

TERENA Compendium
of National Research and
Education Networks in Europe
2004 Edition

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<http://www.terena.nl/compendium/>

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Introduction

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

The 2003 edition of the Compendium was funded by the European Commission through the COM-REN project, an Accompanying Measure in the IST Programme of the Fifth Framework Programme. Funding for the 2004 edition has not been secured, but TERENA was requested by its members to continue the service anyway. The 2003 edition led to comments from a number of sides. We would like to express our gratitude here to all those who provided feedback and critical comments.

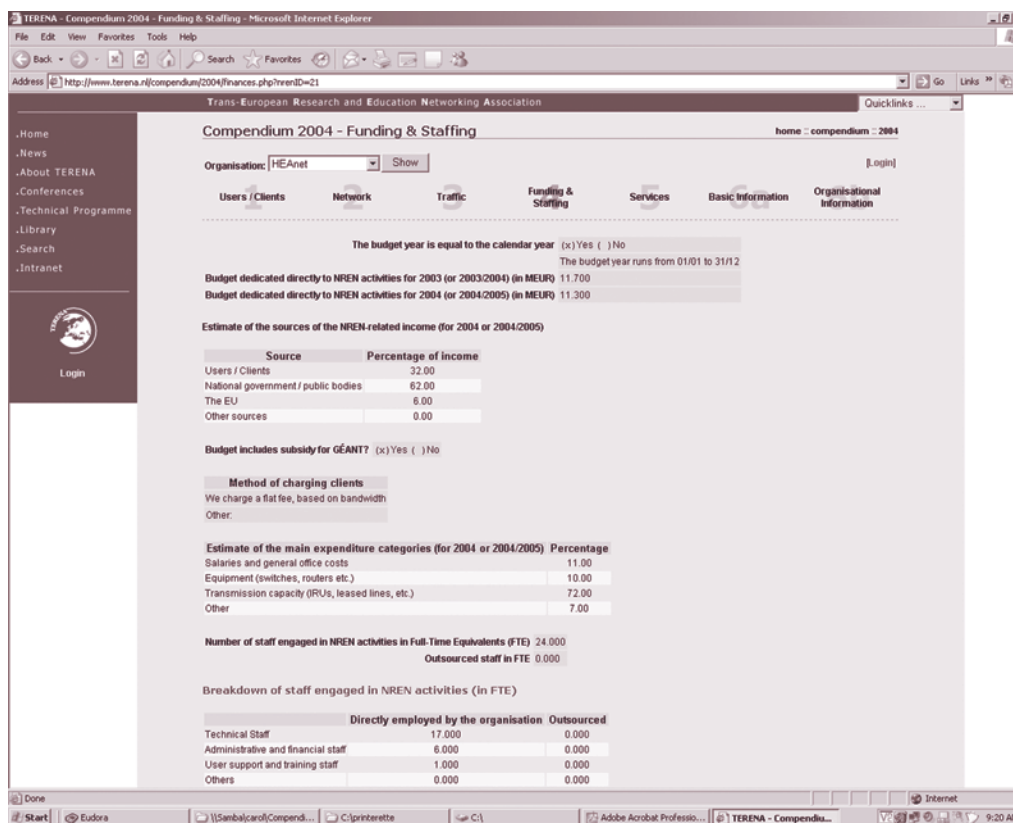
The production of the 2004 edition was overseen by a the Review Panel composed of the following people: Lajos Bálint (Hungary), Marko Bonac (Slovenia), Peter Kaufmann (Germany), Urs Eppenberger (Switzerland), Sabine Jaume-Rajaonia (France) and Mike Norris (Ireland). This panel met once and participated in frequent e-mail exchanges. These people deserve a large part of the credit for the improvements in this edition of the Compendium.

This year, for the first time, a web-based interface was used, allowing NRENs to submit and update their information on-line. Collecting data of this type typically requires the involvement of a number of people from each NREN, as well as careful checking by NREN staff. The web interface has made it easier for NRENs to do this. Many

NRENs managed to submit their replies. As a result, this edition of the Compendium contains information from 53 NRENs in and around Europe.

The Compendium consists of two parts: the basic information as submitted by the individual NRENs

(available only on the Web at <http://www.terena.nl/compendium>) and a number of maps, tables and graphs that try to bring together and summarize the information from the NRENs (available on the Web and in printed form). Just as in previous years, a limited edition was produced first, for review by the TERENA members.



The Web version of the TERENA Compendium: HEAnet's page on Funding and Staffing

This publication contains a number of new elements. For example, the Compendium now has information about the use NRENs make of dark fibre (section 3.6) and about the percentage of institutions connected through IPv6 (section 4.5).

In a number of graphs, comparative information for earlier years has been provided.

In many of the graphs, information is presented in the same order of countries. First, the information from the EU and EFTA countries is listed together, then the information from other countries, in alphabetical order of the country name (in English).

No questions were asked this year about the different network levels. Those form the subject of the 'Focus Study on Funding, Management and Operation of European Research Networks' by Dr. John Martin and Baiba Kaskina, that was published by TERENA earlier this year, within the framework of the COM-REN project.

Many other improvements have been made, mainly to increase the readability of the graphs. For the future, still more work will be needed to improve data collection and presentation.

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

Bert van Pinxteren,
TERENA Chief Administrative Officer.

Throughout the Compendium, the following classification of countries is used;

EU (European Union) countries

Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden and United Kingdom

EFTA (European Free Trade Area) countries

Iceland, Norway, Switzerland

Other countries

Albania, Algeria, Azerbaijan, Belarus, Bosnia Herzegovina, Bulgaria, Croatia, Georgia, Iran, Israel, Jordan, Kazakhstan, Kyrgyzstan, Lebanon, Moldova, Morocco, Romania, Russian Federation, Serbia Montenegro, Turkey, Ukraine, Uzbekistan

1 Basic Information

1.0 NRENs that have responded to the Questionnaire

Fifty-three NRENs responded to the survey, from 50 different countries. Not all NRENs were able to answer all of the questions, but many were. The map and table below give an overview of the NRENs that sent their replies and gives an impression of the completeness of those replies.

NRENs have been asked to double-check and update their replies.

In most of the tables and graphs the English-language abbreviation of the NREN's name has been used in order to denote the NREN. Table 1.0.1 provides a list of countries and the abbreviations of the NREN(s) from those countries that submitted information. Table 1.0.2 provides a list of some countries where we know that research networking exist, but from which no replies were received.

Three projects are relevant in this context: the EUMEDCONNECT project aims at research and education networking in the Mediterranean region (see <http://www.dante.net/eumedconnect/>); the SEEREN project aims at research and education networking in South-Eastern Europe (see <http://www.seeren.org/>); and the Virtual Silk Highway project is aimed at Central Asian countries (see <http://www.silkproject.org/>). In addition, CEENet (<http://www.ceenet.org/>) maintains contacts and provides support to many NRENs in Central and Eastern Europe and the Former Soviet Union.

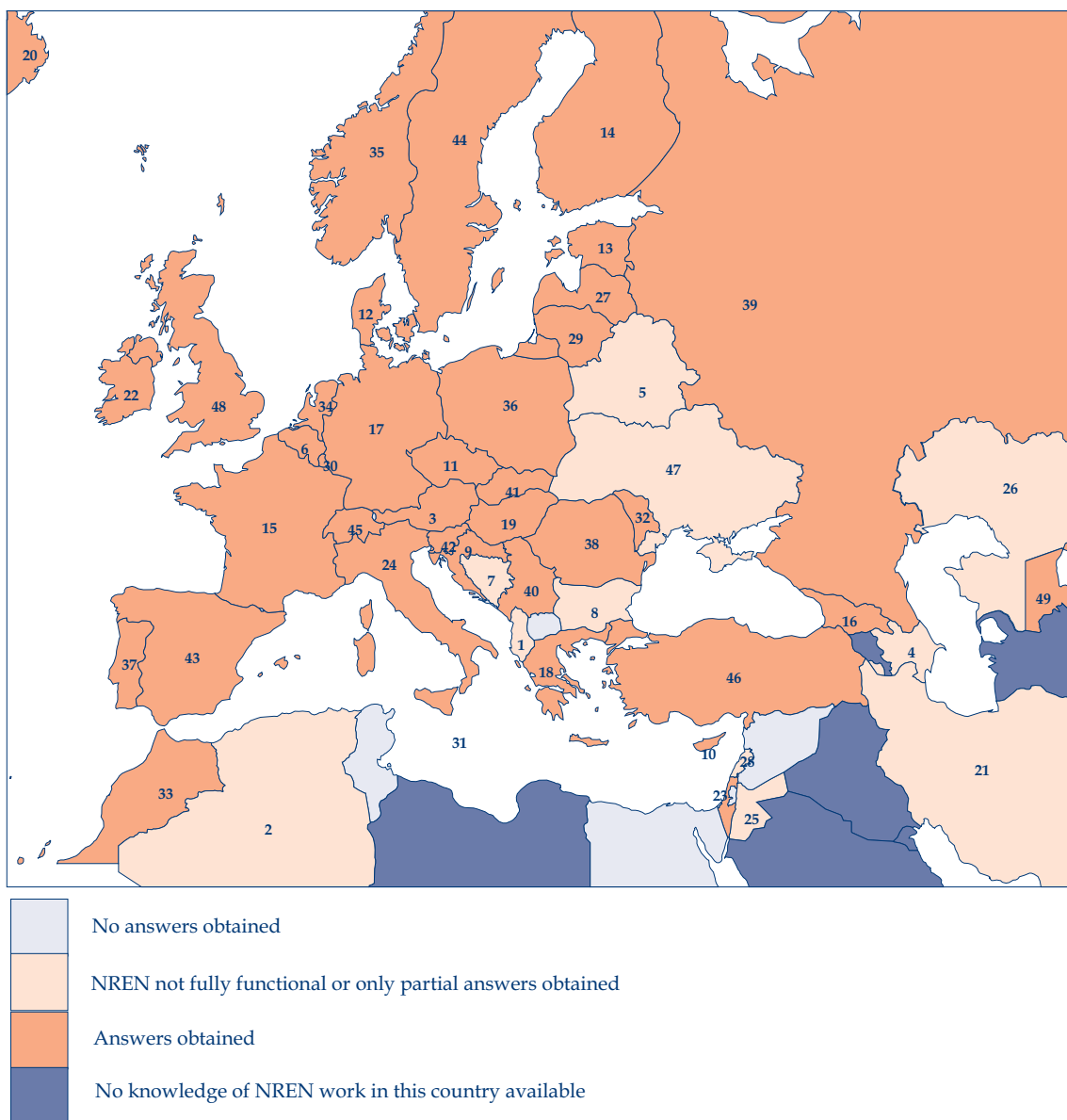


Table 1.0.1 NRENs and urls. NRENs in bold are TERENA members.

#	Country	NREN	URL
1	Albania	ANA	
2	Algeria	CERIST	www.cerist.dz
3	Austria	ACOnet	www.aco.net/
4	Azerbaijan	OSI-AF/Azerbaijan	www.aznet.org
		AzRENA	www.azrena.org/index_en.htm
5	Belarus	BASNET	www.basnet.by
6	Belgium	BELNET	www.belnet.be
7	Bosnia Herzegovina	BIHARNET	www.biharnet.ba (not functional)
8	Bulgaria	IST Foundation	www.ist.bg
9	Croatia	CARNet	www.carnet.hr
10	Cyprus	CYNET	www.cynet.ac.cy
11	Czech Republic	CESNET	www.cesnet.cz
12	Denmark	UNI•C	www.uni-c.dk
13	Estonia	EENet	www.eenet.ee
14	Finland	FUNET	www.funet.fi
15	France	RENATER	www.renater.fr
16	Georgia	GRENA	www.grena.ge
17	Germany	DFN	www.dfn.de
18	Greece	GRNET	www.grnet.gr
19	Hungary	HUNGARNET	www.hungarnet.hu
20	Iceland	RHnet	www.rhnet.is
21	Iran	IRANET	www.iranet.ir
22	Ireland	HEAnet	www.heanet.ie
23	Israel	IUCC	www.iucc.ac.il
24	Italy	GARR	www.garr.it
25	Jordan	NITC	www.niv.gov
26	Kazakhstan	KazRENA	www.kazrena.kz
	Kyrgyzstan *	KRENA/AKNET	
27	Latvia	LANET	www.lanet.lv
		LATNET	www.latnet.lv
28	Lebanon	CNRS	www.cnrs.edu.lb
29	Lithuania	LITNET	www.linet.lt
30	Luxembourg	RESTENA	www.restena.lu
31	Malta	CSC	www.csc.um.edu.mt

#	Country	NREN	URL
32	Moldova	RENAM	www.renam.md
33	Morocco	MARWAN	www.marwan.ma
34	Netherlands	SURFnet	www.surfnet.nl
35	Norway	UNINETT	www.uninett.no
36	Poland	PIONIER	www.pionier.gov.pl
37	Portugal	FNCC	www.fncc.pt
38	Romania	RNC	www.rnc.ro
	Romania	RoEduNet	www.roedu.net
39	Russian Federation	RBNet/RUNNet	www.ripn.net, www.runnet.ru
40	Serbia Montenegro	AMREJ	amrej.rcub.bg.ac.yu
41	Slovakia	SANET	www.sanet.sk
42	Slovenia	ARNES	www.arnes.si
43	Spain	RedIRIS	www.rediris.es
44	Sweden	SUNET	www.sunet.se
45	Switzerland	SWITCH	www.switch.ch
46	Turkey	ULAKBIM	www.ulakbim.gov.tr
47	Ukraine	URAN	www.uran.net.ua
48	United Kingdom	UKERNA	www.ukerna.ac.uk
49	Uzbekistan	UzSciNet	www.uzsci.net

* outside the map area

Table 1.0.2 NRENs not included in the Compendium

	Country	NREN	URL
	Egypt	EUN	www.eun.eg
	Macedonia, FYRo	MARNet	
	Syria *	SHERN	www.shern.net
	Tunisia	RNR	

* replies received after the deadline

1.1 Legal Form

NRENs have many different legal forms and those legal forms are themselves difficult to compare. What is called a ‘foundation’ in one country may be something very different from that which is called a ‘foundation’ in another country, and the same is true of many other designations. Also, governments and government departments are organised differently from country to country. Based on the work in earlier years, this Compendium distinguishes two parameters that together help to characterize the legal form of NRENs.

Separate legal entity

Many NRENs operate as a separate legal entity; many others form part of a larger organisation (often either a Ministry, a University or a research institution). A few NRENs have a special status in the sense that they do not operate as a separate legal body but are not either part of a larger organisation (for example, because they operate on a project basis). Typically, the final institutional identity of these NRENs has not yet been decided.

Relationship with the Government

Those NRENs that are a government agency or part of a government ministry are typically directly controlled by the government, even though in some cases (e.g., Turkey) such agencies can enjoy a reasonable degree of autonomy, comparable to that of some of the NRENs that are separate legal entities.

A number of NRENs that are separate legal entities have governing boards that are at least half government-appointed. Those NRENs are marked with ‘appoints’ in the table below.

Many NRENs have an indirect relationship with the government; they are controlled by the research and education community which in itself is (largely) government-funded.

Some NRENs have a mixed model, being governed both by government representatives and representatives from the research and education community.

The tables below show the relationship between the two parameters for the EU and EFTA countries and the other countries. As can be seen from the table, the most common model in the EU and EFTA countries is an NREN which is a separate legal entity and is controlled by the research and education community, which in itself is (largely) government funded. However, this is not the only model – it is the one chosen by a large minority of almost 40% of the NRENs. Seven other models are found.

In the other countries, a larger variety exists, with a total of 10 models. The largest minority (28%) is made up of NRENs which are separate legal entities, controlled by the research and education community.

A number of NRENs offer up-to-date information regarding their governing structure on their websites. A list of URLs is provided on page 7.

Table 1.1.1 Legal Form of NRENs, EU + EFTA countries

Relationship with Government	Separate legal entity	Not a separate legal entity	Other	Total
Indirect	11	3		14
Direct	2	5		7
Both	3	1		4
Appoints	2			2
Other	1			1
None				
Total	19	9		28

Table 1.1.2 Legal Form of NRENs, Other countries

Relationship with Government	Separate legal entity	Not a separate legal entity	Other	Total
Indirect	5	2	1	8
Direct	3		2	5
Both	1	1		2
Appoints	1			
Other		1		1
None	1			1
Total	11	4	3	18

Table 1.1.3 Relationship with Government

EU & EFTA countries	NREN	Separate legal entity?	Relationship with Government	Remarks/ Parent Organisation
Austria	ACOnet	no	indirect	Vienna University Computer Centre
Belgium	BELNET	no	direct	Ministry of Science Policy
Cyprus	CYNET	yes	both	Our governing body consists of representatives from education, research and government agencies.
Czech Republic	CESNET	yes	indirect	
Denmark	UNI•C	no	direct	For Forskningsnet: Danish ministry of Science,Technology and Innovation, For UNI-C: Danish ministry of Education
Estonia	EENet	yes	direct	EENet is a public institution operating under the administration of the Estonian Ministry of Education and Research
Finland	FUNET	no	direct	CSC - Scientific Computing Ltd., owned by the Ministry of Education
France	RENATER	yes	both	Among funding members (on the Administration Board), the French Ministry in charge of Universities.
Germany	DFN	yes	indirect	
Greece	GRNET	yes	direct	Greek Ministry of Development, under the supervision of the General Secretariat for Research and Technology
Hungary	HUNGARNET	yes	both	Joint NREN function by HUNGARNET (independent) and NIIF (government supervised).
Iceland	RHnet	yes	indirect	
Ireland	HEAnet	yes	indirect	
Italy	GARR	yes	indirect	
Latvia	LANET	no	indirect	Ministry of Education and Science
Latvia	LATNET	no	indirect	The LATNET network is working as a financially independent subunit (department) of the Institute of Mathematics and Computer Science that is an independent unit of Latvia University.
Lithuania	LITNET	no	direct	Ministry of Science and Education of Lithuania
Luxembourg	RESTENA	yes	appoints	
Malta	CSC	no		University of Malta
Netherlands	SURFnet	yes	indirect	Stichting SURF (English: SURF Foundation)
Norway	UNINETT	yes	other	Limited company wholly owned by the Department of Education and Research
Poland	PIONIER	yes	indirect	
Portugal	FCCN	yes	indirect	
Slovakia	SANET	yes	indirect	
Slovenia	ARNES	yes	appoints	
Spain	RedIRIS	no	direct	Entidad publica empresarial RED.ES
Sweden	SUNET	no	both	The Swedish Research Council (the parent organization) is a government agency and part of the funding comes from the State
Switzerland	SWITCH	yes	both	The government has delegates in our governing body, the council of foundation.
United Kingdom	UKERNA	yes	indirect	

Table 1.1.3 Relationship with government (continued)

Other countries	NREN	Separate legal entity?	Relationship with Government	Remarks/ Parent Organisation
Albania	ANA	neither	indirect	
Algeria	CERIST		indirect	Ministry of higher education and scientific research
Azerbaijan	AzRENA		indirect	
Azerbaijan	OSI-AF/Azerbaijan	no	other	Open Society Institute (SOROS Foundation Network)
Belarus	BASNET		indirect	National Academy of Sciences of Belarus
Bosnia/Herzegovina	BIHARNET	yes		
Bulgaria	IST Foundation	yes	indirect	The Foundation is founded by distinguished academic and IT industry figures.
Croatia	CARNet	yes	appoints	
Georgia	GRENA	yes	indirect	
Iran	IRANET			Institute for Studies in Theoretical Physics and Mathematics (IPM)
Israel	IUCC	yes	indirect	
Jordan	NITC	yes	direct	Ministry of Information and Communication Technology (MoICT)
Kazakhstan	KazRENA		other	KazRENA works closely with the Ministry of Education and Science of Kazakhstan on a state programme.
Kyrgyzstan	KRENA-AKNET	yes	none	
Lebanon	CNRS	yes	direct	
Moldova	RENAM	yes	indirect	
Morocco	MARWAN	neither	direct	National Scientific and Technical Research Centre (CNRST)
Romania	RNC	no	indirect	Ministry of Education and Research
Romania	RoEduNet	yes	direct	
Russian Federation	RBNet/RUNNet	yes	both	We are controlled partly by the Government and partly by the research community.
Serbia/Montenegro	AMREJ	neither	direct	The NREN is now a special project funded by the Ministry for Science, Technology and Development. It is planned that it will become a separate legal entity.
Turkey	ULAKBIM	no	both	The Scientific and Technical Research Council of Turkey (TUBITAK). TUBITAK is a semi-independent government agency managed by a self-elected manager.
Ukraine	URAN	no	indirect	Centre for European Integration Ltd. (CEI)
Uzbekistan	UzSciNet	yes	indirect	

2 Users/Clients

The tables and graphs in this section together give an impression of the users/clients of the NRENs.

Table 2.1 gives an overview of which types of institutions can be connected to the NREN. As is clear from the table, all NRENs can connect Universities. For other institutions, there are great differences between NRENs. Note that sometimes there are further restrictions, not included in the table. For example, some NRENs only connect government departments that have a connection to research and education, etc. For more details on individual NRENs, please consult the country entries on the website or the NREN websites themselves.

Some NRENs have sent us summaries of their Acceptable Use Policies or have given us the URLs to the Acceptable Use Policies as published on their websites. This information is now available on-line at <http://www.terena.nl/compendium/2004/aup.php>.

Tables 2.2 through 2.7 list information about the number of institutions connected to NRENs as well as about the bandwidth at which institutions are connected. For Universities, we have provided information comparing 2003 with 2004.

Absolutely no conclusion can be drawn about the situation in countries not included in the tables. Various cases may apply:

- * The NREN may connect the relevant institutions, but may not have been able to answer these questions in the survey (see also the information in table 2.1);

- * The Institutions may be connected through a different organisation. For example, secondary schools in many countries are connected to the Internet through separate organisations, federated in the European Schoolnet; <http://www.eun.org> provides more information about this;
- * Institutions may be connected through commercial ISPs;
- * Institutions may not be connected to the Internet at all.

Earlier issues of the Compendium have provided information about the 'market share' of the NRENs. In many cases, NRENs have been formed either by Universities or at the initiative of Governments. In the EU and EFTA countries, NRENs cater for all or almost all Universities. In the other countries, where NRENs are often less well-developed and are struggling to find finances, this is not always the case. The overall situation in 2004 is not much different from that of 2003. Therefore, no new table is provided in this edition of the Compendium.

2.1 Connection Policies

Table 2.1 Connection policies

EU & EFTA countries	NREN	Universities	Research institutes	Institutes of higher/further education	Secondary schools	Primary schools	Libraries, museums, national archives	Hospitals (other than university hospitals)	Government departments (national, regional, local)	Others
Austria	ACOnet	✓	✓	✓	✓	✓	✓	✓	✓	
Belgium	BELNET	✓	✓	✓	✓	✓	✓	✓	✓	X
Cyprus	CYNET	✓	✓	✓	X	X				
Czech Republic	CESNET	✓	✓	✓	✓	✓	✓	✓	✓	✓
Denmark	UNI•C	✓	✓	✓	X	X	✓	X	X	X
Estonia	EENet	✓	✓	✓	✓	✓	✓	✓	✓	X
Finland	FUNET	✓	✓	X	X	X	✓	X	✓	✓
France	RENATER	✓	✓	✓	✓	X	✓	✓	✓	X
Germany	DFN	✓	✓	✓	✓	✓	✓	✓	✓	✓
Greece	GRNET	✓	✓	✓	✓	✓	✓	✓	✓	X
Hungary	HUNGARNET	✓	✓	✓	✓	✓	✓	X	✓	X
Iceland	RHnet	✓	✓	✓	X	X	X	X	X	X
Ireland	HEAnet	✓	✓	✓	✓	✓	✓	X	✓	X
Italy	GARR	✓	✓	✓	✓	✓	✓	✓	✓	X
Latvia	LANET	✓	✓	✓	✓	X	✓	✓	✓	
Latvia	LATNET	✓	✓	✓	✓	✓	✓	✓	✓	✓
Lithuania	LITNET	✓	✓	✓	✓	✓	✓	✓	✓	✓
Luxembourg	RESTENA	✓	✓	✓	✓	✓	✓	✓	✓	X
Malta	CSC	✓	✓	✓						
Netherlands	SURFnet	✓	✓	✓	X	X	✓	✓	X	
Norway	UNINETT	✓	✓	✓	✓	✓	✓	X	X	X
Poland	PIONIER	✓	✓	✓	✓	X	✓	✓	✓	X
Portugal	FCCN	✓	✓	✓	✓	✓	✓	X	X	X
Slovakia	SANET	✓	✓	✓	✓	✓	✓	X	✓	X
Slovenia	ARNES	✓	✓	✓	✓	✓	✓	X	✓	X
Spain	RedIRIS	✓	✓	X	X	X		✓		
Sweden	SUNET	✓	✓	✓	X	X	✓	X	✓	✓
Switzerland	SWITCH	✓	✓	✓	X	X	✓		✓	X
United Kingdom	UKERNA	✓	✓	✓	✓	✓	✓	✓	✓	

Table 2.1 Connection Policies (continued)

Other countries	NREN	Universities	Research institutes	Institutes of higher/further education	Secondary schools	Primary schools	Libraries, museums, national archives	Hospitals (other than university hospitals)	Government departments (national, regional, local)	Others
Albania	ANA	✓	✓	✓			✓			
Algeria	CERIST	✓	✓	✓	✓	✓	✓	✓	✓	
Azerbaijan	AzRENA	✓	✓	X	✓	X		X	✓	
Azerbaijan	OSI-AF/Azerbaijan	✓	X	✓	✓		✓		✓	✓
Belarus	BASNET	✓	✓	✓	✓	X	✓	✓	✓	
Bosnia/Herzegovina	BIHARNET	✓	✓	✓	✓	✓	✓			
Bulgaria	IST Foundation	✓	✓	✓	✓	✓	✓	X	X	X
Croatia	CARNet	✓	✓	✓	✓	✓	✓	✓	✓	✓
Georgia	GRENA	✓	✓	✓	✓	X	✓	✓	X	X
Iran	IRANET	✓	✓	✓	✓	✓	✓	✓	✓	✓
Israel	IUCC	✓	✓			✓	✓			
Jordan	NITC	✓	✓	✓	✓	✓	✓	✓	✓	✓
Kazakhstan	KazRENA	✓	✓	✓	✓	✓	✓	✓	✓	✓
Kyrgyzstan	KRENA-AKNET	✓	✓	✓	✓	✓	✓	✓	X	X
Lebanon	CNRS	✓	✓	X	X	X	X	X	X	X
Moldova	RENAM	✓	✓	✓	✓	✓	✓	✓	✓	✓
Morocco	MARWAN	✓	✓	✓	X	X	✓	X	X	
Romania	RNC	✓	✓	✓	✓	X	✓	✓	✓	✓
Romania	RoEduNet	✓	✓	✓	✓	✓	✓	X	✓	X
Russian Federation	RBNet/RUNet	✓	✓	✓	✓		✓		✓	
Serbia/Montenegro	AMREJ	✓	✓		✓	X	✓	✓		X
Turkey	ULAKBIM	✓	✓	✓	X	X	✓	X	✓	X
Ukraine	URAN	✓	✓	✓	✓	✓	✓	✓	✓	✓
Uzbekistan	UzSciNet	✓	✓	✓	✓	✓	✓	✓	✓	✓

2.2 Number of connected Universities and bandwidth

The setup of Universities and other institutes can be very different from country to country. For example, in some countries Research Institutes are part of Universities; in other countries, they are not. Some countries have relatively few but large Universities, others have relatively many, but smaller ones. Also, some countries have listed entire Universities as one institution, others have counted faculties or schools that form part of a University but are geographically at different locations as different institutions.

In this section, information is provided for 2003 and 2004, showing the evolution over the past year, in three graphs: Graph 2.2.1. gives the situation in the EU and EFTA countries with more than 50 connected Universities. Graph 2.2.2. gives the situation in EU and EFTA countries with fewer than 50 connected Universities. Graph 2.2.3 gives the situation in the other countries.

Several points should be noted:

- * The evolution is not gradual, but goes in leaps and bounds. Thus, if in some countries a major network upgrade took place in 2002, it is possible that another one will only take place in 2005. These upgrades generally require a considerable investment, both in terms of planning and in terms of equipment.

Likewise, bandwidth upgrades of individual institutions do not occur gradually -- the evolution is often not, for example, from 34 MB/s to 155 Mb/s to 622 Mb/s to 1 Gb/s, but goes directly, for example, from 34 Mb/s to 1 Gb/s.

- * Note that the Polish information from 2004 is accurate only concerning the division over the categories, not concerning the number of connected institutions. The PIONIER network is a consortium of autonomous MANs. PIONIER was not able to supply reliable data about the total number of connected Universities or other institutions for 2004.

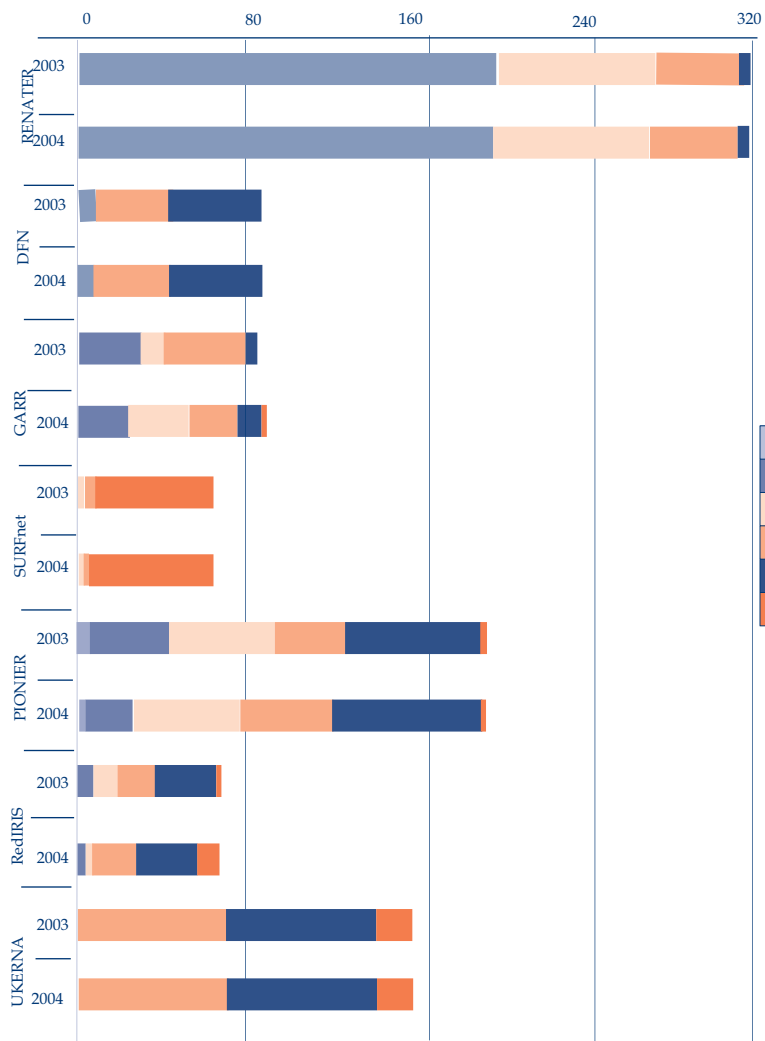
RENATER (France) has given the information on the number of separate institutions that are connected. DFN (Germany) has instead given information about the number of connected Universities. France does not have four times the number of Universities that Germany has.

The information of some NRENs in 2003 (e.g., AMREJ, HUNGARNET, SWITCH) concerns the number of connected institutions, whereas in 2004 it concerns the number of connected Universities.

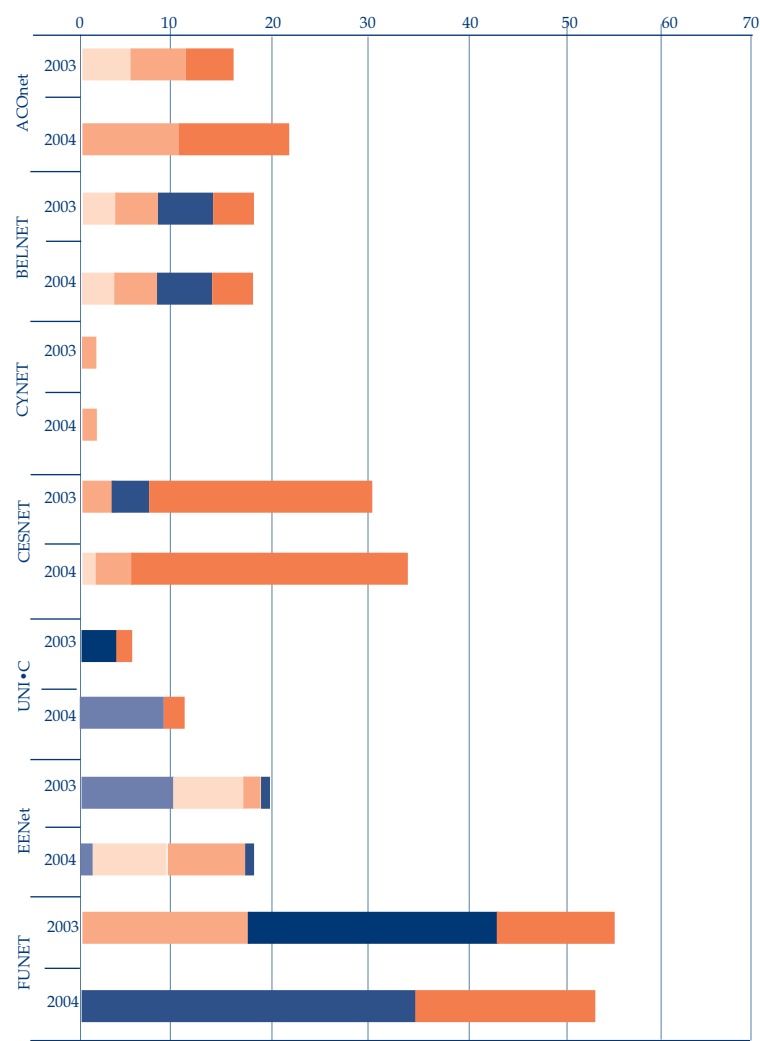
In some cases (e.g., CARNet) the reverse applies: the information from 2003 concerns the number of connected Universities as such, the information from 2004 concerns rather the connections to the separate institutions that are part of those Universities.

It may not be possible to normalize this completely, because not all NRENs are able to supply the data in both ways.

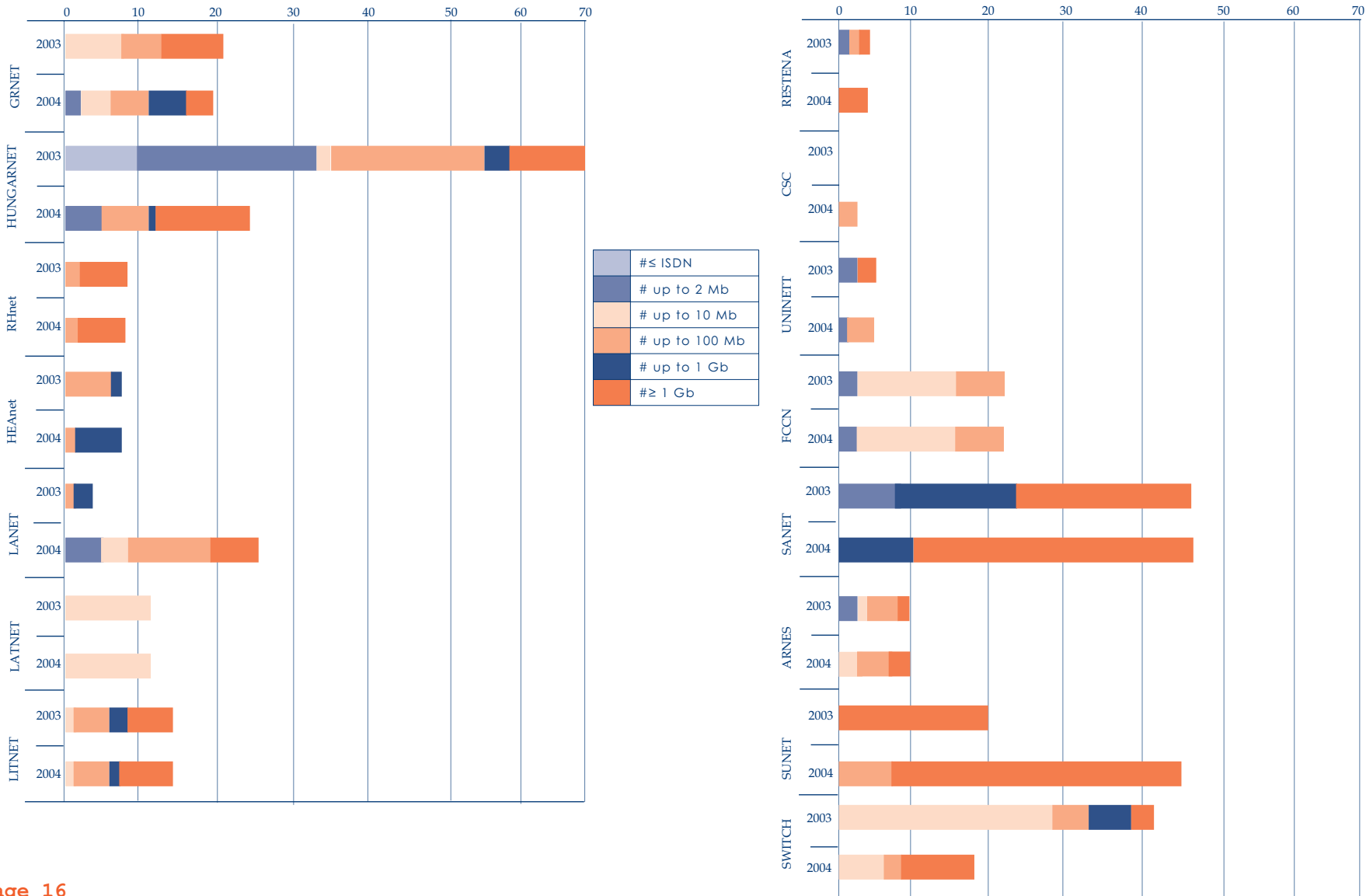
Graph 2.2.1 Number of connected Universities and bandwidths >50 EU & EFTA countries



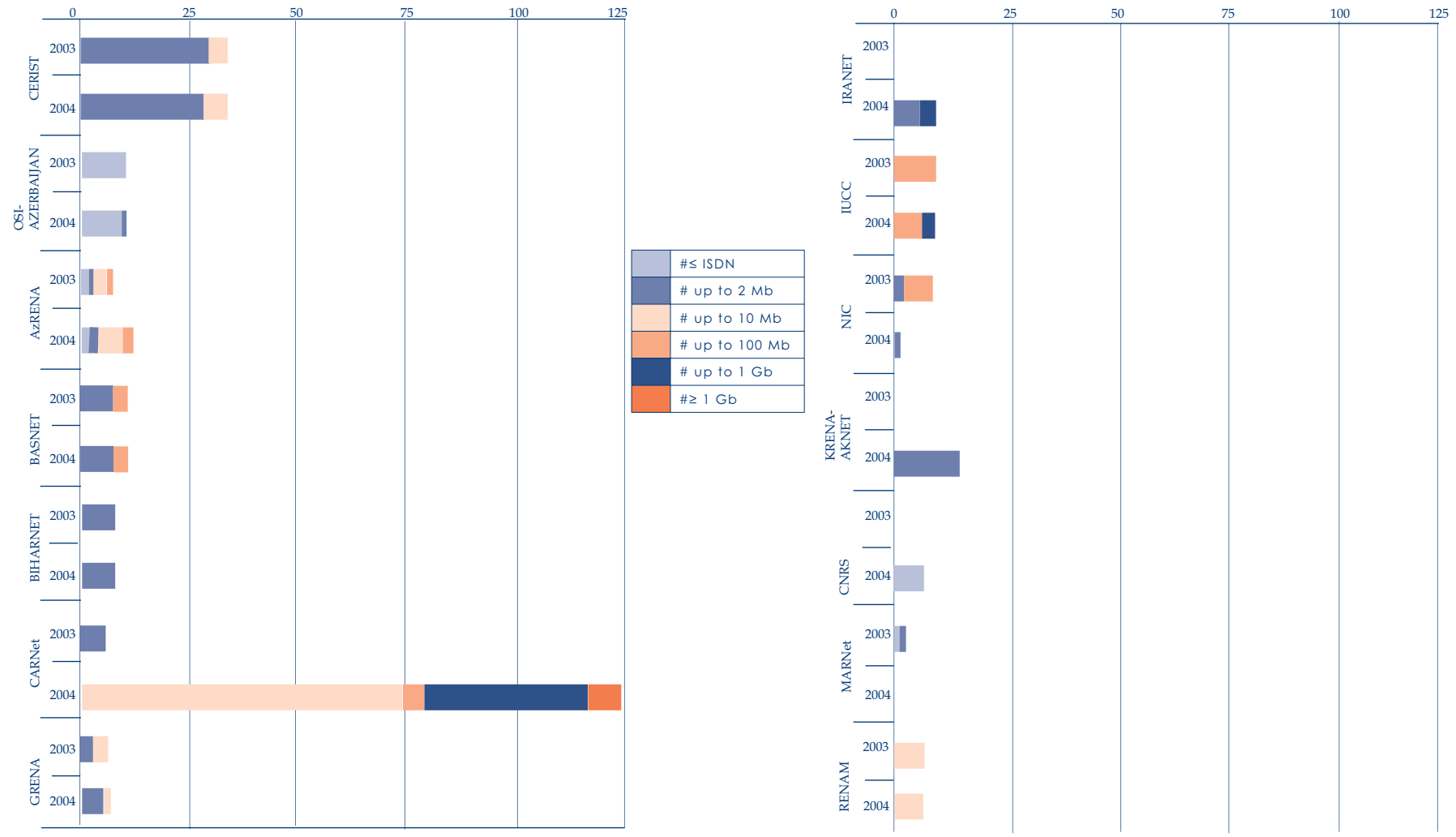
Graph 2.2.2 Number of connected Universities and bandwidth <50 EU & EFTA countries



Graph 2.2.2 Number of connected Universities and bandwidth <50 EU & EFTA countries (continued)



Graph 2.2.3 Number of connected Universities and bandwidth
Other countries



Graph 2.2.3 Number of connected Universities and bandwidth
Other countries (continued)

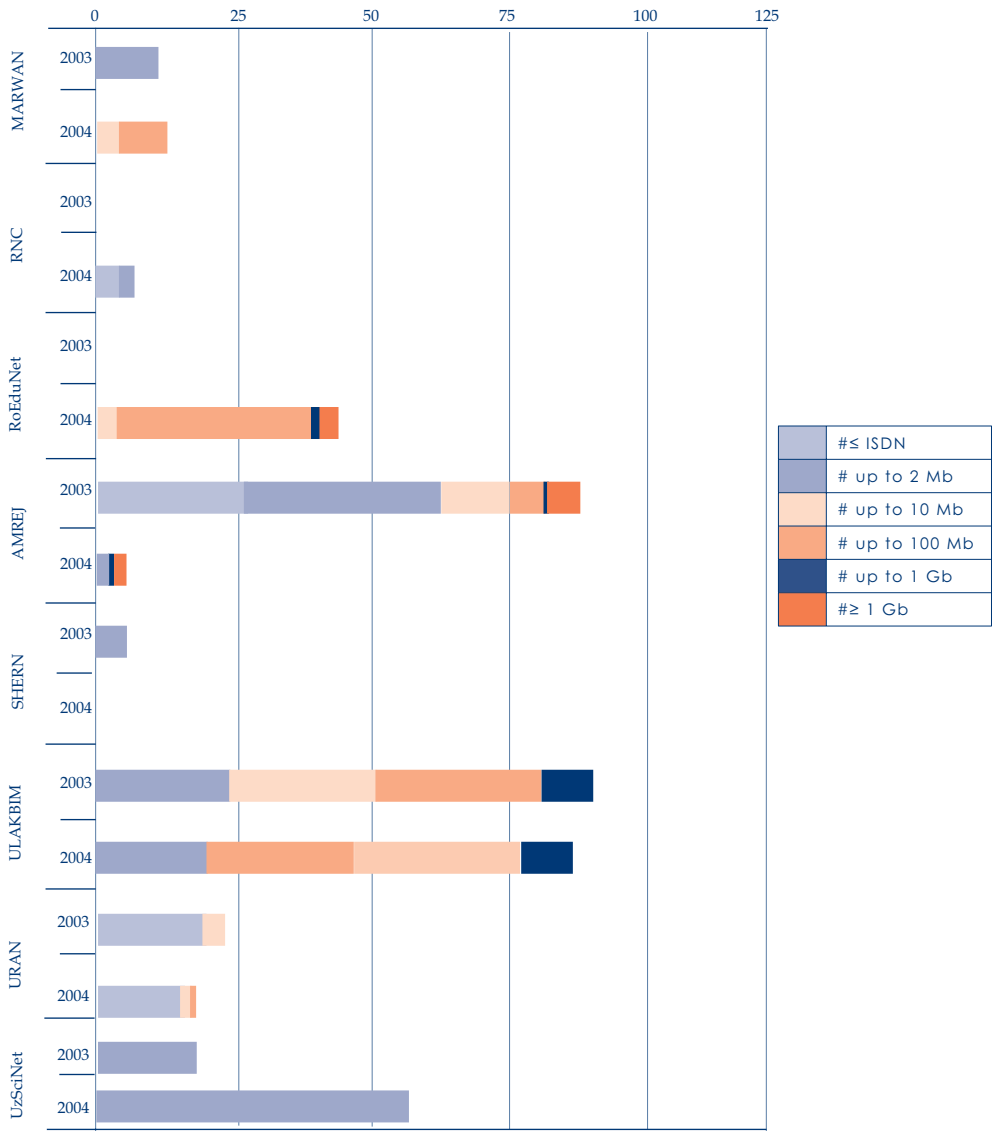


Table 2.3 Number of connected research institutes and bandwidth, EU & EFTA countries

EU & EFTA countries	NREN	Number	% ≤ ISDN	% up to 2Mb	% up to 10 Mb	% up to 100 Mb	% up to 1 Gb	% ≥ 1 Gb
Austria	ACOnet	11		18.2	54.5	27.3		
Belgium	BELNET	34			79.0	21.0		
Cyprus	CYNET	3		100.0				
Czech Republic	CESNET	23		56.6	30.5	8.5	4.5	
Denmark	UNI•C	25		75.0	10.0	15.0		
Estonia	EENet	19		10.0	74.0	16.0		
Finland	FUNET	15			10.0	20.0	60.0	10.0
France	RENATER	165		70.0	22.0	8.0		
Greece	GRNET	19	5.0	21.0	63.0	11.0		
Hungary	HUNGARNET	84	24.0	48.0	8.0	6.0	2.0	12.0
Iceland	RHnet	7						100.0
Ireland	HEAnet	9		67.0	11.0	22.0		
Italy	GARR	142		45.0	16.0	20.0	18.0	1.0
Latvia	LANET	36				100.0		
Latvia	LATNET	5			100.0			
Lithuania	LITNET	43		7.0	88.0			5.0
Luxembourg	RESTENA	16			25.0		20.0	55.0
Netherlands	SURFnet	65		20.0	5.0	10.0	5.0	60.0
Norway	UNINETT	80		50.0	25.0	17.0	5.0	3.0
Portugal	FCCN	12		60.0	40.0			
Slovakia	SANET	20			10.0		80.0	10.0
Slovenia	ARNES	57	14.0	35.0	21.0	23.0		7.0
Spain	RedIRIS	150	5.0	36.0	30.0	20.0	3.0	6.0
Sweden	SUNET	2					50.0	50.0
Switzerland	SWITCH	7			29.0	29.0		42.0
United Kingdom	UKERNA	50		20.0	40.0	25.0	10.0	5.0

Table 2.3 Number of connected research institutes and bandwidth, other countries

Other countries	NREN	Number	% ≤ ISDN	% up to 2Mb	% up to 10 Mb	% up to 100 Mb	% up to 1 Gb	% ≥ 1 Gb
Algeria	CERIST	9		100.0				
Azerbaijan	AzRENA	16	20.0			80.0		
Belarus	BASNET	180		60.0	35.0	5.0		
Croatia	CARNet	43	2.0	86.0	2.0	2.0		8.0
Georgia	GRENA	30	10.0	90.0				
Iran	IRANET	6		100.0				
Israel	IUCC	4		50.0	50.0			
Kyrgyzstan	KRENA-AKNET	3		100.0				
Lebanon	CNRS		50.0	50.0				
Moldova	RENAM	21			100.0			
Morocco	MARWAN	5		100.0				
Romania	RNC	50	50.0	50.0				
Romania	RoEduNet	35		20.0	20.0	50.0		10.0
Serbia/Montenegro	AMREJ	33	33.0	24.0	27.0	3.0		12.0
Turkey	ULAKBIM	8		62.0	12.5	25.0		
Ukraine	URAN	5	33.0		67.0			
Uzbekistan	UzSciNet	21		90.0		10.0		

Table 2.4 Number of connected institutions of higher/further education and bandwidth, EU and EFTA countries

EU & EFTA countries	NREN	Number	% ≤ ISDN	% up to 2Mb	% up to 10 Mb	% up to 100 Mb	% up to 1 Gb	% ≥ 1 GB
Austria	ACOnet	5			60	40		
Belgium	BELNET	35			54	43	3	
Cyprus	CYNET	6				100		
Czech Republic	CESNET	19		42	47	11		
Denmark	UNI•C	74		50	20	20	10	
Estonia	EENet	17		47	47	6		
France	RENATER	68		65	28	7		
Greece	GRNET	158	89	3	7	1		
Hungary	HUNGARNET	35		30	14	28	22	6
Iceland	RHnet	2			50	50		
Ireland	HEAnet	21		5	5	90		
Italy	GARR	5			40	60		
Latvia	LATNET	18	10		90			
Lithuania	LITNET	83			90	10		
Luxembourg	RESTENA	10	25	75				
Netherlands	SURFnet	15		50			50	
Norway	UNINETT	64		31	17	14	31	6
Portugal	FCCN	24		50	50			
Slovakia	SANET	4		25			75	
Slovenia	ARNES	10		70		30		
Switzerland	SWITCH	1				100		
United Kingdom	UKERNA	560		70	20	10		

Table 2.4 Number of connected institutions of higher/further education and bandwidth, other countries

Other countries	NREN	Number	% ≤ ISDN	% up to 2 Mb	% up to 10 Mb	% up to 100 Mb	% up to 1 Gb	% ≥ 1 Gb
Algeria	CERIST	11		100				
Azerbaijan	AzRENA	2	100					
Azerbaijan	OSI-AF/ Azerbaijan	5	100					
Belarus	BASNET	40		100				
Croatia	CARNet	34			85	11		4
Georgia	GRENA	20	100					
Iran	IRANET	10		100				
Israel	IUCC	9			100			
Jordan	NITC	28	93	7				
Kyrgyzstan	KRENA-AKNET	1		100				
Moldova	RENAM	2			100			
Morocco	MARWAN	12						
Romania	RNC	5	60	40				
Serbia/Montenegro	AMREJ	100						
Turkey	ULAKBIM	199		100				
Ukraine	URAN	1	75		25			

Table 2.5 Number of connected secondary schools and bandwidth

EU & EFTA countries	NREN	Number	% ≤ ISDN	% up to 2Mb	% up to 10 Mb	% up to 100 Mb	% up to 1 Gb	% ≥ 1 Gb
Czech Republic	CESNET	74		79.5	20.5			
Estonia	EENet	112		33	22	30	15	
France	RENATER	53		56	30	4		
Greece	GRNET	3546	97	1	2			
Hungary	HUNGARNET	34	9	64	18	9		
Ireland	HEAnet	4		100				
Latvia	LANET	11	100					
Latvia	LATNET	35	15		85			
Lithuania	LITNET	294		90	4	5		
Luxembourg	RESTENA	52			48			52
Norway	UNINETT	19		79	5		16	
Portugal	FCCN	1700	100					
Slovakia	SANET	80		20		80		
Slovenia	ARNES	156	38	43	13	6		
Other countries								
Algeria	CERIST	100	100					
Azerbaijan	AzRENA	3	100					
Azerbaijan	OSI-AF/Azerbaijan	3	100					
Belarus	BASNET	20		100				
Bosnia Herzegovina	BIHARNET	4						
Bulgaria	IST Foundation		60	40				
Croatia	CARNet	7	14	14	58	14		
Georgia	GRENA	30	100					
Iran	IRANET	2		100				
Jordan	NITC	2		100				
Kyrgyzstan	KRENA-AKNET	2		100				
Romania	RNC	8	75	25				
Romania	RoEduNet	450	50	25		25		
Serbia/Montenegro	AMREJ	2	100					
Uzbekistan	UzSciNet	27						

Table 2.6 Number of connected primary schools and bandwidth

EU & EFTA countries	NREN	Number	% ≤ ISDN	% up to 2Mb	% up to 10 Mb	% up to 100 Mb	% up to 1 Gb	% ≥ 1Gb
Czech Republic	CESNET	25		100				
Estonia	EENet	93		91	1	8		
Greece	GRNET	5004	100					
Hungary	HUNGARNET	52	100					
Ireland	HEAnet	9		100				
Latvia	LATNET	3			100			
Lithuania	LITNET	25		100				
Luxembourg	RESTENA	153	40	59	2			
Norway	UNINETT	60	17	83				
Portugal	FCCN	7500	100					
Slovakia	SANET	20		20		80		
Slovenia	ARNES	419	73	26				
Other countries								
Croatia	CARNet	3		100				
Iran	IRANET	1		100				
Kyrgyzstan	KRENA-AKNET	1		100				
Romania	RoEduNet	200	95	5				

Table 2.7 Number of other connected institutions and bandwidth

EU & EFTA countries	NREN	Number	% ≤ ISDN	% up to 2Mb	% up to 10 Mb	% up to 100 Mb	% up to 1 Gb	% ≥ 1 Gb
Belgium	BELNET	4					25	75
Czech Republic	CESNET	41		37	45	15	3	
Denmark	UNI•C	10		40	30	30		
Estonia	EENet	222		72	14	14		
Finland	FUNET	18			20	30	50	
Greece	GRNET	545	87	4	4	9	1	
Hungary	HUNGARNET	423	59	35		3	1	2
Ireland	HEAnet	6			84	16		
Italy	GARR	76		96	1	2	1	
Lithuania	LITNET	170		100				
Luxembourg	RESTENA	57	20	80				
Netherlands	SURFNet	20	20		30	5	5	60
Norway	UNINETT	8	100					
Slovenia	ARNES	213	37	50	8	5		
Spain	RedIRIS	1					100	
Sweden	SUNET	20			20	60	20	
Switzerland	SWITCH	17			15	70		15
Other countries								
Azerbaijan	AzRENA	2	50	50				
Azerbaijan	OSI-AF/ Azerbaijan	5	100					
Croatia	CARNet	80	10	58	4	15	5	8
Iran	IRANET	15		100				
Jordan	NITC	268	58	42				
Kyrgyzstan	KRENA-AKNET	4		100				
Romania	RNC	19	63	37				
Romania	RoEduNet	70	25	20	25	25		5
Serbia/Montenegro	AMREJ	11		27	36	27		9
Turkey	ULAKBIM	120	85.8	1.7	12.5			
Ukraine	URAN	6	33		67			
Uzbekistan	UzSciNet	49	100					

3 Network

3.1 Core Capacity on the network

We have asked NRENs how they would describe their network in bandwidth terms. In other words, we have asked for the current typical core usable backbone capacity on the networks (in Mbit/s) (excluding backup links). By this, we mean the typical core capacity of the linked nodes in the core. Some networks do not have a core backbone, for example, because they have a star topology. In that case, we have asked for the maximum capacity into the central node of the network. Some NRENs have dark fiber with a very high theoretical capacity. In those cases, we have asked NRENs to tell us the usable IP capacity.

Note that many NRENs employ a range of capacities on their backbone. What may be considered the 'typical' leaves, of course, some scope for differences in interpretation between NRENs. Many NRENs provide maps of the topology of their backbone on their websites; more information about these maps can be found in the country-entries on the Compendium website.

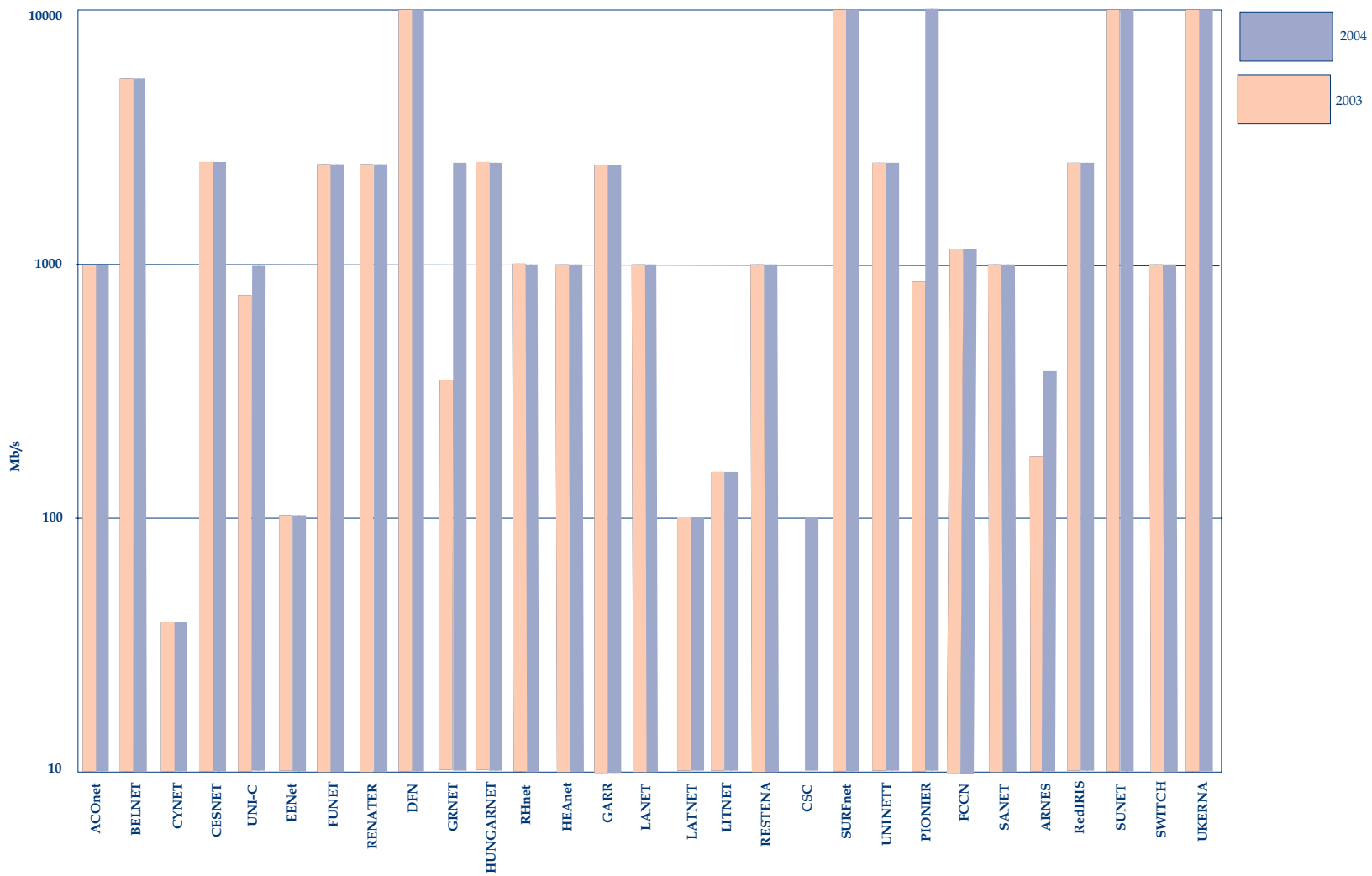
Graphs 3.1.1 and 3.1.2 give an idea of the evolution of network capacity from 2003 to 2004. For presentational purposes, the information is given in two graphs: 3.1.1 for the EU and EFTA countries, graph 3.1.2 for the other countries.

Note that the scales are logarithmic and not the same for the two tables!

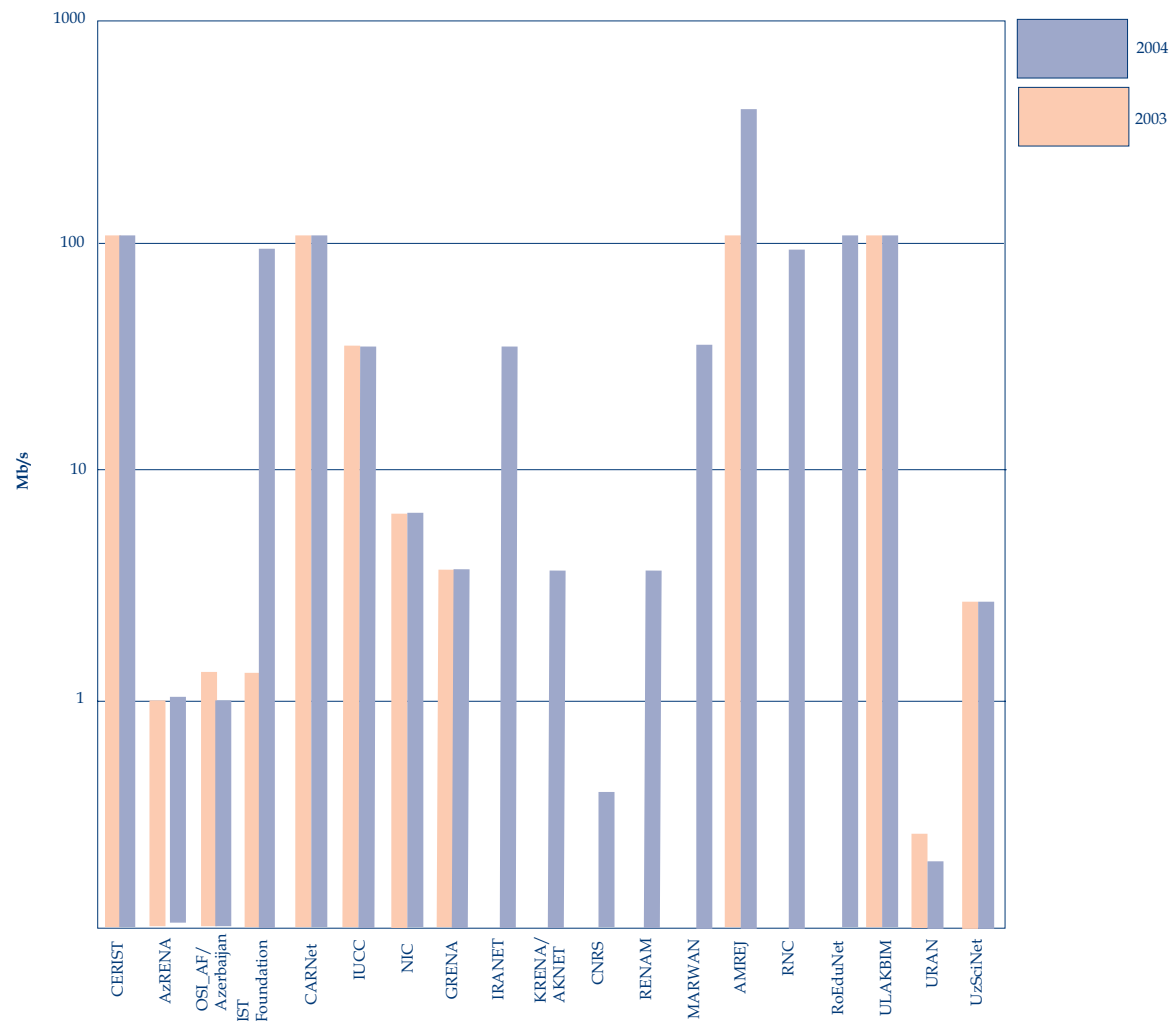
In a number of cases, the core capacity has stayed the same but the backbone itself has been extended (e.g., in the cases of GARR and UKERNA). For a more complete picture, see also the data in sections 3.2 and 3.3.

For a number of NRENs, we have data going back to 2001. Graph 3.1.3 gives the increase in core capacity on the networks between 2001 and 2004 for those countries (note again that the scale is logarithmic). In 2001, a number of countries already had a backbone of 2.5 Gb/s capacity; at that time, this was the highest capacity that was available. Some of those NRENs are still at that level. Others are now at the 10 Gb/s level. The largest increase was in NRENs that had a relatively low capacity in 2001 and that progressed since then to state-of-the-art. Examples are PIONIER (Poland), that increased from 155 Mb/s to 10 Gb/s capacity, and SANET (Slovakia), that went from 4 Mb/s to 1 Gb/s.

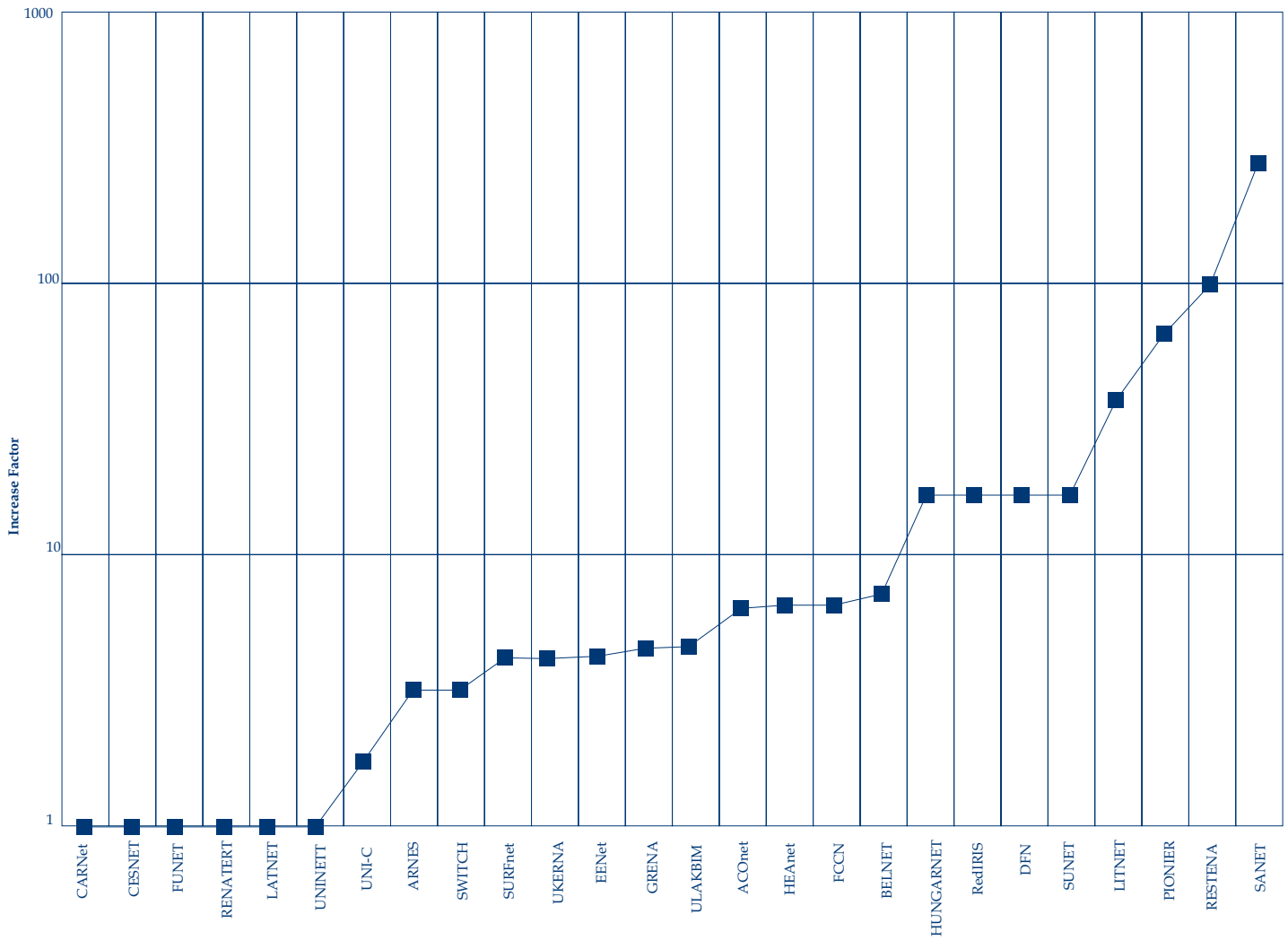
Graph 3.1.1 Core capacity on the networks, 2003 - 2004, EU and EFTA countries



Graph 3.1.2 Core capacity on the networks, 2003 - 2004, other countries



Graph 3.1.3 Core capacity on the network, increase factor 2001 - 2004



3.2 Expected change in the core capacity in two years' time

The following table gives the current core capacity (in Mb/s), the expected increase in two years' time and the expected (computed) core capacities for early 2006.

Note that, typically, the core capacity goes up in leaps, involving the change from one type of technology to another. Note also that it is not always easy to predict the evolution in core capacity. This is because this evolution depends on many factors, such as developments in technology and pricing and the availability of sufficient funds for investment. If one would compare the answers now predicted for 2006 with the predictions given last year for 2005, one would find differences in both directions; some NRENs now predict an increase that they would not have thought likely a year ago, while others have predicted a level of capacity for 2006 that is below what they predicted last year for 2005. The same is true when one compares the expectations for 2004 as formulated two years ago with the actual situation. The SERENATE studies that were published by TERENA in 2003 may have helped to make expectations more realistic (see <http://www.serenate.org>).

The trend seems to be that in the more advanced countries, the core capacity will evolve to 10Gb/s or even 20 Gb/s. This will also happen in many of the 'new' EU countries. Only some of the smallest countries (Cyprus, Malta, Iceland) seem to expect that they will not follow this direction – it is not clear whether this is because they see no need or because they lack the means. On the other hand, most of the countries in the Middle East and in the former Soviet Union expect that they will be unable to bridge the 'digital divide'.

Table 3.2 Expected change in the core capacity in two years' time, EU and EFTA countries

EU & EFTA countries	NREN	Core capacity (Mb/s)	Expected increase in 2 years	Expected core capacity in 2006
Austria	ACOnet	1000	2.5 X	2500
Belgium	BELNET	5000	4 X	20000
Cyprus	CYNET	34	5 X	170
Czech Republic	CESNET	2500	4 X	10000
Denmark	UNI•C	1000	1.5 X	1500
Estonia	EENet	100	4 X	400
Finland	FUNET	2500	4 X	10000
France	RENATER	2500	4 X	10000
Germany	DFN	10000	2 X	20000
Greece	GRNET	2500	4 X	10000
Hungary	HUNGARNET	2500	4 X	10000
Iceland	RHnet	1000	2 X	2000
Ireland	HEAnet	1000	10 X	10000
Italy	GARR	2500	4 X	10000
Latvia	LATNET	100	10 X	1000
Lithuania	LITNET	30-622	4 X	155-2500
Malta	CSC	100	10 X	1000
Netherlands	SURFnet	10000	2 X	20000
Norway	UNINETT	2500	4 X	10000
Poland	PIONIER	10000	2 X	20000
Portugal	FCCN	1200	2 X	2400
Slovakia	SANET	1000	10 X	10000
Slovenia	ARNES	310	4 X	1240
Spain	RedIRIS	2500	4 X	10000
Sweden	SUNET	10000	none	10000
Switzerland	SWITCH	1000	10 X	10000
United Kingdom	UKERNA	10000	none	10000

Table 3.2 Expected change in the core capacity in two years' time, other countries

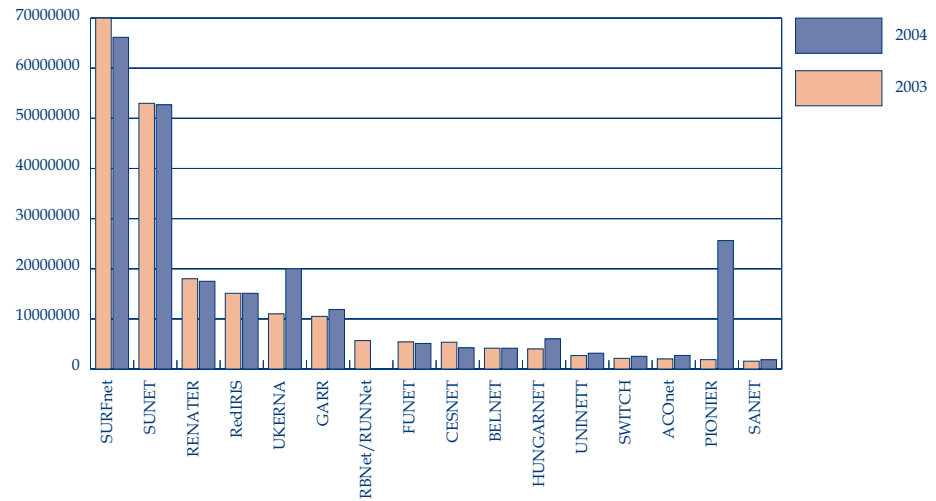
Other countries	NREN	Core Capacity (Mb/s)	Expected increase in 2 years' time	Expected core capacity in 2006
Algeria	CERIST	155	4 X	620
Azerbaijan	AzRENA	5	40 X	200
Bulgaria	IST Foundation	100	6 X	600
Croatia	CARNet	155	16 X to 64 X	6200
Georgia	GRENA	4	2 X	8
Iran	IRANET	56	35 %	75.6
Jordan	NITC	8	5 X	40
Lebanon	CNRS	448 Kb/s	2 X	0.896
Moldova	RENAM	4	10 X	40
Morocco	MARWAN	34	10 X	340
Romania	RNC	100	100 X	2500
Romania	RoEduNet	155	4 X	620
Serbia/Montenegro	AMREJ	500	2 X	1000
Turkey	Ulakbim	155	4 X	620
Ukraine	URAN	0.128	up to 100 Mbps	100
Uzbekistan	UzSciNet	2	2 X	4

3.3 Core network size

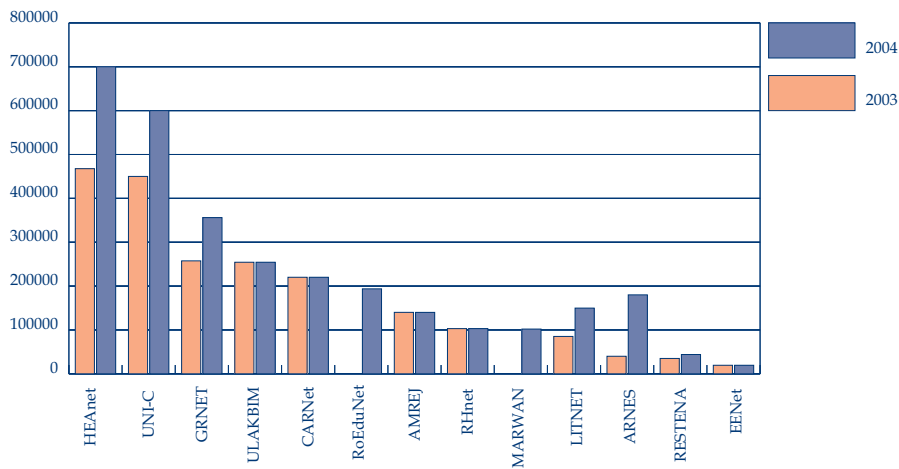
Like earlier years, we have asked NRENs to estimate the total size of their networks by multiplying the length of the various links in the backbone with the capacity of those links in Mb/s. The resulting unit is network size in Mb/s x km. As before, this question was difficult to answer for some NRENs. However, a number of NRENs have been able to provide more accurate estimates than in the past. This explains the difference in the value for SURFnet and SUNET. The graphs clearly show the advances made by the Polish network, PIONIER and by a number of the 'smaller' networks.

For presentational purposes, three graphs are presented, for countries with different network sizes.

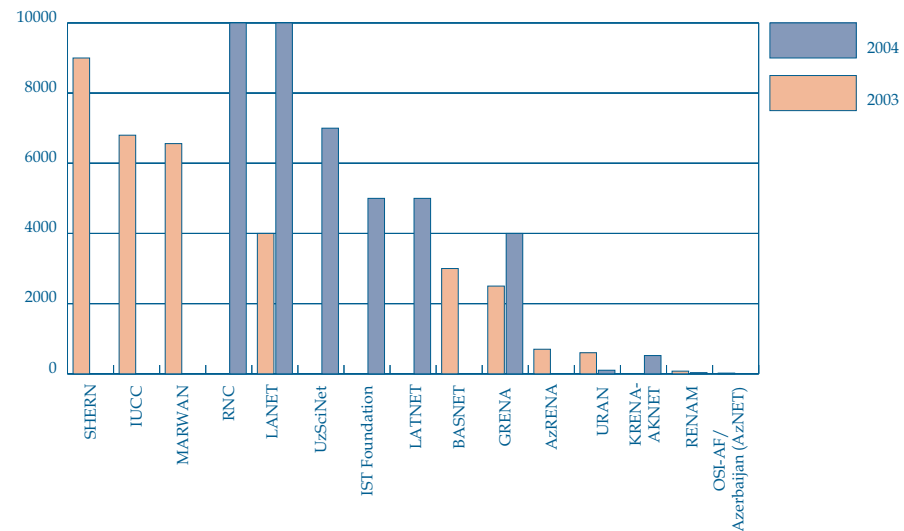
Graph 3.3.1 Core Network Size 2003 - 2004: > 1M Mb/s x km.



Graph 3.3.2 Core Network Size 2003 - 2004: > 10,000, < 1 M Mb/s x km



Graph 3.3.3 Core Network Size 2003 - 2004: < 10,000 Mb/s x km



3.4 Capacity of the highest link

Many countries are now linked at the highest capacity currently offered by the GÉANT network, 10 Gb/s. Some networks have several links of the same capacity. Table 3.4.1 lists the highest links and their capacities, for January 2004.

of those NRENs between December 2001 and January 2004 (note that the scale is logarithmic). The highest increases were in Croatia and Portugal, which both went from 17 Mb/s to 1244 Mb/s. Many others went from 2.5 Gb/s to 10 Gb/s.

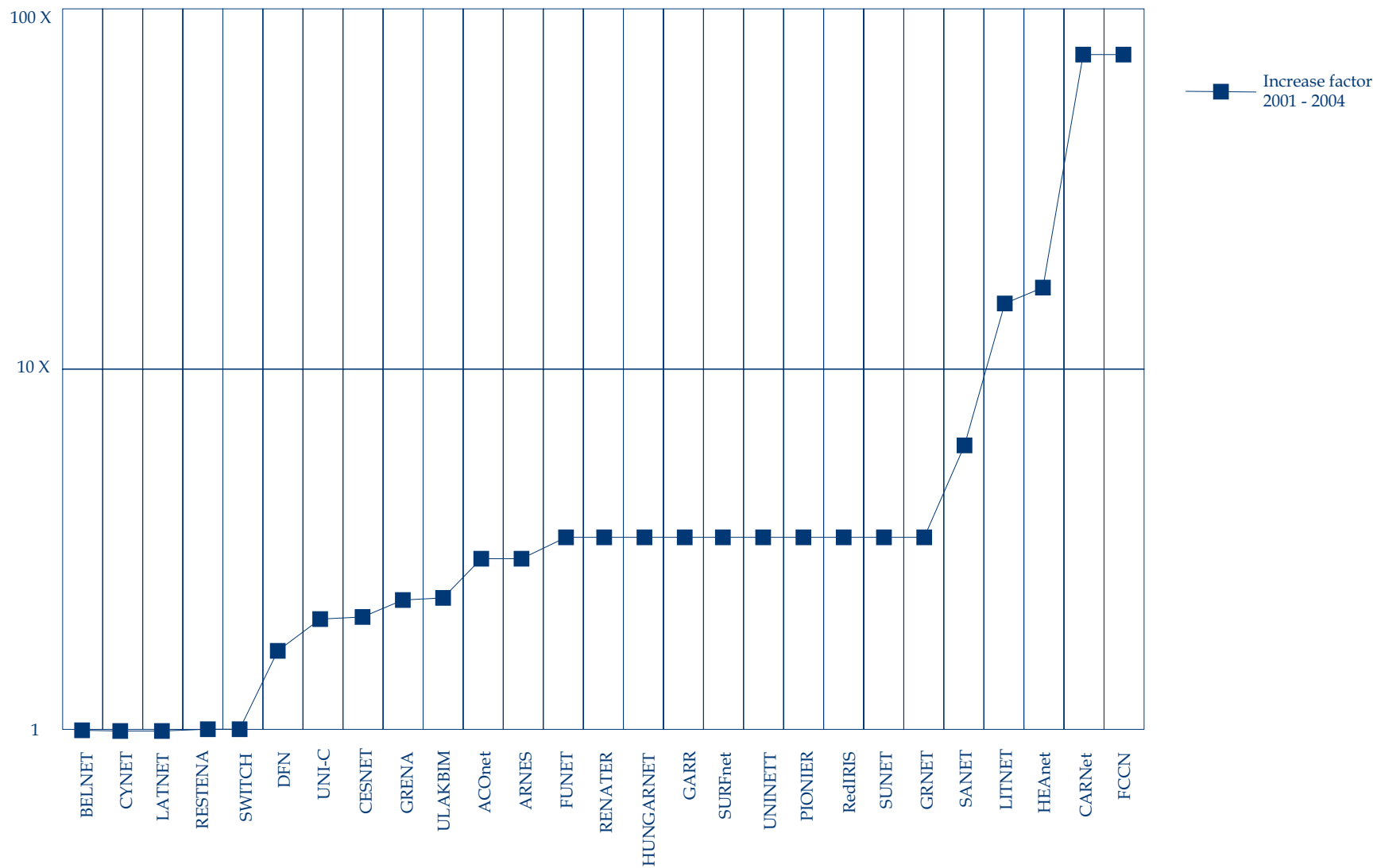
For a number of NRENs, we have data going back to 2001. Graph 3.4.2 gives the increase in the highest external links

Table 3.4.1 Capacity of the highest link, January 2004

EU & EFTA countries	NREN	Link	Capacity
Austria	ACOnet	VIX	2000
Belgium	BELNET	GÉANT	2500
Cyprus	CYNET	GÉANT	40
Czech Republic	CESNET	NetherLight	2500
Denmark	UNI•C	NORDUnet	5000
Estonia	EENet	Tallinn Internet eXchange	1000
Finland	FUNET	NORDUnet	10000
France	RENATER	GÉANT	10000
Germany	DFN	Peering IX	4000
Greece	GRNET	GÉANT	1244
Hungary	HUNGARNET	GÉANT	10000
Iceland	RHnet	RIX	1000
Ireland	HEAnet	GÉANT	2500
Italy	GARR	GÉANT	10000
Latvia	LANET	LIX	100
Latvia	LATNET	GÉANT	34
Lithuania	LITNET	GÉANT	622
Luxembourg	RESTENA	GÉANT	155
Netherlands	SURFnet	Abilene, CA*net and other networks via MANLAN; CERN; GÉANT; StarLight	10000 each
Norway	UNINETT	NORDUnet	10000
Poland	PIONIER	GÉANT	10000
Portugal	FCCN	GÉANT; Gigapix- Portuguese Exchange Point	1244 each

Country	NREN	Link	Capacity
Slovakia	SANET	ACONET + VIX; CESNET + NIX; SIX	1000 each
Slovenia	ARNES	Slovenian Internet Exchange	1000
Spain	RedIRIS	GÉANT	10000
Sweden	SUNET	NORDUnet	10000
Switzerland	SWITCH	GÉANT	2500
Other countries			
Albania	ANA	GRNET/SEEREN	2
Algeria	CERIST	Teleglobe	34
Azerbaijan	AzRENA	DESY/DFN Germany	2.5
Azerbaijan	OSI-AF/ Azerbaijan	Azerbaijan IXP	10
Bulgaria	IST Foundation	GÉANT/SEEREN	18
Croatia	CARNet	GÉANT	1244
Georgia	GRENA	GÉANT via DFN; SMS Internet	2
Iran	IRANET	opentransit	48
Israel	IUCC	GÉANT	310
Jordan	NITC	Commercial Internet	8
Kyrgyzstan	KRENA-AKNET	Hamburg-DESY (Germany)	4
Romania	RNC	Commodity through peering BUHIX, RONIX	200
Romania	RoEduNet	GÉANT	622
Russian Federation	RBNet/RUNNet	NORDUnet	622
Serbia/Montenegro	AMREJ	GRNET (SEEREN)	34
Turkey	ULAKBIM	TTNET	465
Ukraine	URAN	IX-UA; KARnet	100 each
Uzbekistan	UzSciNet	DESY/DFN Germany	2

Graph 3.4.2 External connections, increase factor 2001 -> 2004



3.5 External connectivity: total external links

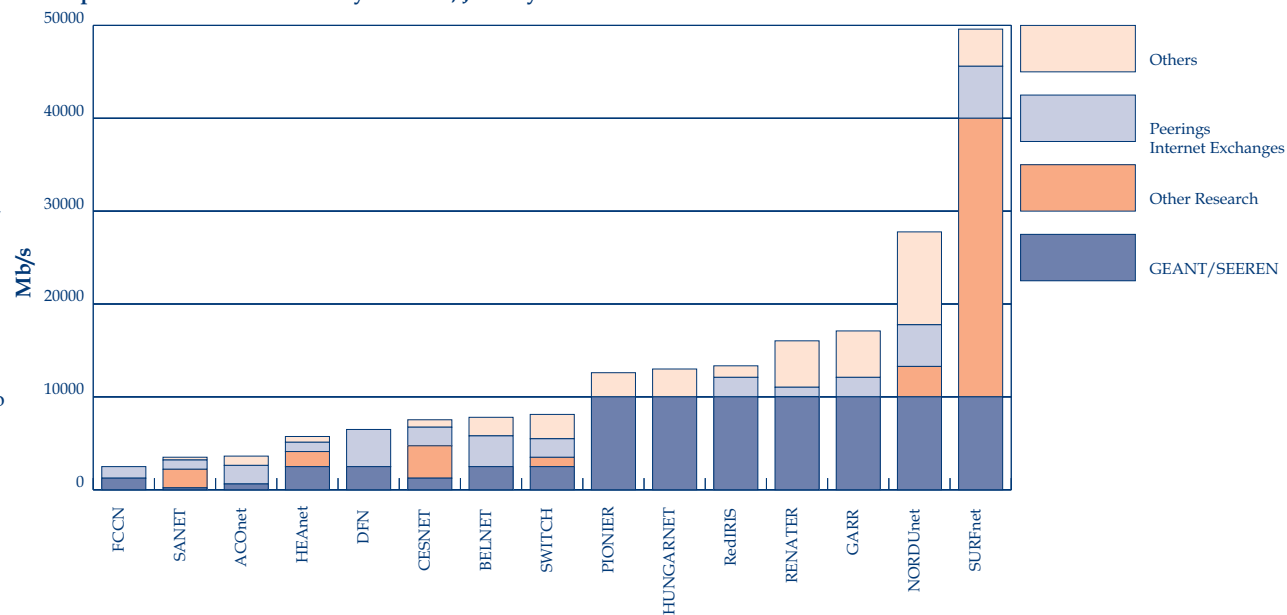
NRENs have been asked to list all of their external connections in January 2004.

The Nordic NRENs (FUNET of Finland, RHnet of Iceland, SUNET of Sweden, UNINETT of Norway and UNI-C (Forskningsnettet) of Denmark) share their external connections through NORDUnet. Therefore, the data for NORDUnet has been given in the graph below, instead of the data from the individual countries. Several Nordic NRENs have national peering arrangements in addition to the NORDUnet arrangements. In January 2004, UNI-C of Denmark had a connection of 5 Gb/s to DIX, the Danish Internet Exchange; FUNET of Finland had a connection of 2 Gb/s to Ficix, the Finnish Internet Exchange; RHnet of Iceland had a connection of 1 Gb/s to RIX, the Reykjavik Internet Exchange; and UNINETT of Norway had two connections of 1 Gb/s each to Norwegian Internet Exchanges.

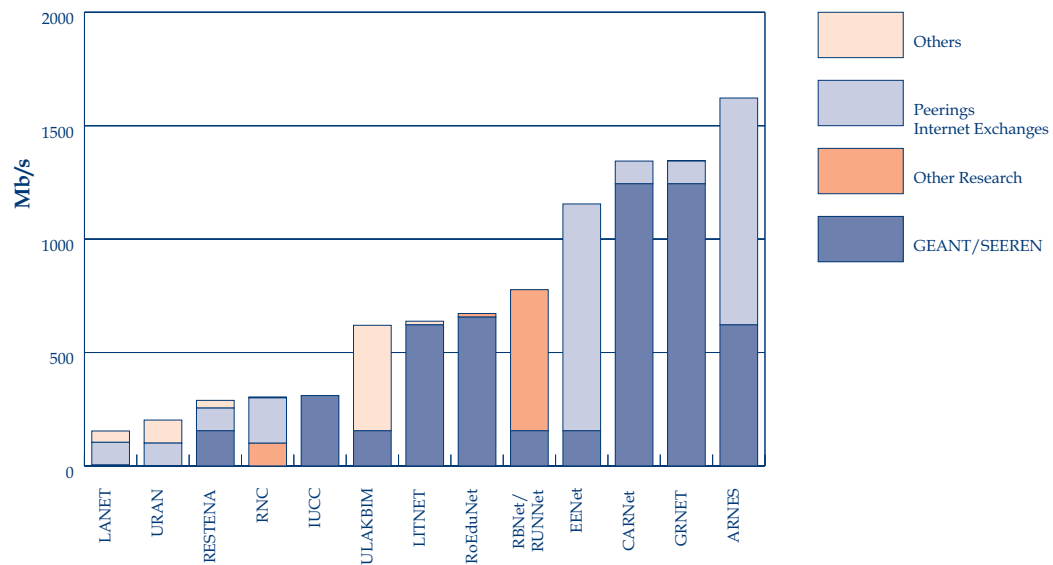
Several NRENs have backup connections for their connection to GEANT or to NORDUnet. These backup links have not been counted. Connections to CERN, Abilene and StarTAP have been grouped as 'Other research', because these connections are essentially for research traffic only.

For presentational purposes, three graphs are presented.

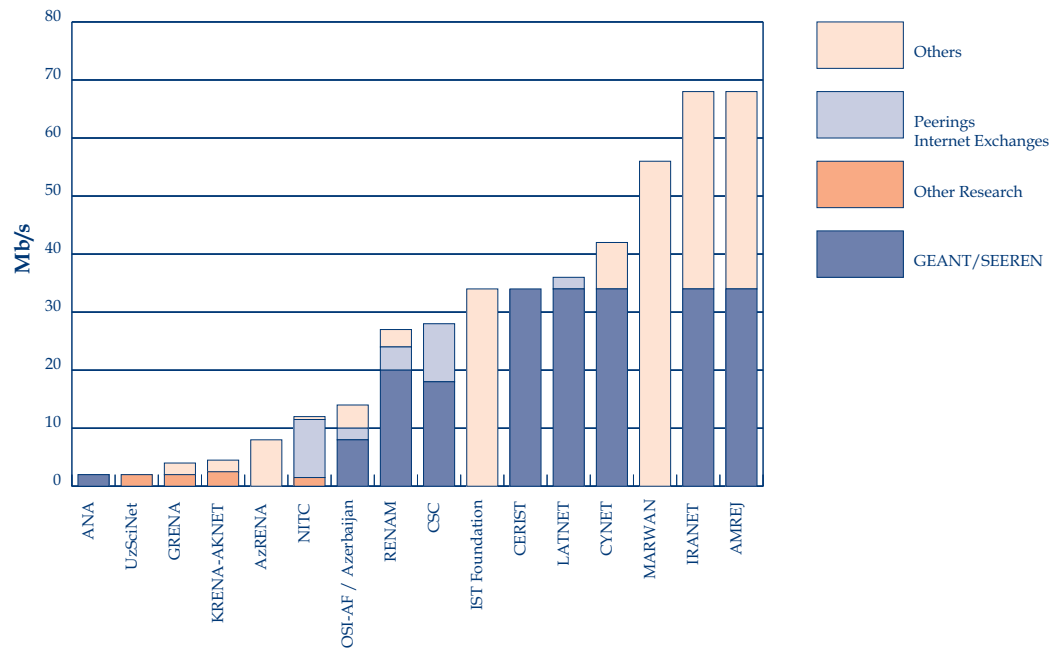
Graph 3.5.1 External connectivity > 2.4 Gb, January 2004



Graph 3.5.2 External connectivity > 100 Mb, < 2400 Mb, January 2004



Graph 3.5.3 External connectivity < 100 Mb, January 2004



3.6 Some network characteristics

The following table gives data about a few key network characteristics: the number of PoPs on the network and whether or not NRENs have or plan to get IRUs¹ or their own dark fibre.

Some NRENs own dark fibre or have IRUs and can decide themselves what technology and what speeds to use on it. In order to document this, we have asked NRENs if they currently have IRUs or own dark fibre, or if they plan to get it during the coming year. We have also asked approximately what percentage of their backbone is dark fibre, in Km, in point-to-point distances .

Whether or not owning IRUs or dark fibre is interesting for an NREN, of course, depends very much on the national situation, for example, regarding regulations and pricing. The table shows that owning dark fibre or IRUs is becoming an interesting option for NRENs in many different countries.

[1] IRU stands for ‘Indefeasible Right of Use’. This is the effective long-term lease (temporary ownership) of a portion of the capacity of a cable. See, for example, <http://whatis.techtarget.com> for more information.

Table 3.6 Some network characteristics

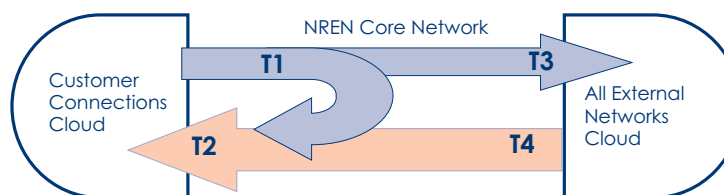
EU & EFTA countries	NREN	Number of PoPs	Have dark fibre	% of backbone
Austria	ACOnet	8	no	
Belgium	BELNET	15	no	
Cyprus	CYNET	1	no	
Czech Republic	CESNET	11	yes	85
Denmark	UNI•C	8	yes	10
Estonia	EENet	18	no	
Finland	FUNET	14	yes	1
France	RENATER	30	no	
Germany	DFN	27	next year	
Greece	GRNET	9	no	
Hungary	HUNGARNET	56	no	
Iceland	RHnet	12	no	
Ireland	HEAnet	7	next year	
Italy	GARR	28	yes	
Latvia	LANET	1	yes	80
Latvia	LATNET	16		
Lithuania	LITNET	16	next year	
Luxembourg	RESTENA	8	yes	70
Malta	CSC	1	no	
Netherlands	SURFnet	25	yes	50
Norway	UNINETT	40	yes	
Poland	PIONIER	22	yes	60
Portugal	FCCN	2	next year	
Slovakia	SANET	20	yes	100
Slovenia	ARNES	27	yes	25
Spain	RedIRIS	20	no	
Sweden	SUNET	23	yes	
Switzerland	SWITCH	13	yes	90
United Kingdom	UKERNA	8	no	

Other countries	NREN	Number of PoPs	Have dark fibre	% of backbone
Algeria	CERIST	4	yes	50
Azerbaijan	AzRENA	6	next year	
Azerbaijan	OSI-AF/Azerbaijan	4	next year	
Bulgaria	IST Foundation	10	no	
Croatia	CARNet	21	yes	5
Georgia	GRENA	16	yes	10
Iran	IRANET	6	yes	20
Israel	IUCC	2	yes	5
Jordan	NITC	1	no	
Kyrgyzstan	KRENA-AKNET	25	no	
Lebanon	CNRA	5	no	
Moldova	RENAM	11	next year	
Morocco	MARWAN	16	no	
Romania	RNC	9	no	
Romania	RoEduNet	40	next year	
Serbia/Montenegro	AMREJ	1	yes	10
Turkey	ULAKBIM	3	no	
Ukraine	URAN	12	yes	1
Uzbekistan	UzSciNet	15	yes	1

4 Traffic

In this section, a distinction is made between internal and external networking and network traffic. These terms are not immediately clear to all NRENs. The figure below illustrates how these terms are being used for the purpose of the Compendium.

External traffic is all traffic to GÉANT, the Commercial Internet, Internet exchanges, etc. (made up of T3 and T4 in the diagram).

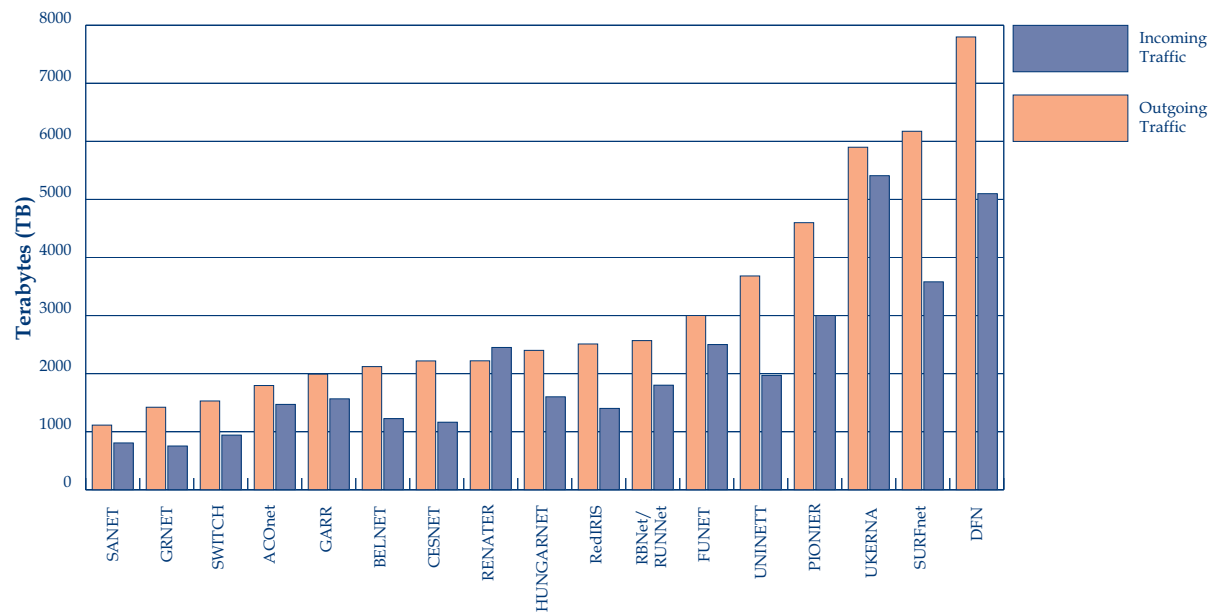


- T1 - all outbound traffic from customer sites
- T2 - all inbound traffic to customer sites
- T3 - all outbound traffic to external network clouds
- T4 - all inbound traffic to the NREN backbone.

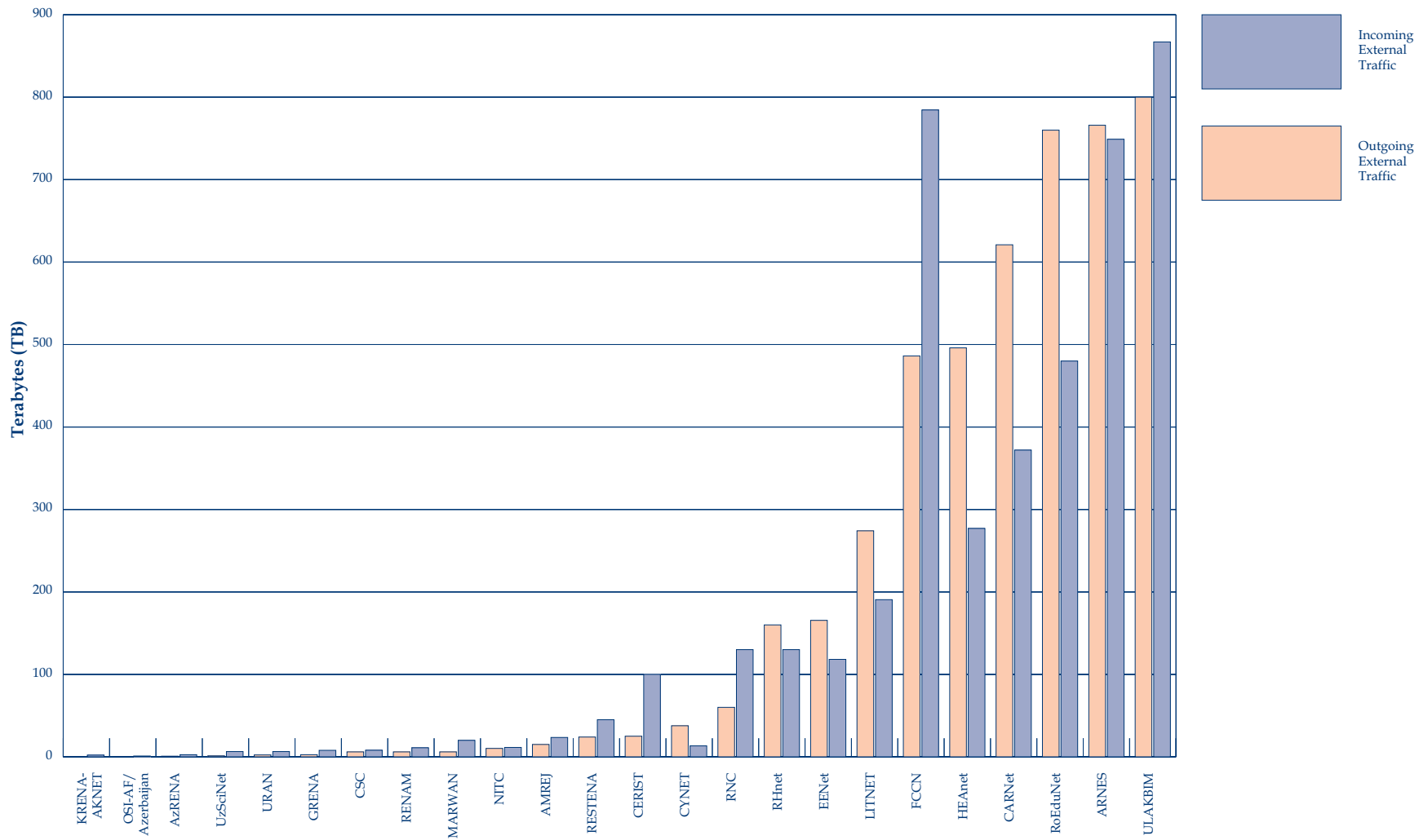
4.1 Incoming and outgoing external traffic, 2002 and 2003

For presentation purposes, two graphs are presented: graph 4.1.1 shows the information for those NRENs with total external traffic above 1000 Terabytes; graph 4.1.2 gives the same information for NRENs with total external traffic below 1000 Terabytes.

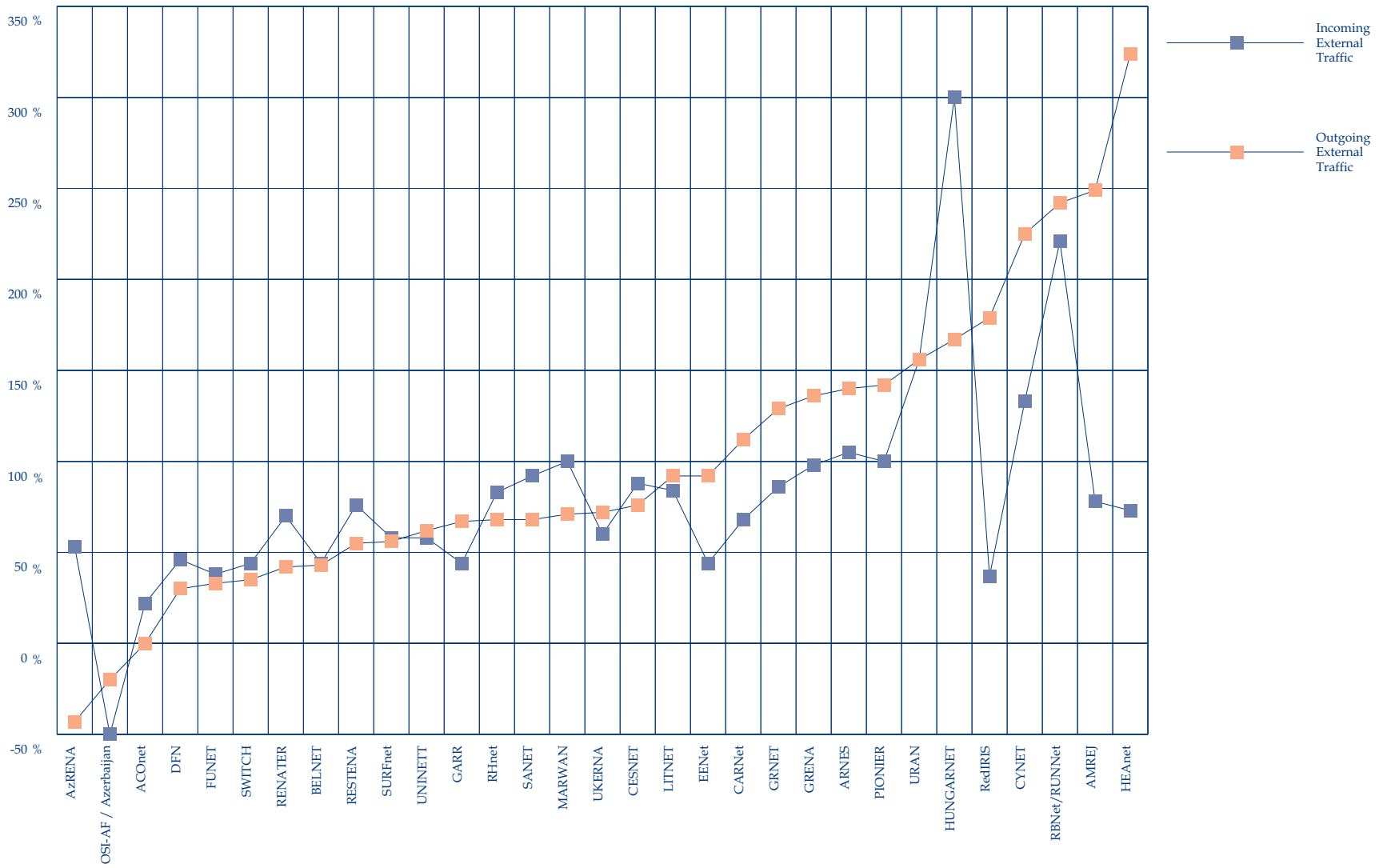
Graph 4.1.1 Incoming and outgoing external traffic 2003, > 1000 Terabytes (TB)



Graph 4.1.2 Incoming and outgoing external traffic 2003, < 1000 Terabytes (TB)



Graph 4.1.3 External traffic growth pattern, 2002 - 2003



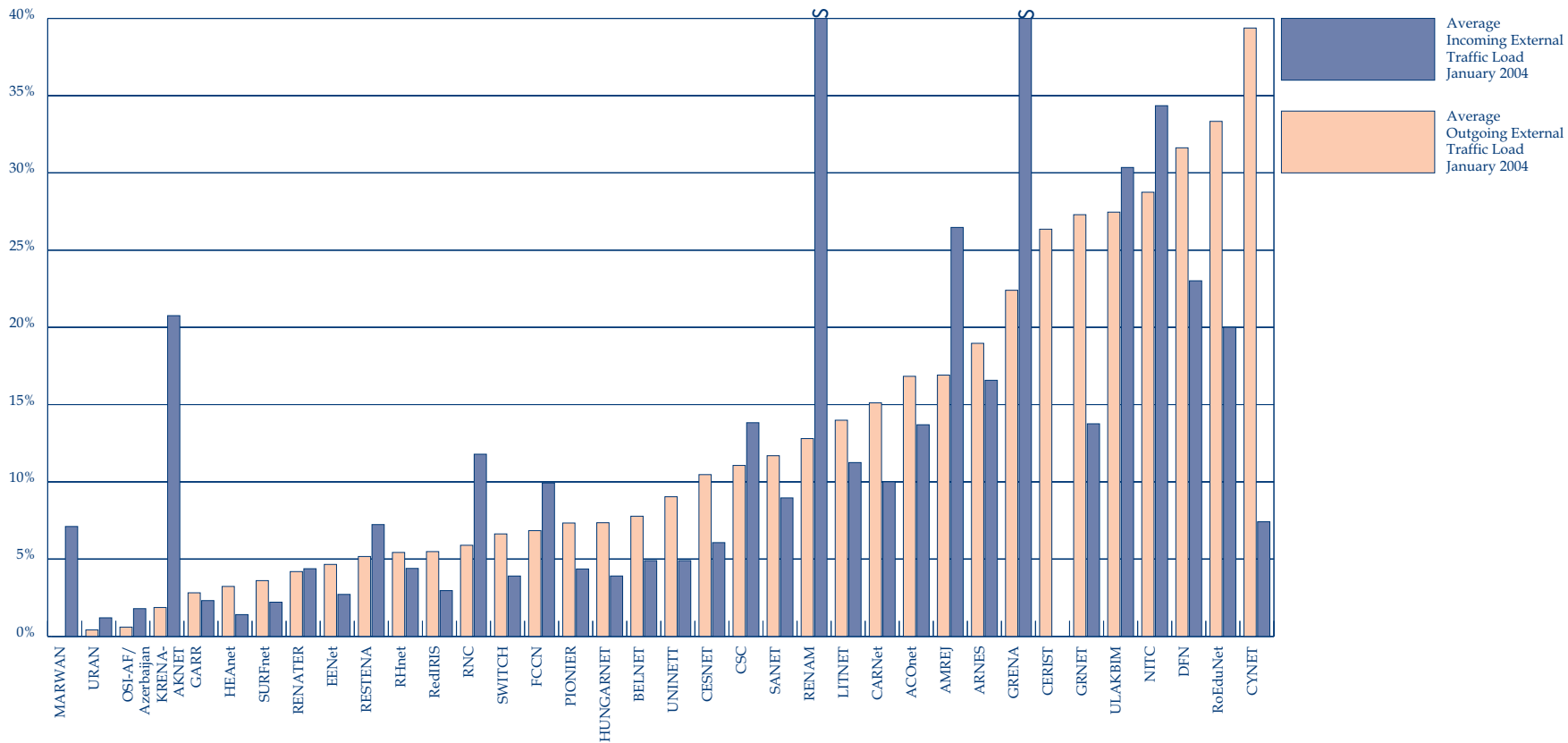
4.2 Average traffic load

Traffic load on the network is one potential way of measuring congestion and thus also of measuring customer demand.

RENAM of Moldova and GRENA of Georgia are outside of the range of the graph, with incoming external traffic loads of respectively 64% and 60%.

The graph below shows the average incoming and outgoing external traffic loads for January, 2004. For an indication of sustained peak usage, these figures should be multiplied by 3.

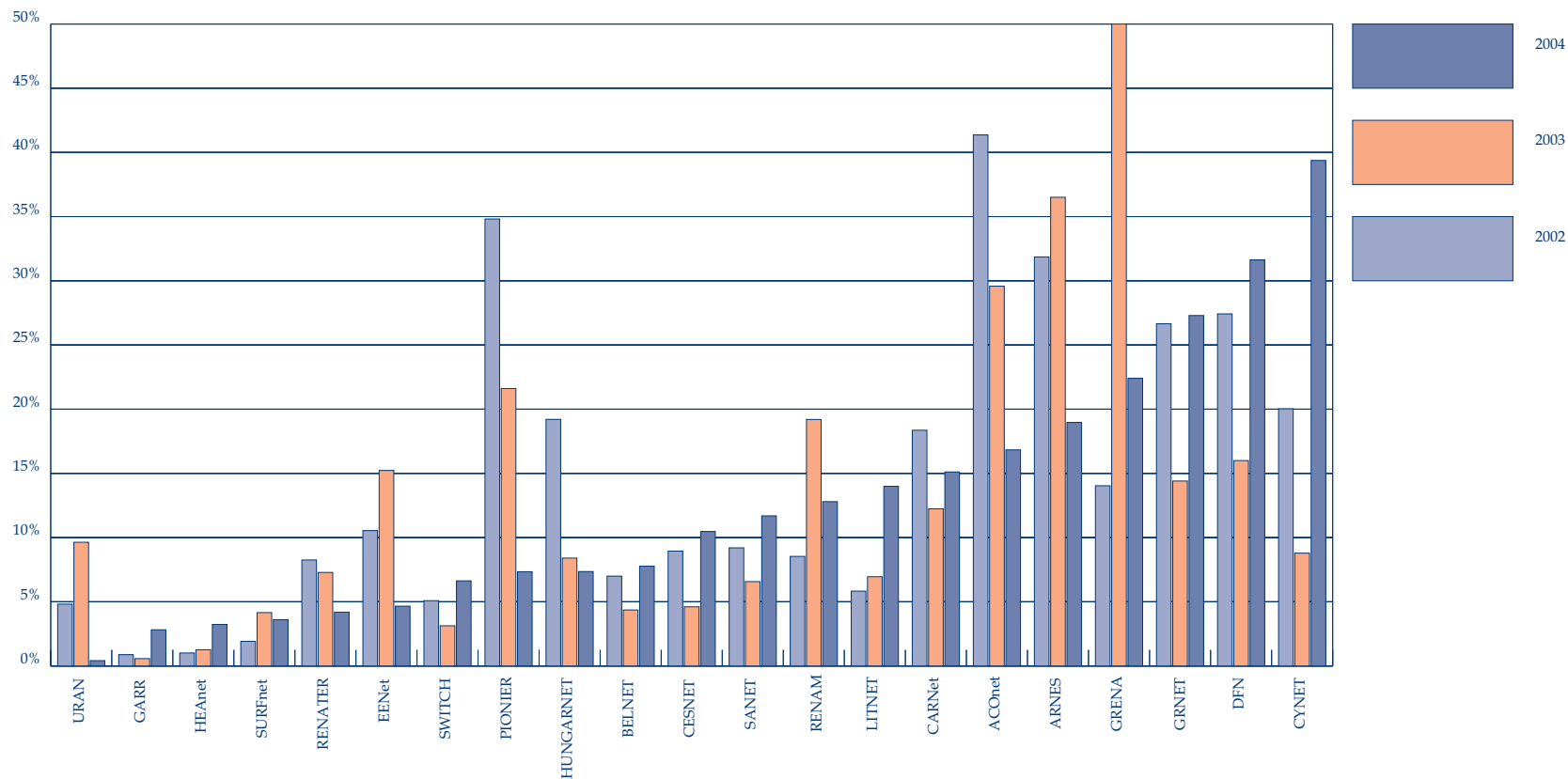
Graph 4.2.1 Average traffic load, January 2004



The next graph compares the average outgoing external traffic load in January, 2004 with that of 2002 and 2003, for those countries that provided the relevant data in all three years.

This graph, in combination with the information about traffic growth (section 4.1) and external links (section 3.5) shows how NRENs need to keep extending their external links from time to time in order to keep up with increasing demand.

Graph 4.2.2 Average outgoing external traffic load, January 2002, 2003 and 2004

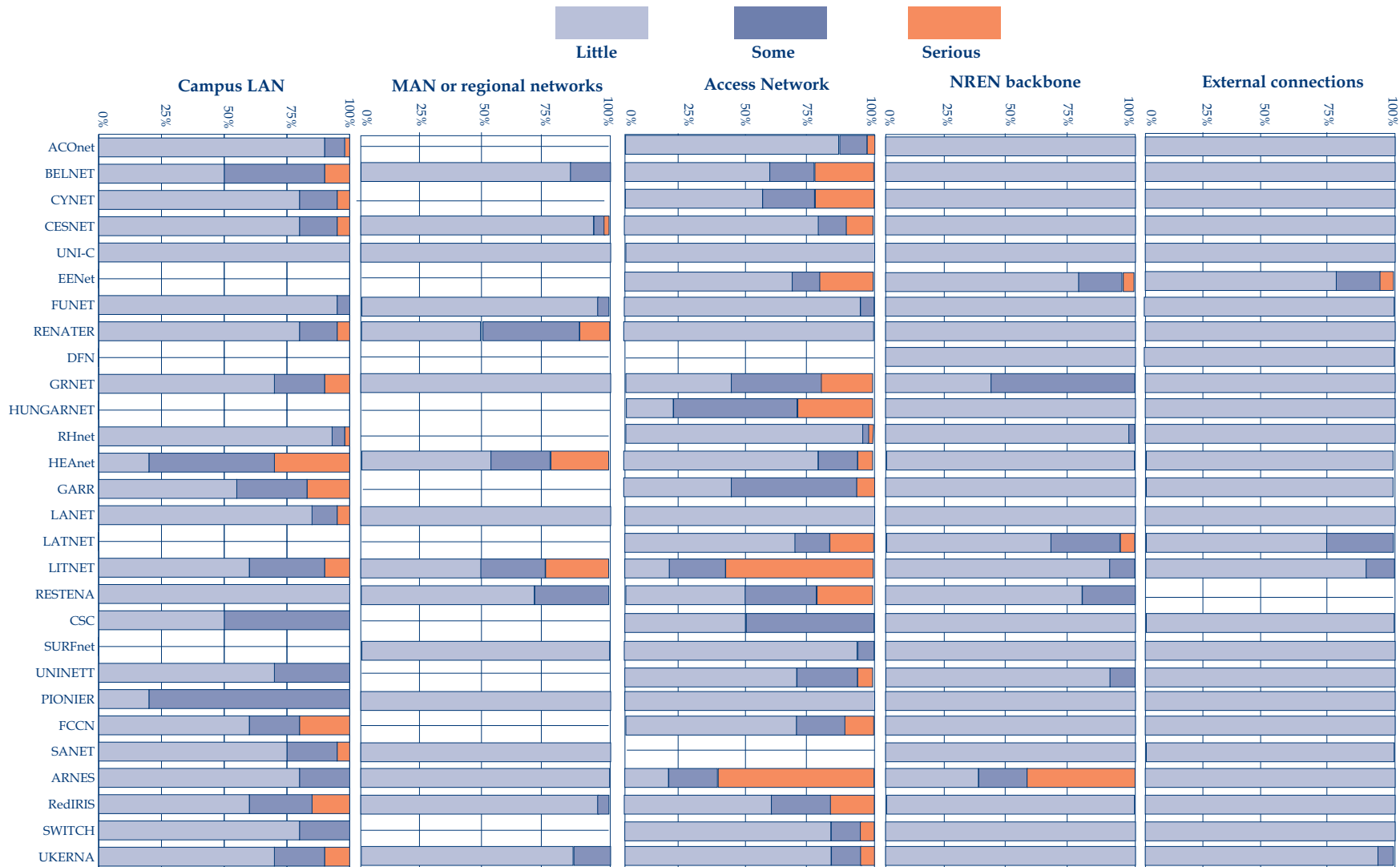


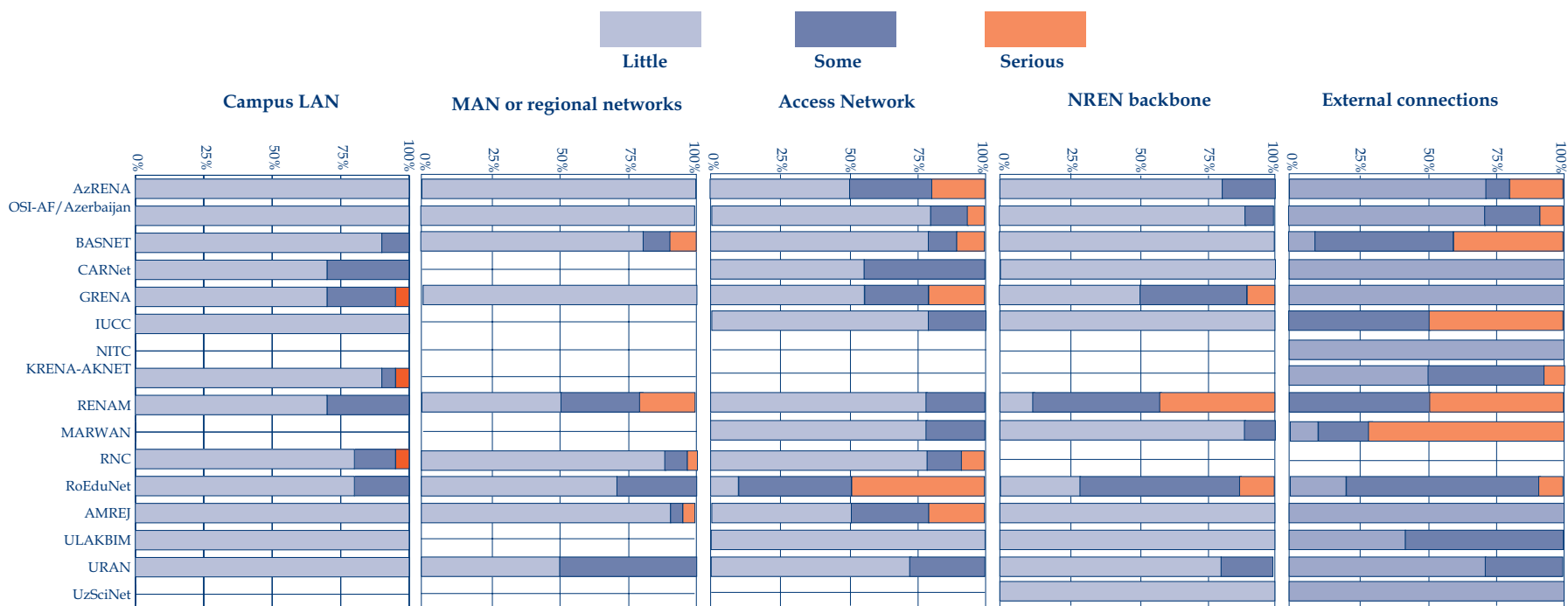
4.3 Congestion

NRENs were asked to give an estimate of where there is congestion (if any) in their networks and of the percentage of client institutions that are affected by congestion at that level. Note that not all NRENs gave an answer for all of the network levels and note also

that not all levels exist in all networks (see also the “Focus Study on Funding, Management and Operation of European Research Networks analysed by network hierarchy” by John Martin and Baiba Kaskina, TERENA, May 2004).

These graphs show that in the EU countries, congestion, if any, occurs mainly at the levels of the Campus LAN and of the access networks. For the other countries, congestion occurs at all levels except the Campus LANs.





4.4 Important applications in IPv6 development

Many NRENs are planning to, or have already started to implement IPv6 on their networks. We have asked NRENs what they think will be the most important application(s) for IPv6 development. Not many NRENs have answered this question, but the answers obtained are given below.

Table 4.4 Important applications for IPv6

Country	NREN	Important applications for IPv6
Croatia	CARNet	DNS, FTP, HTTP, e-mail, IRC, DHCP
Greece	GRNET	Peer-to-peer and telematics applications
Hungary	HUNGARNET	Applications requiring real end-to-end connections: Voice over IP, Instant Messaging, peer-to-peer applications
Ireland	HEAnet	3G applications, use by new user communities
Italy	GARR	Peer-to-peer, on-line gaming
Netherlands	SURFnet	The most important stimulus for the development of IPv6 will be the growth of the number of clients (i.e. appliances) with an IP-connection.
Norway	UNINETT	Peer-2-peer
Poland	PIONIER	Mobility
Romania	RoEduNet	Applications with mobility support.
Turkey	Ulakbim	DNS, WWW

4.5 Percentage of Institutions connected via IPv6

Now that many NRENs are starting to, or have started to implement IPv6, it is interesting to know how many institutions are actually being connected to them via IPv6. We have asked what percentage of the Universities and Research Institutions are connected to the NREN via IPv6, either via native IPv6 or via tunnelled IPv6.

The following table shows that the Czech Republic is the clear leader in this field, with 80% of the Universities and Research Institutions connected to them via native IPv6. Note, though, that a number of NRENs did not answer this question. For technical reasons, CESNET does not know how much of the traffic on its backbone is actually IPv6 traffic. However, for PIONIER from Poland, with 20% of the Universities and Research Institutions connected to it via native IPv6, the IPv6 traffic percentage in December 2003 was only 0.1%. For FCCN from Portugal, with the same percentage of connected Universities and Research Institutions, the percentage of IPv6 traffic was 1%.

More information about this and about other aspects of IPv6 adoption can be found in the individual country entries on the Compendium website.

Table 4.5 Percentage of institutions connected via IPv6

Country	NREN	Native	Tunnelled
Belgium	BELNET	5.0	0.0
Croatia	CARNet	2.0	0.0
Czech Republic	CESNET	80.0	20.0
Estonia	EENet	5.4	8.0
Finland	FUNET	5.0	5.0
Greece	GRNET	4.0	2.6
Hungary	HUNGARNET	10.0	0.0
Iceland	RHnet	0.0	10.0
Ireland	HEAnet	6.0	9.0
Italy	GARR	3.0	3.0
Lithuania	LITNET	0.4	0.6

Country	NREN	Native	Tunnelled
Netherlands	SURFnet	5.0	5.0
Norway	UNINETT	6.0	3.0
Poland	PIONIER	20.0	0.0
Portugal	FCCN	20.0	0.0
Romania	RoEduNet	4.0	2.0
Russia	RBNet/RUNNet	0.0	100.0
Slovenia	ARNES	0.0	1.0
Spain	RedIRIS	5.0	20.0
Sweden	SUNET	10.0	40.0
Switzerland	SWITCH	10.0	11.0
Turkey	ULAKBIM	3.0	0.0

5 Tasks, staffing, funding

5.1 Staffing

Note that some NRENs provide services only to the Research or Education communities in their country. Others provide other services as well, for example, because they administer the country-code tld or because they connect individuals, companies or institutions that are clearly outside of the Research or Education communities. For the sake of comparability, we have asked NRENs to provide information only about the activities for the Research or Education communities. For short, we have called these 'NREN activities'.

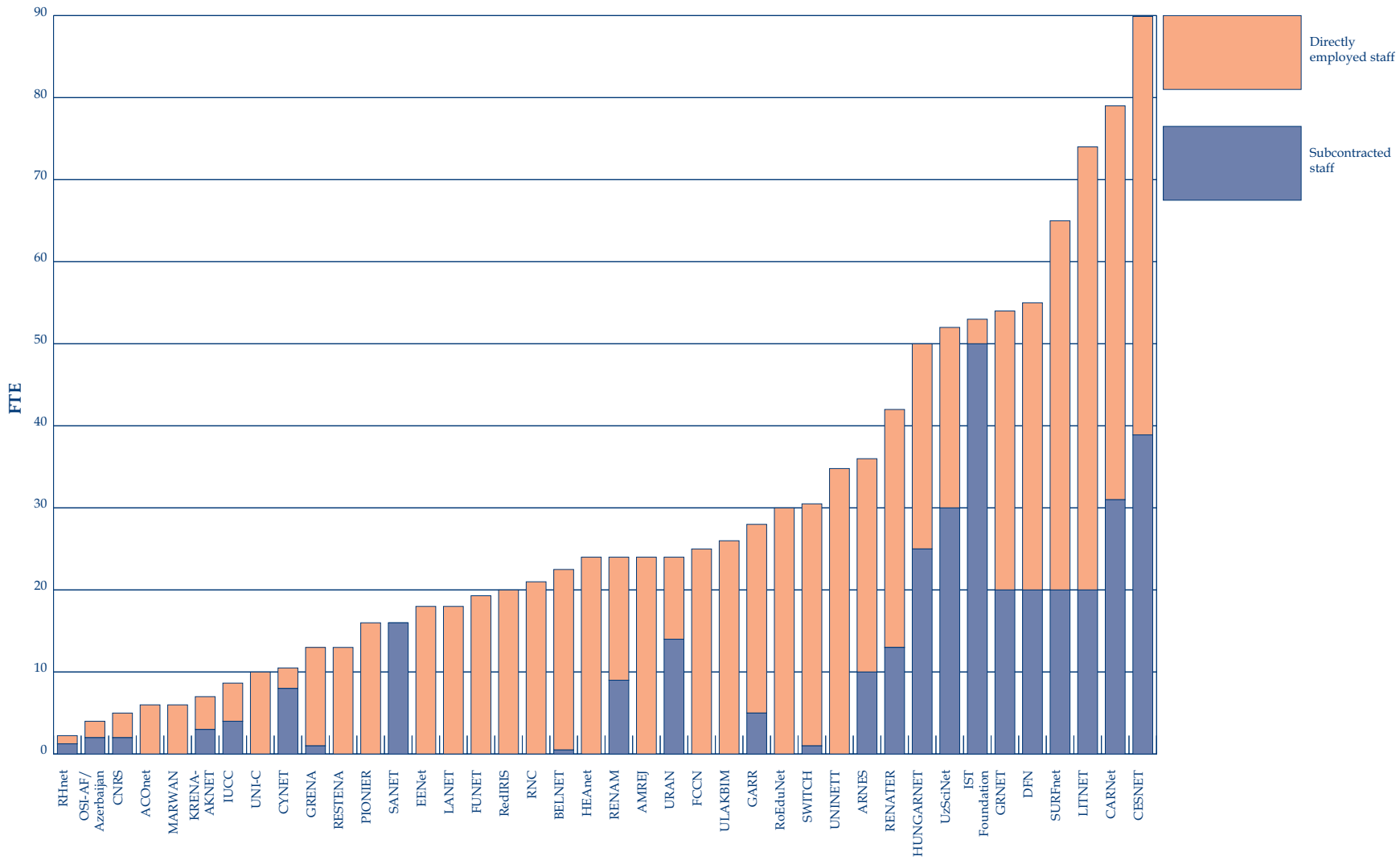
Because many NRENs contract out part of their work, the staff size in itself is not a reliable measure of the amount of person-power that is available to an NREN. The following graph gives an overview of the staff that is directly employed in NREN activities, plus subcontracted staff, in Full-Time Equivalents (FTE).

The second graph gives the same information, but only for the technical staff.

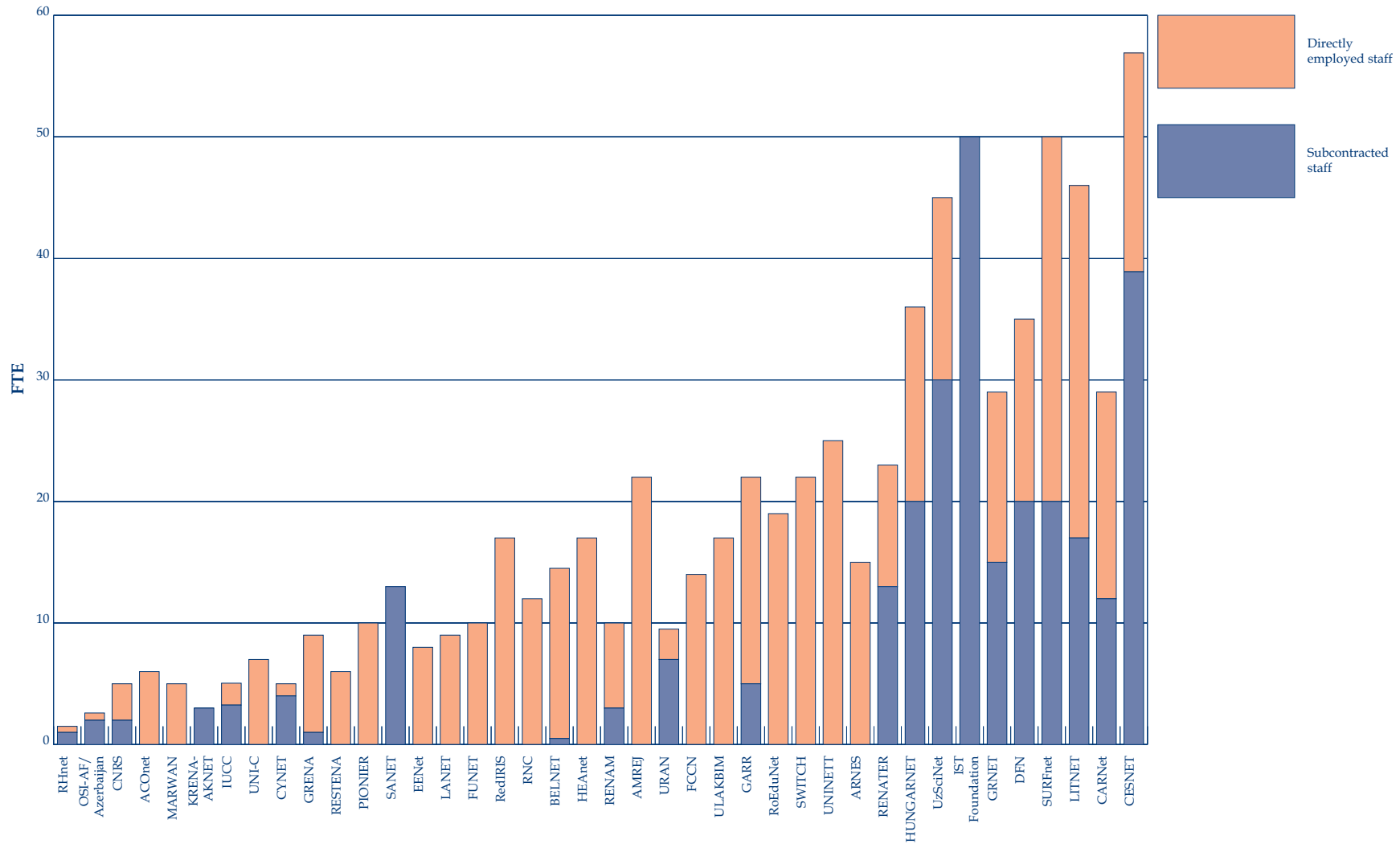
The tasks performed by individual NRENs are different. This may help to explain some of the differences as seen in the graphs. Thus, CARNet provides training and user support to individual students; it operates from three locations in Zagreb and has four additional branch offices. In other countries, the Universities themselves typically do this. As can be seen from the third graph, the proportion of technical staff to total staff of CARNet is relatively low.

The third graph also shows two NRENs which have only technical staff. This is because, in these NRENs, the research networking is provided as a service by a parent organisation and it has not been possible for the NRENs to give a specific estimate of the non-technical staff time devoted to the NREN functions. This may also be a factor explaining why some of the other NRENs have a high proportion of technical staff to total staff.

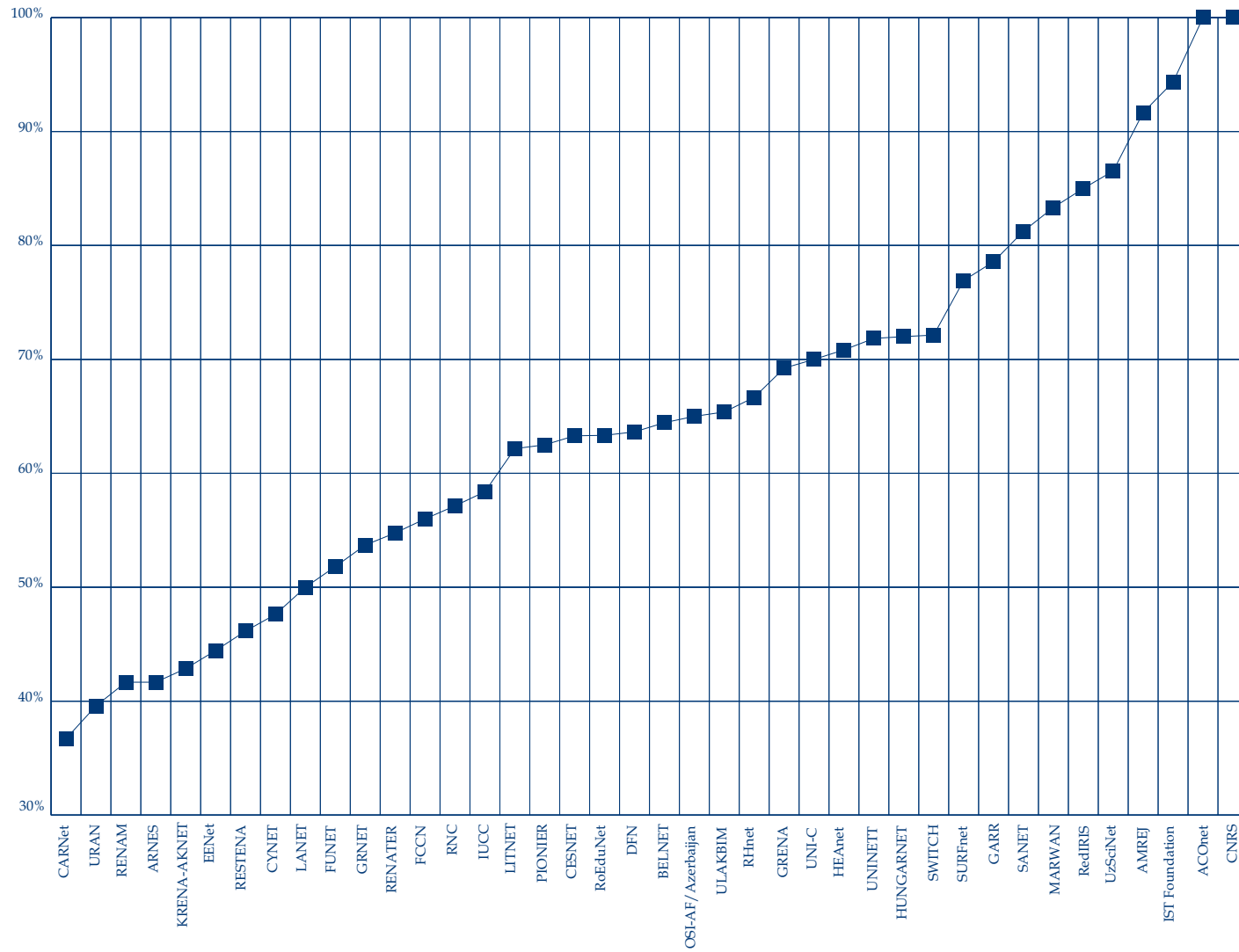
Graph 5.1.1 Total NREN staff in FTE



Graph 5.1.2 NREN technical staff in FTE



Graph 5.1.3 Proportion of NREN technical staff to total staff



5.2 Percentage of total staff effort going towards services for secondary and primary schools

Many NRENs have now started or are starting to connect secondary and primary schools to their network. Potentially, this can lead to a lot of work for the NRENs involved, if only because of the large numbers of secondary and primary schools. For the first time, we have asked NRENs to estimate how much of their staff effort is going towards services for secondary and primary schools. Not all NRENs answered this questions. As can be seen from the following table, the replies received ranged from nothing to more than 50% (for two NRENs).

Table 5.2 Percentage of staff effort going towards services for secondary and primary schools

EU & EFTA countries	NREN	% of staff effort
Austria	ACOnet	0 - 25
Belgium	BELNET	none
Cyprus	CYNET	none
Czech Republic	CESNET	none
Denmark	UNI•C	none
Estonia	EENet	0 - 25
Finland	FUNET	none
France	RENATER	0 - 25
Germany	DFN	0 - 25
Greece	GRNET	0 - 25
Hungary	HUNGARNET	0 - 25
Iceland	RHnet	none
Ireland	HEAnet	0 - 25
Italy	GARR	0 - 25
Latvia	LANET	none
Lithuania	LITNET	0 - 25
Luxembourg	RESTENA	0 - 25

	NREN	% of staff effort
Netherlands	SURFnet	none
Norway	UNINETT	0 - 25
Poland	PIONIER	0 - 25
Portugal	FCCN	25 - 50
Slovakia	SANET	0 - 25
Slovenia	ARNES	50 - 100
Spain	RedIRIS	none
Sweden	SUNET	none
Switzerland	SWITCH	none
United Kingdom	UKERNA	0 - 25

Other countries	NREN	& of staff effort
Azerbaijan	OSI-AF/ Azerbaijan	25 - 50
Bulgaria	IST Foundation	0 - 25
Croatia	CARNet	0 - 25
Georgia	GRENA	0 - 25
Kyrgyzstan	KRENA-AKNET	0 - 25
Romania	RNC	0 - 25
Romania	RoEduNet	0 - 25
Serbia/Montenegro	AMREJ	none
Turkey	ULAKBIM	none
Ukraine	URAN	25 - 50
Uzbekistan	UzSciNet	50 - 100

5.3 Total budgets 2003, 2004

The following graphs give the total NREN budgets for 2003 and 2004.

NREN budgets may fluctuate from year to year, because investments can vary considerably from year to year. Note that the budget year of CERIST (Algeria) runs from March to February; that of UKERNA (UK) runs from August to July. In those cases, the 2004 budget is really the 2004/2005 figure.

Note that NRENs have many different tasks and are organised in different ways. Some NRENs provide services only to the Research or Education communities in their country. Others provide other services as well, for example, because they administer the country-code top-level domain or because they connect others who are clearly outside of the Research or Education communities. For the sake of comparability, we have asked NRENs to provide information only about the budget for the activities for the Research and Education communities in their countries.

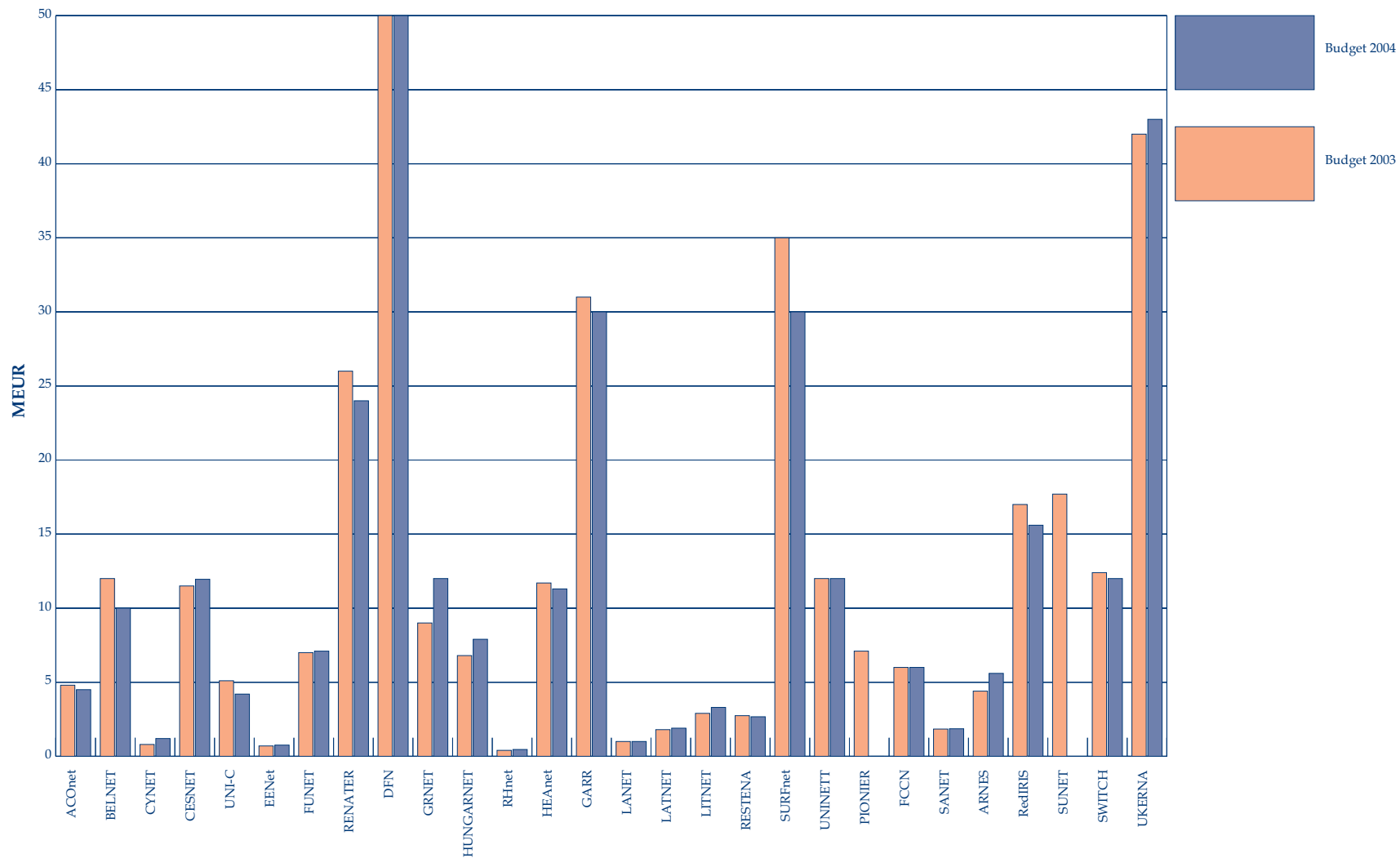
Even so, a comparison between the budgets of different NRENs is tedious. We have asked NRENs if the budget figure given includes the GÉANT subsidy - for some NRENs, this subsidy is shown in the budget, for others, it appears as a reduced cost and is not shown in the budget. Table 5.3.1 below gives the answers received. There are also other reasons why comparisons are difficult. Thus, in section 5.5 it seems that some NRENs do not spend money on salaries. Yet, they do have staff, but this staff is not paid from the NREN budget. Similar situations may apply for other budget categories as well.

Table 5.3.1 Is the GÉANT subsidy included in your budget figures?

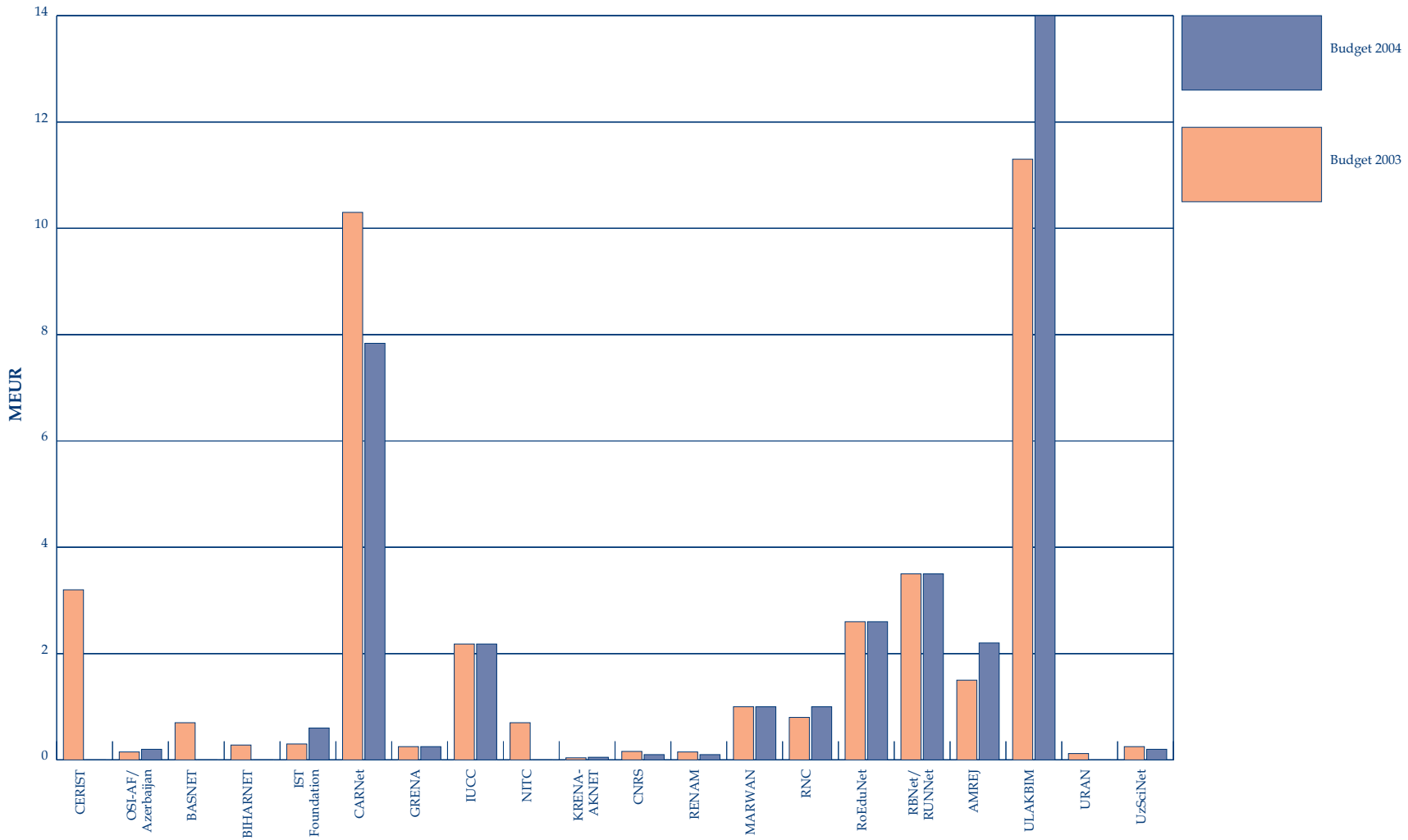
Country	NREN	GÉANT subsidy included?
Belgium	BELNET	no
Croatia	CARNet	no
Cyprus	CYNET	yes
Czech Republic	CESNET	no
Denmark	UNI•C	no
Estonia	EENet	no
Finland	FUNET	yes
France	RENATER	yes
Germany	DFN	no
Greece	GRNET	yes
Hungary	HUNGARNET	yes
Iceland	RHnet	no
Ireland	HEAnet	yes
Italy	GARR	yes
Latvia	LANET	no
Lithuania	LITNET	no
Luxembourg	RESTENA	yes
Moldova	RENAM	no
Morocco	MARWAN	no
Netherlands	SURFnet	yes
Poland	PIONIER	yes
Portugal	FCCN	yes
Romania	RNC	no
Romania	RoEduNet	no
Russia	RBNet/RUNNet	no
Serbia & Montenegro	AMREJ	yes
Slovenia	ARNES	yes
Spain	RedIRIS	yes
Sweden	SUNET	no
Switzerland	SWITCH	yes
Turkey	ULAKBIM	no
United Kingdom	UKERNA	yes

Graph 5.3.2 gives the total budgets for the NRENs from the EU and EFTA countries, graph 5.3.3 gives the same information for the other countries.

Graph 5.3.2 Total budget 2003 and 2004, EU and EFTA countries



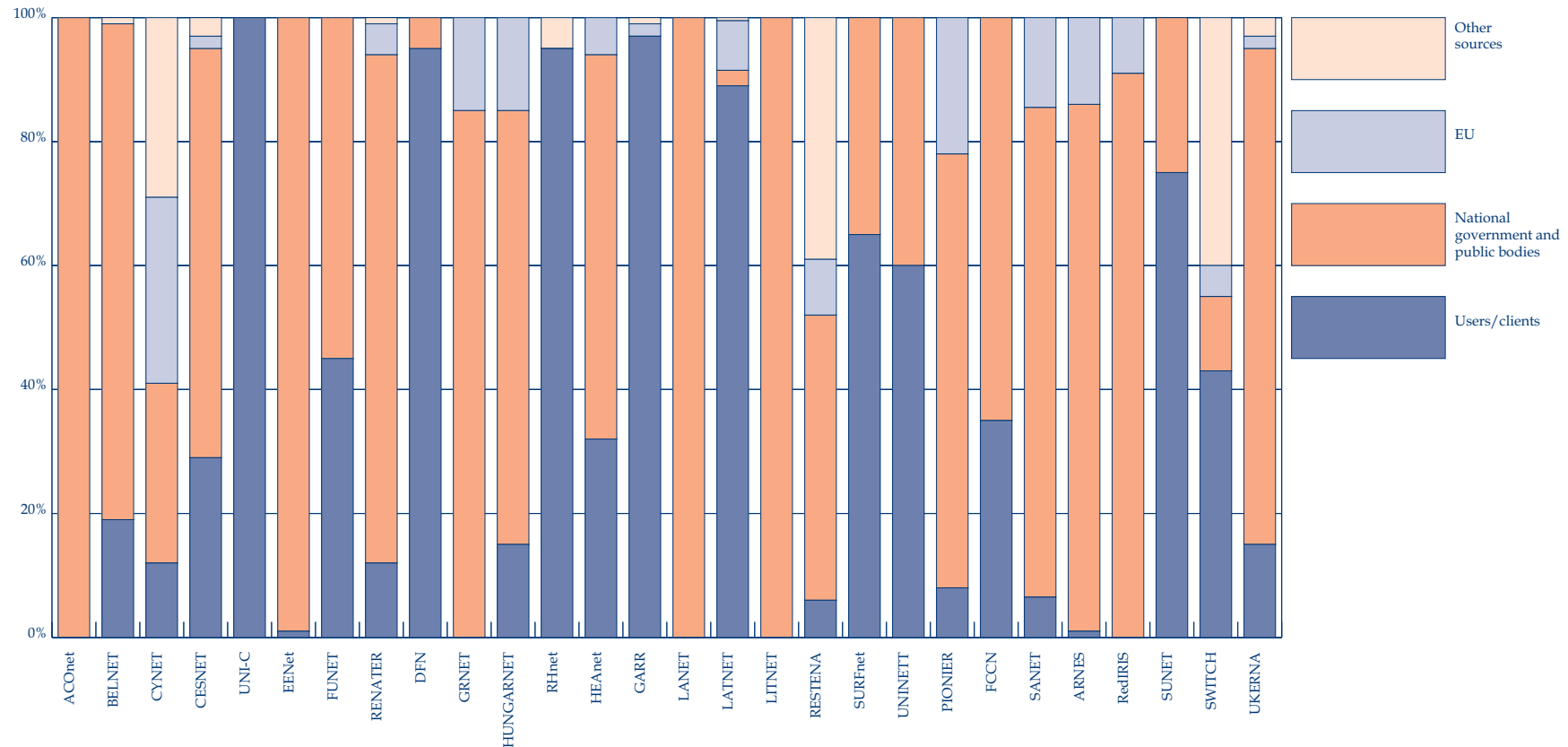
Graph 5.3.3 Total budget 2003 and 2004, other countries



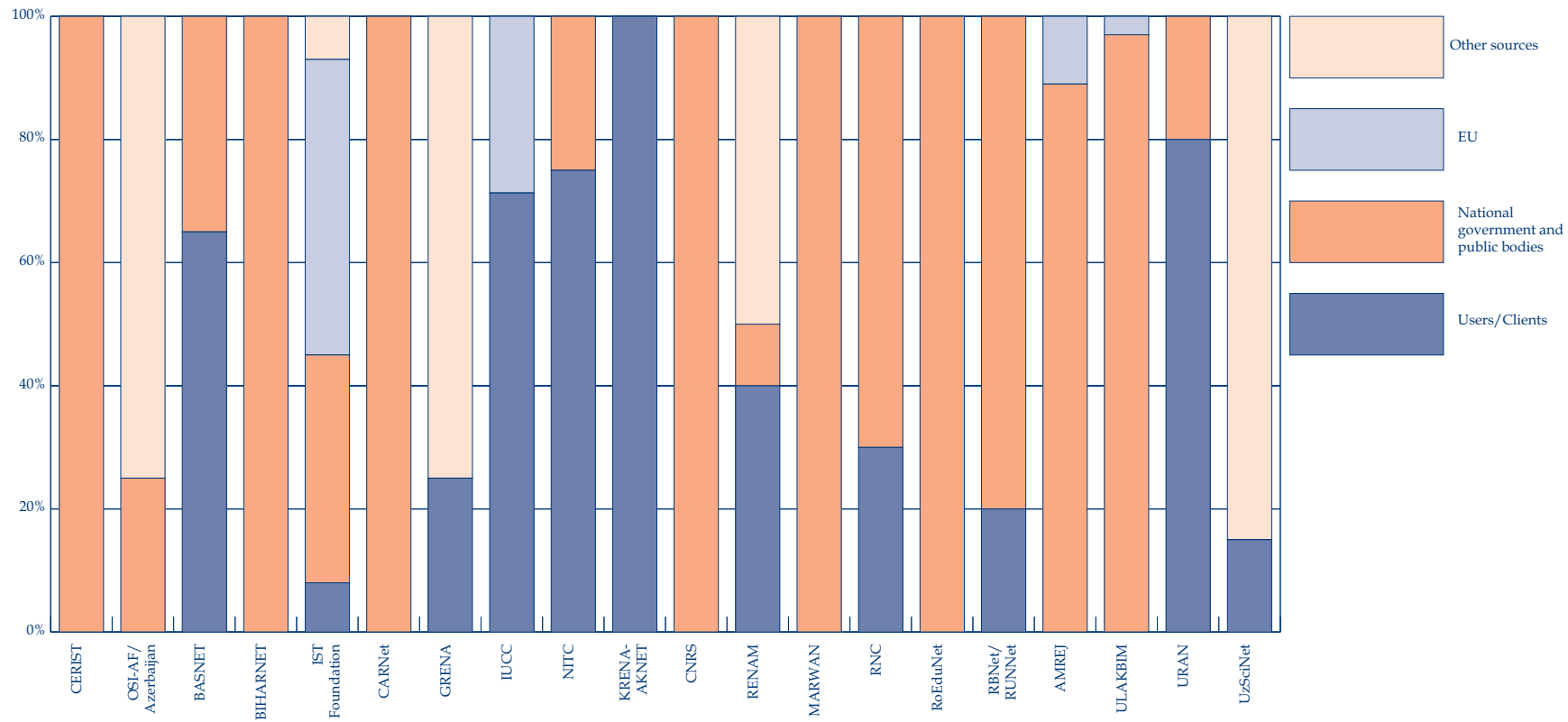
5.4 Income Sources

NRENs are funded in different ways: some receive their funding directly from the National Government, others are funded by their users (who may in turn be government-funded). Graphs 5.4.1 and 5.4.2 give information on what percentage of NREN funds come from which source and clearly show the differences. Note that in many cases (see also table 5.5.1) the amount of funding received from the EU is not shown in this table.

Graph 5.4.1 Income sources, EU and EFTA countries



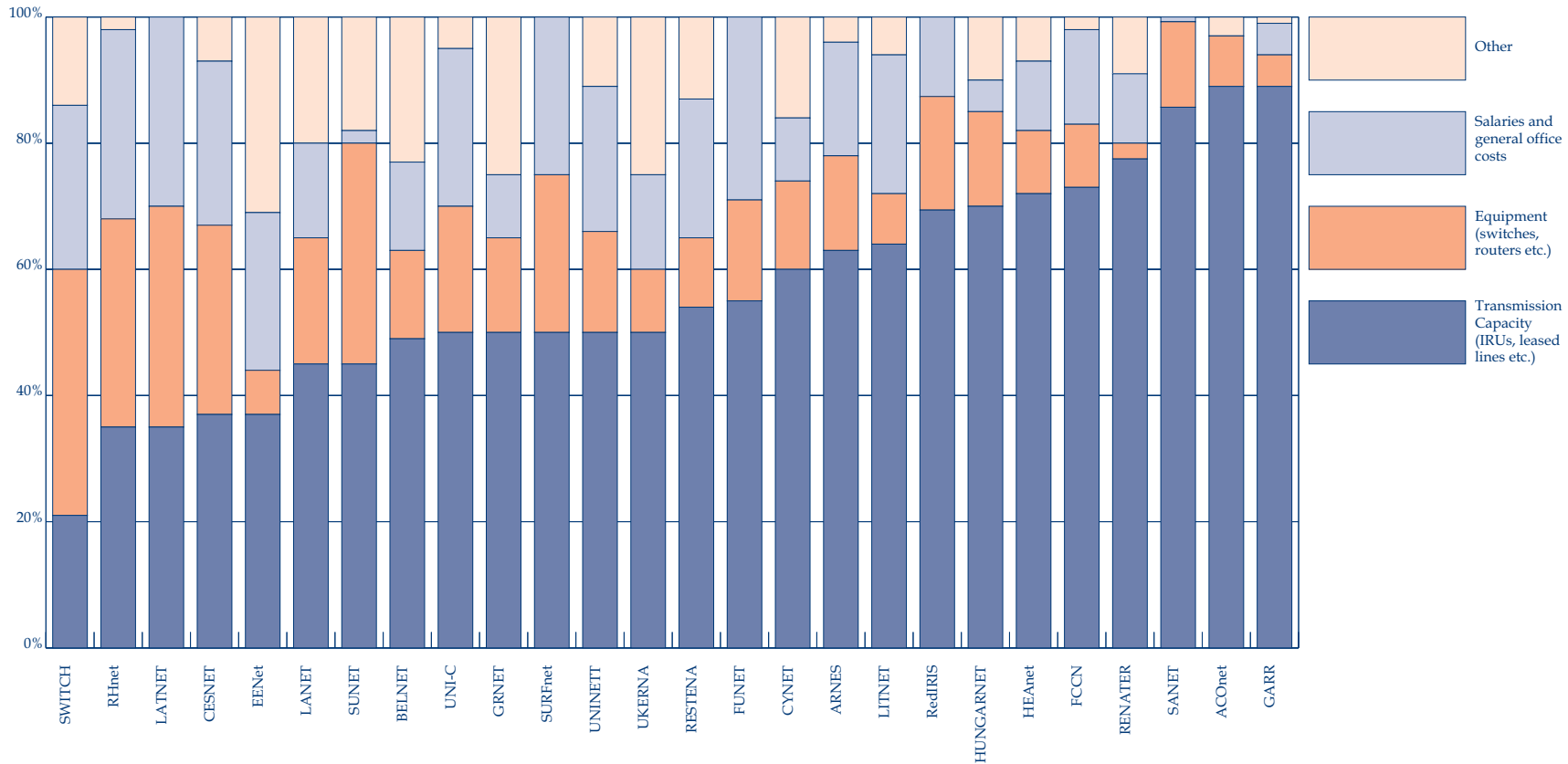
Graph 5.4.2 Income sources, other countries



5.5 Expenditure Categories

Graphs 5.5.1 and 5.5.2 below show which percentage of NREN income is spent on which categories of expenditure. For ease of readability, the data has been sorted in the order of the largest expenditure category, which for most NRENs is the transmission capacity. Note that not everything may be funded through the NREN budget in all countries. More information about this can also be found in the “Focus Study on Funding, Management and Operation of European Research Networks analysed by network hierarchy” by John Martin and Baiba Kaskina, TERENA, May 2004.

Graph 5.5.1 Expenditure by category, EU and EFTA countries



Graph 5.5.2 Expenditure by category, other countries

