link to GÉANT, to be upgraded to 622 Mb/s in 2003. Its figures for connected institutions are as follows:

- 80 universities and higher level education institutions
- 179 high schools
- 55 elementary schools
- 42 county school boards
- 37 research centres and institutions
- 41 other not-for-profit and governmental institutions (e.g., ministries, city councils, hospitals, branches and institutes of the Romanian Academy).

As the Ministry of Education and Research intends to put Internet connected computer networks in every school in Romania, the figures for connected schools will increase rapidly.

RoEduNet was officially founded in August 1998 and is funded by the Romanian Ministry of Education and Research. The main goal of RoEduNet is to provide a modern data communications infrastructure that connects all educational, research and cultural institutions in Romania, and to provide Internet connectivity for all connected institutions. During 1999-2000 RoEduNet had problems with funding the internal connections between NOCs and between NOCs and POPs. Following this, RoEduNet discontinued the satellite connections, which were expensive, and moved to terrestrial 8 Mb/s links.

RoEduNet offers a full range of IPv4 services, such as DNS, mail relay, web hosting, ftp and web cache servers, and network time protocol services. IPv6 services are in the test phase. Multicast services have been tested and there are periodical test videoconferences between NOCs. VoIP has also been tested over RoEduNet since 2002.

Another aspect of RoEduNet activities is the development of human resources for information technology and since 1998 RoEduNet has been part of the Cisco Networking Academy Program.

Future plans include an increase of bandwidth for external connectivity, to take better advantage of GÉANT resources, as well as a backup link for reliability to eliminate any significant network outages. In step with this planned increase in external capacity, the links of the national backbone will also be upgraded. Finally, in connection with extension of GÉANT to the east, there is already a project (currently in its final phase) to connect the Moldova Academic Network (RENAM) to RoEduNet.

Serbia and Montenegro

NREN name: Yugoslav Academic and Research Network

Abbreviation: AMREJ

Visiting address: Kumanovska b.b., Belgrade 11000, Serbia and Montenegro

Fax: +381-11-3031258

Phone: +381-11-3031257

General e-mail address: noc@rcub.bg.ac.yu

Website: <http://amrej.rcub.bg.ac.yu/>

AMREJ is the education and research network for Serbia and Montenegro. It is supported by the Ministry of Science, Technology and Development and by the Ministry of Education and Sport.

AMREJ is managed by a Board of Directors, which consists of the directors of the university computing centres of all universities in Serbia and Montenegro. It has not yet been established as a separate legal entity, but the draft version of the constitutional act of the NREN of Serbia has been agreed upon between the ministries and the universities and will be presented to parliament for approval.

Belgrade University Computing Centre is the main network operation centre of the network, and also coordinates international co-operation and technical network development. The director of Belgrade University Computing Centre represents AMREJ in international bodies.

Connectivity inside Serbia and Montenegro is based on a star-topology network with Belgrade University Computing Centre (RCUB) in the middle and five other university computing centres connected to this node. These centres, with their connection speeds, are Novi Sad (1 Gb/s + 2Mb/s backup), Nis JUNIS (155 Mb/s + 2 Mb/s backup), University of Montenegro (2 Mb/s), University of Kragujevac (2 Mb/s) and University of Krusevac (2 Mb/s)

Each of these nodes operates as a NOC for a part of the territory of Serbia and Montenegro and their staff form part of the AMREJ team. Belgrade University Computing Centre operates as the NOC for both the University of Belgrade and the University of Arts in Belgrade. The nodes have numerous leased lines connecting faculties, research and development institutes and some secondary schools. These local connections vary from 1 Gb/s to 10 Mb/s lines through fibre optics, 2 Mb/s to 128 kb/s and 64 kb/s through copper (HDSL, MSDSL, ...), and even to 33 kb/s. The University of Belgrade has a 1 Gb/s backbone with four nodes that is 20 km long. At present, more than 150 educational and research institutions are connected to AMREJ.

The University of Belgrade has significantly improved its computer network in the last two years. By far the most credit for these achievements goes to the SINSEE project. This project was jointly accomplished by the German Federal Ministry for Education and Science, the Serbian Ministry of Science, Technology and Development, the Max Planck Institute and the University of Belgrade. Along with the creation of new local area networks and Gigabit metropolitan backbones, a very important result of the SINSEE project pilot phase has been the creation of a nation-wide backbone. The overall result is a scalable and extensible network, which can sustain future upgrades.

AMREJ has more than 200 dialup ports in most of the towns for PPP-based remote access for organisations from the research and educational area which cannot afford a leased line, and for individuals working in the research and development institutions. Connection via public ISDN is also possible.

International connectivity is provided by a 2 Mb/s line to GRNET (currently being upgraded to 6 Mb/s) and then to the GÉANT network. AMREJ also has a 1.5 Mb/s link to a commercial provider in Yugoslavia (BeoTel). These connections are overloaded even after midnight. Some basic services (FTP for example) are available only from midnight to early in the morning, in order to make other basic services available during the day.

It is estimated that there are altogether more than 100,000 individuals who are connected to the AMREJ network and use AMREJ services in Serbia and Montenegro, most of them through permanent connections. Individuals from research and educational institutions can get a personal dialup account directly from AMREJ.

The current sources (in percent of total) of funding for investments and maintenance for the network infrastructure are as follows: Ministry of Science, Technologies and Development of Serbia 80%, Ministry of

Education and Sport of Serbia 13%, Ministry of Education and Science of Montenegro 7%. Other sources are foreign donors (SINSEE, SEEREN, HRK - Hochschulrektorenkonferenz).

Slovak Republic

NREN name: SANET - Association of users of Slovak Academic data NETWORK

Abbreviation: SANET

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The Slovak Academic Network (SANET) was established in 1990 to build and operate a computer network connecting academic and research organisations in Slovakia, with connections to similar networks around the world. Today SANET is an independent association, where the members have agreed to conditions that will provide each member with Internet services. SANET is a non-profit organisation whose members contribute to the operations and build-out of the network.

In 1996 just above 100,000 students in tertiary education were connected to the network through 26 connected universities. Besides universities and research institutes also hospitals, libraries and entities of other levels of education are connected to SANET today, where more than 300 entities have permanent connections to the network.

The SANET network covers 21 towns. The entire backbone was built in a framework of the project SANET2 by leasing dark fibres and using Gigabit Ethernet. Two towns are still connected via leased lines with speeds up to 2 Mb/s. They will be moved to Gigabit Ethernet via dark fibre in near future.

The backbone of the SANET network is built on Ethernet technology with a transmission speed of 1 Gb/s. Where it has not been possible to lease dark fibres the different entities are connected to the nearest access point through leased digital circuits.

SANET has an optical ring infrastructure, which is connected in the middle between Zvolen and Banska Bystrica. This means that if any segment is physically interrupted, the operation of the network will be redirected through the nearest node on the opposite end, and high redundancy and reliability of the network will be ensured.

National connectivity is realised through an Ethernet link to the Slovak Exchange point SIX placed in the Computer Centre of the Slovak Technical University in Bratislava, with a 1 Gb/s connection.

The international connectivity is realised through the dark fibre lines to CESNET (Brno, Czech Republic) and ACOnet (Vienna, Austria). These lines are used also for connection to the exchange points NIX-CZ and VIX-AT.

There are also several local Gigabit Ethernet connections to GTS in Bratislava (200 Mb/s), SPRINT in Vienna (200 Mb/s) and, as mentioned before, the Slovak Exchange Point SIX in Bratislava.

Connection to the GÉANT network is realised through a PoP in Bratislava with a capacity of 2.5Gbps. SANET uses 200 Mb/s of this capacity.

The SANET budget for 2002 was approximately 815,000 euro, and can roughly be divided as follows: office and travel costs 4.4%, hardware and software 5.5%, data transmission 90%.

It should be noted that SANET has no staff of its own: all personnel who are working within the network and also all Board members are related to some academic institutions, which pay their salaries and general expenses.

Slovenia

NREN name: Academic and Research Network of Slovenia

Abbreviation: ARNES

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ARNES was established as an independent public institution in 1992 following the model of other European academic and research networks. Its main tasks are the development, operation and management of the communication and information network for education and research. The bulk of the operating costs incurred by ARNES are covered by the Ministry of Information Society, so that services can be free-of-charge for the majority of its users. In legal matters ARNES acts independently.

ARNES plans, operates and maintains the network and its international connections, manages the central activities required for the provision of services, takes care of security, provides advice on technical solutions and educates users.

In addition to ensuring connectivity, ARNES also performs a series of activities required for the undisturbed use of Internet services. To this end, it operates a whole series of central servers for services such as DNS, WWW, FTP, IRC, NTP, NEWS, LDAP, RADIUS and a proxy WWW cache.

From the very start of networking in Slovenia ARNES has supported some basic activities and services for the entire Internet community in the country. ARNES manages the national top-level domain (.si) and runs the top-level Domain Name Server. In addition ARNES runs the SIX (Slovenian Internet Exchange) where all those Internet providers that have their own international connectivity can peer between themselves. SI-CERT is ARNES' service for co-ordinating notification and resolution of security problems in Slovene computer networks.

ARNES is a national member of TERENA, a shareholder in DANTE, a member of CEENet, CENTR and RIPE NCC and an associate member of Internet2. Together with other academic networks, ARNES develops and tests new Internet technology and services.

The government adopted the eligibility criteria for organisations and individuals using the ARNES network. ARNES currently provides network services to universities, secondary and primary schools, private research institutions, libraries and cultural institutions. One-third of the approximately 120,000 ARNES users can access the network individually via the telephone or cable network, using their personal ARNES account. Two-thirds of users use services via a local-area network in one of eight hundred organisations connected to the ARNES network via leased lines, (self-owned and leased) optical fibres, CATV networks and wireless connections. For leased lines and CATV networks the capacity is between 64 kb/s and 2 Mb/s, and for fibre optic or wireless, 10 or 100 Mb/s Ethernet.

ARNES has a 622 Mb/s connection to the pan-European research network GÉANT. The basis for connectivity inside Slovenia is a backbone network comprising main routers (nodes of concentration) connected by leased lines. The ARNES network is composed of the ARNES backbone and all lines and routers at final destinations, which are managed by ARNES.

Nodes of concentration (NOC) are located in major towns in Slovenia. Small towns are connected with 1 Mb/s lines, larger with 2 Mb/s or 20 Mb/s and Maribor with a 155 Mb/s line. Upgrade of these unusually low capacities has been repeatedly delayed as a result of the monopolistic telecommunications market, which cannot provide – at a reasonable price – the necessary infrastructure (esp. dark fibre) for building high-capacity networks. As an ever increasing proportion of users and organisations has an option of broadband access to ARNES network, the provision of not only advanced, but basic network services is seriously hindered by the low capacity of the backbone itself.

Turkey

NREN name: Turkish National Academic Network & Information Centre

Abbreviation: ULAKBIM

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In 1986, the Turkish Universities and Research Institutions Network (TÜVAKA) was set up. Only few universities were connected. It had a limited networking capacity and it was not based on the Internet Protocol, but had connections with BITNET and EARN. TR-NET was set up to connect Turkey to the Internet and in 1993 connection to NSFNET was established.

In 1996, the National Academic Network & Information Centre (ULAKBIM) was established, taking over the responsibilities of TÜVAKA, TR-NET and the Higher Education Council Documentation Centre. The objectives of ULAKBIM are:

- to establish and operate a computer network enabling interaction with the institutional elements of the national innovation system, and to provide information technology support to help information production;
- to provide information services, which will reflect the information accumulation in the national innovation system via this network and/or using traditional ways, and to offer information services that will help information production.

The first objective was met by the creation of Turkish National Academic Network (ULAKNET) in 1997, which today provides access for all universities and research organisations in Turkey (more than 230 connections) to the global Internet. Access is provided to these organisations over an ATM backbone installed between three main

Points of Presence (PoP) in Ankara, Istanbul and Izmir. The bandwidth of ULAKNET to the global Internet is currently 465 Mb/s. As of December 2002, a 34 Mb/s GÉANT link has been established via satellite and this link was increased to 155 Mb/s in January 2003. The nodes connected to ULAKNET are universities, research and development organisations, some governmental organisations, and military and police academies. Access speeds range from 2 Mb/s to 155 Mb/s. Dicle University in Diyarbakir, for example, is connected at 8 Mb/s and the 40+ universities and research institutions in Istanbul are connected with speeds from 2 Mb/s to 155 Mb/s.

The second objective has been met by the establishment of Cahit Arf Information Centre, which offers information and documentation services to the national innovation system, conducts research and development studies in the field of information and knowledge management, conducts studies to form national data bases, and provides co-ordination among the organisations that produce and store information.

Annex II – Survey Questionnaire Form

The questionnaire that was sent to each NREN in Neighbouring Countries in April 2003 and the accompanying letter describing the purpose of this work item within the overall SERENATE programme.

SERENATE questionnaire

A.

Where are the most severe problems in the research and education networking hierarchy?

1. Computer/laboratory equipment at universities
2. Local networks at universities
3. Access network
4. Metropolitan network
5. National backbone
6. International connectivity

Can you illustrate this by giving some numbers/data from certain universities, labs or networks that illustrate the size of the problems?

B.

Are you affected by the following problems, if yes, can you illustrate the problem by some numbers/data or stories, and do you see a possible solution?

1. Lack of awareness by politicians and decision makers of the importance of the NREN for research, education and general development of the country
2. Lack of awareness by university chancellors and directors of research institutes of the importance networking and NREN services
3. Lack of awareness by researchers and professors of the importance of networking and NREN services
4. Lack of funds for computers, networking equipment and functioning of NREN
5. Shortage of appropriate infrastructure in the country
6. High prices of the telecommunication infrastructure
7. Shortage of managerial skills in (our)your NREN
8. Shortage of technical competence and skills in (our)your NREN

C.

Can NREN get telecommunication infrastructure under better conditions than others?

Is it possible to lease optical fibre for access?

Is it possible to lay your own optical fibre in cities?

Is it possible to lease optical fibre (or get IRUs) between cities for the NREN backbone?

D.

Do you think that your Telecom company (former monopoly provider) tries to hinder the development of NREN (are you seen as a competitor on the internet market)? If yes, how did you find out about the obstruction by the telecom operator?

E.

Do you think that ISPs in your country see the NREN as a competitor? If yes, can you give some examples of how this attitude of manifests itself?

F.

What do you think about connecting schools and public libraries?

1. Our NREN is already doing this.
Please explain your experiences.
2. Our NREN does not want to do this.
Please explain why not (e.g. this would bring a lot of additional work, our NREN would not be able to provide the best service to universities any more, etc)
3. Our NREN would like to do this.
So why are you not doing it yet? (e.g. government decision etc)
Why do you think this would benefit your organisation (e.g. greater visibility, more secure financing, economy of scale etc.)?

G.

Do you think that the European Commission can do or should do something to close the gap between most and least developed NRENs? If so, what should the EC do?

H.

Do you think that TERENA can or should do something to close the gap between most and least developed NRENS? If yes, what?

I.
Any other idea(s) or suggestion(s)?

If there are any parts in your answers that you would not like to see published, then please mark them "confidential" and SERENATE will use those parts of your replies only in such a fashion that the information cannot be identified with you or your organisation.

Accompanying letter

Dear colleague,

SERENATE is the name of a series of strategic studies into the future of research and education networking in Europe. The current situation is that NRENS and the wider research networking community in Europe are at the forefront of global technological developments. SERENATE is investigating strategic aspects of the development of the next generation of »leading high speed« networks, looking into the technical, organisational and financial aspects, the market conditions and the regulatory environments. As a result, by the end of the project, the relevant policy makers, founders and managers of research networks in Europe will have at their disposal a set of recommendations and background material that will enable them to set their policies for the further development of European research networking.

The SERENATE project is broken down into several work items. One of these is entitled »Report identifying issues related to geographic coverage of European research and education networking«. This report will provide a review of the present status of research networking opportunities for researchers in various parts of Europe, including the availability and cost of services and infrastructures, and an assessment of realistic scenarios to improve the situation. At the national level, the current situation in EU Accession countries and some other Eastern European Countries is that most of the NRENS in this region are not able to provide the same levels of services as NRENS in some of the more developed European countries. Some possible reasons are lack of funds, lower levels of competition, less mature telecommunication infrastructure and consequently high prices. There is, however, a political will to achieve the strategic goal of providing »equal opportunities« for all researchers from all European countries. The SERENATE report therefore aims to provide advice on what can be done to close this digital divide.

To achieve the purpose of this report I would like to ask you the following:

Could you please send me a description of your NREN. As the SERENATE report will try to describe the digital divide in Europe and how to close it, the emphasis should be on the problems you have and ideas for possible solutions. Please be candid in describing the situation. And if there are some pieces of information that you would like to give to the SERENATE project to help us write our report but that you would not like to see published in a recognisable form, then please mark that information as confidential.

In a separate attachment there is a general description of the telecommunication market in your country and a short description of your NREN which has been already collected by the SERENATE project from different sources. This could help you in the description of your network and the environment you work. If you find that some information in that text is not correct please delete or change those parts and add what you think is missing.

Many facts about the present status of your NREN have already been received for the TERENA Compendium 2003. To get a better picture about the problems your network has to face and to get your suggestions about overcoming them, please answer the SERENATE questionnaire which is in a separate attachment.

I believe that the suggestions and recommendations in this SERENATE report will be read by policy makers in your country and in Brussels and that this could help all of us who try to run a NREN to provide the best service to our users and to achieve the goal of »equal opportunities« for all researchers in Europe.

Best regards,
Marko Bonač

Annex III – Continental and Intercontinental Geographic Issues

This report has focused on geographic issues related to the geographic coverage of European research and education networking as regards the wider Europe, in particularly looking at the countries in geographic Europe that are neighbouring the European Economic Area. There are other issues of a geographic nature, which are related to the pan-European backbone and to connectivity to other continents. Aspects of these issues have been discussed elsewhere in the SERENATE reports. A summary of some of the global connectivity issues in research networking is given below.

Global Issues

The scope of pan-European research networking has expanded significantly in the last few years. In the year 1998, TEN-34 interconnected 16 research networks. For GÉANT, there are 27 networks within Europe. In addition, there are interconnections with Turkey, already operational, Russia, which is planned, and South Africa, which is also planned. There is a connection to the Ukraine which connects via AConet to the GÉANT network. In terms of intercontinental connections, the position has also changed dramatically. In 1998, there was one 34 Mb/s connection to the United States, which carried both research connectivity and commodity IP. Today, there are three 2.5 Gb/s connections between Europe and North America and a planned 10 Gb/s connection co-funded by the Americans to the GÉANT network. Whereas in 1998 the bulk of global connectivity was organised by individual NRENs to their own countries, today the bulk of global connectivity connects to the GÉANT backbone and acts as a shared resource for NRENs in Europe.

There are several practical issues in terms of establishing policy for global connectivity. These are:

1. Interconnection versus participation

There are two categories of networks that connect to GÉANT. The first category is best labelled "participants". These networks share the costs of GÉANT amongst themselves and share the overall direction and decision making in respect of the project. In contrast, the second category, "interconnected networks", connect to GÉANT as a network without having any say in the policy or direction of the project. The interconnected networks may, or may not, pay a contribution to covering the costs for their interconnection. The number of participants has increased steadily over the years as more European countries have connected to the network. The issue of what limits, if any, should be placed on the many participants within the GÉANT project is an important policy question, which has both cost and decision-making implications.

2a. Funding

There is no agreed global position on sharing the costs of interconnection. The current arrangements are ad-hoc and evolving. Historically, with the exception of a small number of European countries selected by the United States, Europe has paid for the cost of connecting to the United States. In contrast, Japan has paid the entire cost of connecting to Europe. The recent decision of the National Science Foundation to fund the cost of an interconnection between STARTAP and the GÉANT network represents an interesting development in the area of cost sharing.

2b. Co-funding principles

There are, however, no agreed principles to which this may develop. There has been some limited USA/European co-operation which had the label GTREN (Global Terabit Research and Education Network). This was an informal co-operation with relatively undefined overall objectives.

3. Regional aid funding

The European Union has been prepared to fund, relatively generously, interconnection initiatives that take advantage of objectives that relate to regional aid. Two specific initiatives have been EUMEDCONNECT (North Africa / Mediterranean region) and ALICE (Latin America). Part of the objective of these initiatives has been to provide interconnection between research networks within the respective regions and part has been to interconnect these networks to the GÉANT network. It is probable that a similar initiative will be launched in respect of connectivity to the Asia-Pacific region. These initiatives are interesting and useful in as much as they

improve connectivity, but sometimes mean dealing with political objectives outside research networking for the funding of research networks.

4. Policy issues

The difference between participation and interconnection relates partially to questions of policy. This is especially relevant in respect of the portfolio of services that can be offered to end-users and also the groups of users that can benefit from research networking. There are significant differences, between regions of the world, in terms of the way research networking is organised. In particular, the discipline orientation, which characterises the US networks is generally not apparent outside the United States. Organisation of research networking does, however, vary from country to country in terms of funding, technical capabilities and geographic scope. A global policy approach to research networking needs to recognise this current variety.