



Networks for Knowledge and Innovation

A Strategic Study of European
Research and Education Networking

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TERENA Secretary General

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www.terena.nl



The recommendations from the
SERENATE project:

Strategic choices for research & education
networking in Europe



What was SERENATE?

- SERENATE (May 2002 – December 2003) was a series of strategic studies into the evolution of research & education networking in Europe over the next 5-10 years.
- SERENATE was funded by the EU as an accompanying measure in the 5th Framework Programme.
- Project partners were TERENA, DANTE, CTI, the Academia Europaea and the European Science Foundation.
- SERENATE has produced 15 public reports, which are all available from

www.serenate.org/publications/



The SERENATE results have been achieved thanks to the work of many people.....



Special thanks are due to:

- Knud Erik Skouby (CTI), Claire Milne (Antelope Consulting) and Dai Davies (DANTE) for the studies on telecommunications regulations and markets
- Valentino Cavalli and John Dyer (TERENA), Robert Sabatino and Michael Enrico (DANTE), Eoin Kenny (HEAnet), Michal Przybylski (PSNC) and Stanislaw Sima (CESNET) for the study on technical developments
- Ian Butterworth (Academia Europaea) for the study on the requirements of researchers
- Sabine Jaume-Rajaonia (Renater) for co-ordinating the case studies about “other users”
- Marko Bonač (ARNES) for the study on the digital divide
- Jean-Paul le Guigner (CRU) and Brian Gilmore (University of Edinburgh) for the contributions about campus issues
- David Williams (CERN) for leading the SERENATE project and coordinating the formulation of the conclusions



Executive summary of the SERENATE Final Report



1. Introduction
2. The organisational model
3. Optical networking is coming and everyone can and should participate
4. Very demanding applications are coming and need careful attention
5. There is a digital divide inside the European research & education community
6. The campus is often the weakest link in the network chain
7. Users need end-to-end quality, a compatible European AAI, and value-added services
8. Inclusiveness of the user community of an NREN can only be determined nationally, but obvious economies of scale exist for small countries
9. There is a crucial role for the European Union



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1. Introduction (1/2)

- The Internet had its origins in the world of research and universities. Today, many years later, and despite enormous changes, research networks are still the most advanced part of the Internet.
- Technologies and applications find their way from research networks to the general Internet. Research networks are an important source of innovation.



1. Introduction (2/2)

- The liberalisation of telecommunications markets has had an enormous impact. Prices to be paid to telecommunications operators have been reduced enormously.
- Europe is now a world leader in many aspects of research networking.
- However, progress has not been uniform.



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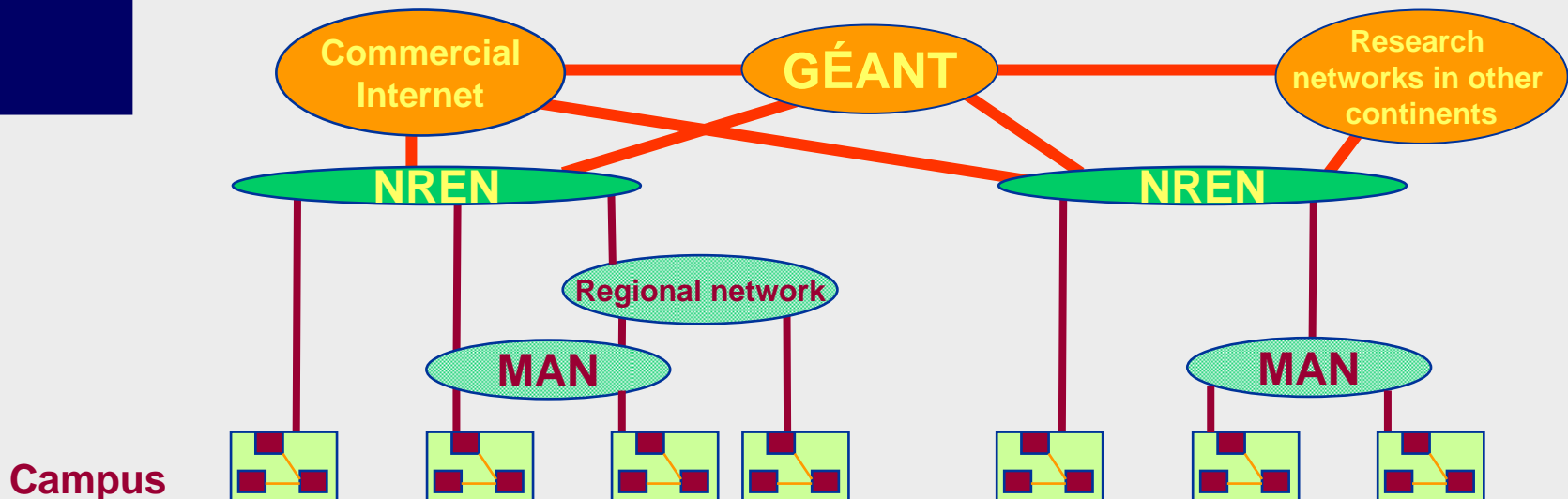
2. The organisational model (1/7)

- In Europe, research network services are organised at three (or four) levels:
 - the Local Area Network (campus)
 - the national network provided by the National Research and Education Network organisation (the NREN)
 - international connectivity in Europe provided by GÉANT
 - [intercontinental connectivity]



2. The organisational model (2/7)

- Peering with the commercial Internet takes place both at the NREN level and at the GÉANT level.
- Connectivity to research networks in other continents is through GÉANT or is provided directly by the NREN.
- In some countries, campuses are connected to the national networks via MANs and/or regional networks.





Intermezzo – TERENA and DANTE

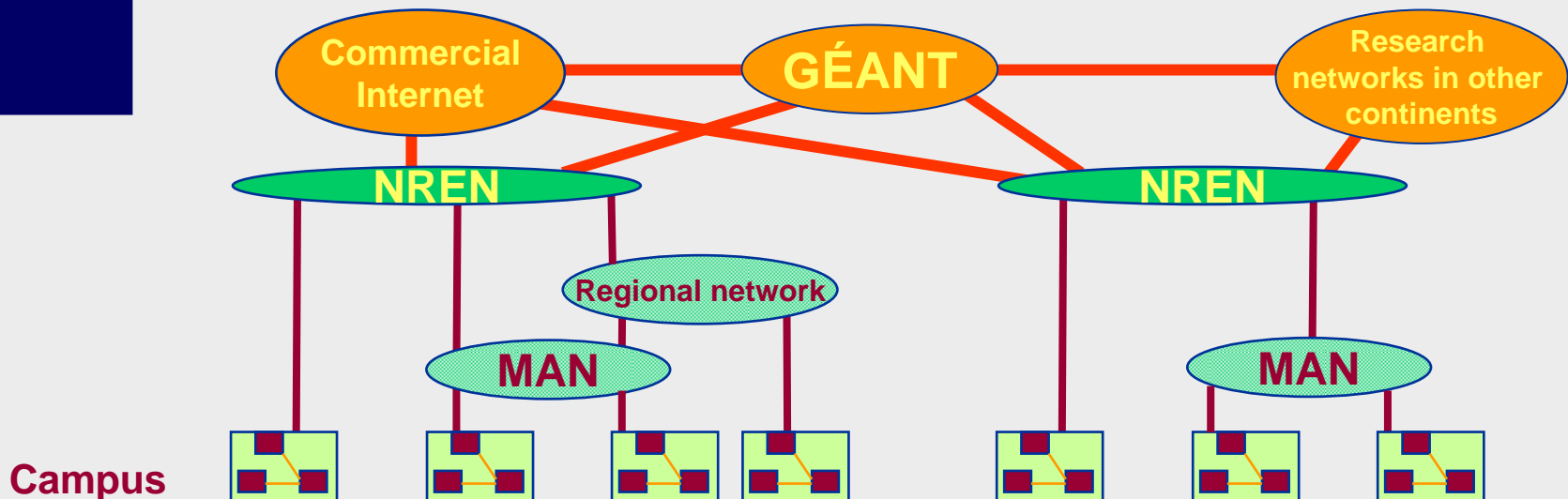
The NRENs in Europe have created two pan-European organisations:

- *DANTE organises, manages and provides the GÉANT interconnect network and intercontinental connectivity*
- *TERENA pursues four main categories of activities:*
 - *fostering new initiatives*
 - *supporting joint European work in developing and testing new technologies and services*
 - *organising conferences and workshops, and promoting knowledge transfer to less advanced regions*
 - *representing the common interests and opinions of the member organisations*



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2. The organisational model (3/7)

- All these networks are run by different organisations.
- A network session between research establishments in two different European countries involves at least five organisations.
- In some countries, MANs and/or regional networks add extra complexity.



2. The organisational model (4/7)

- The European organisational model, with a single NREN per country and close collaboration at the European level, has been a success factor for research and education networking. It is increasingly being copied in other continents.
- We expect this model to remain a key to success for at least the next 5-10 years.



2. The organisational model (5/7)

- NRENs are very different as regards organisation, tasks, staff size, budget etc.
- Directly or indirectly, research & education networks are largely funded from taxpayers' money. But the paths along which the funds are channeled from the government to the responsible organisation may vary.



2. The organisational model (6/7)

- For NRENs, a mixed system of funding can work well, if expenditures of long-term benefit are centrally funded and some of the services whose costs can be directly related to individual connected institutions are funded through those institutions.
- It is not advisable to introduce charging at a lower level in the organisation than the central budget of the university, research centre etc.
- New, very demanding applications may make changes to the funding model necessary.



Intermezzo – Focus Study (1/6)

- *The Annually, TERENA publishes the TERENA Compendium of National Research and Education Networks in Europe*
- *In 2002 and 2003, this publication has been co-funded by the European Commission through the COM-REN project*
- *Also as part of the COM-REN project, TERENA will publish in July 2004 a Focus Study on Funding, Management and Operation of European Research Networks*



Intermezzo – Focus Study (2/6)

The network hierarchy:

- *External: international connections to other research networks (mostly via GÉANT) and connections to the commercial Internet*
- *Backbone: the core of the national research and education network*
- *Access: the connections linking the LAN of an institution to the backbone network*
- *Regional: regional networks and/or MANs*



Intermezzo – Focus Study (3/6)

Responsibility for funding:
(N=24)

| | national gov. | regional gov. | local gov. | user institutions | EU | NREN | other |
|----------|------------------|------------------|---------------|----------------------|----|------|-------|
| external | 13 | | | 10 | 23 | 8 | 2 |
| backbone | 13 | | | 8 | | 8 | |
| access | 7 | 1 | | 16 | | 5 | |
| regional | 8 | 2 | 2 | 12 | | 2 | 2 |
| campus | 1 | | | 24 | | | |



Intermezzo – Focus Study (4/6)

Percentage of funding from various sources:

(N=24)

| | national gov. | regional gov. | local gov. | user institutions | EU | other |
|----------|---------------|---------------|------------|-------------------|-----|-------|
| external | 49% | | | 28% | 22% | 1% |
| backbone | 60% | 1% | | 37% | | 2% |
| access | 38% | 1% | | 61% | | |
| regional | 28% | 11% | 12% | 47% | 2% | |
| campus | 8% | 1% | 3% | 88% | | |



Intermezzo – Focus Study (5/6)

Sources of funding for external connectivity:

(N=18)

| | national gov. | user institutions | EU | NREN | other | average expenditure |
|--|---------------|-------------------|----|------|-------|---------------------|
| to other research networks | 14 | 5 | 18 | 3 | 2 | 1.78 M€ |
| to commercial Internet (national) | 7 | 4 | | 2 | 1 | 0.09 M€ |
| to commercial Internet (international) | 10 | 7 | | 3 | | 0.94 M€ |



Intermezzo – Focus Study (6/6)

Trends in funding for research networking:
(N=24)

| | up | no change | down | other |
|-----------------------------|----|-----------|------|-------|
| from last year to this year | 4 | 16 | 0 | 4 |
| from this year to next year | 3 | 12 | 4 | 5 |



2. The organisational model (6/7)

- For NRENs, a mixed system of funding can work well, if expenditures of long-term benefit are centrally funded and some of the services whose costs can be directly related to individual connected institutions are funded through those institutions.
- It is not advisable to introduce charging at a lower level in the organisation than the central budget of the university, research centre etc.
- New, very demanding applications may make changes to the funding model necessary.



2. The organisational model (7/7)

- Strict adherence to an official Acceptable Use(r) Policy will avoid complaints about unfair competition.
- If there are any problems when research networks are opened up for schools, libraries, museums etc., it is more about conflicts with general public-sector networks than with commercial service providers.



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3. Optical networking is coming and everyone can and should participate (1/5)

- The move towards optical techniques in data transmission is a fundamental change that will not be reversed.
- Likely impacts:
 - A major technical enabler for reducing costs and increasing bandwidth at constant costs (by improving fibres, lasers and receivers)
 - On a longer timescale, move to optical switching
 - Evolution towards hybrid networks (many-to-many via classic packet switching, and high-speed traffic few-to-few via optical paths)
- Direct access to fibres is a critical resource for research networks.



3. Optical networking is coming and everyone can and should participate (2/5)

- The current telecommunications regulations
 - have liberalised the markets, hence promoting competition, hence reducing prices
 - allow an NREN or any organisation to operate its own infrastructure (including construction, if that is what you want to do).



3. Optical networking is coming and everyone can and should participate (3/5)

- This exposes the costs of the components of what used to be a single bundled service:
 - access to optical fibre infrastructure
 - deployment of transmission equipment (including amplifiers and regenerators)
 - handling of back-up in case of break of service
 - operations
- Even if research network organisations do not want to operate their own infrastructure, they should understand these costs.



3. Optical networking is coming and everyone can and should participate (4/5)

- So there is a wide variety of offerings:
 - sale of optical fibre
 - long- and short-term lease of optical fibre
 - dark fibre or managed fibre
 - wavelength services
 - leasing SDH circuits
- Which commercial solution will be sustainable in the longer term?



3. Optical networking is coming and everyone can and should participate (5/5)

- Conclusions:
 - Optical-fibre infrastructure becomes an asset of crucial importance, not only for research and education, but for the economy and society in general
 - A competitive market should therefore be promoted
 - And access to fibre at reasonable prices should be ensured



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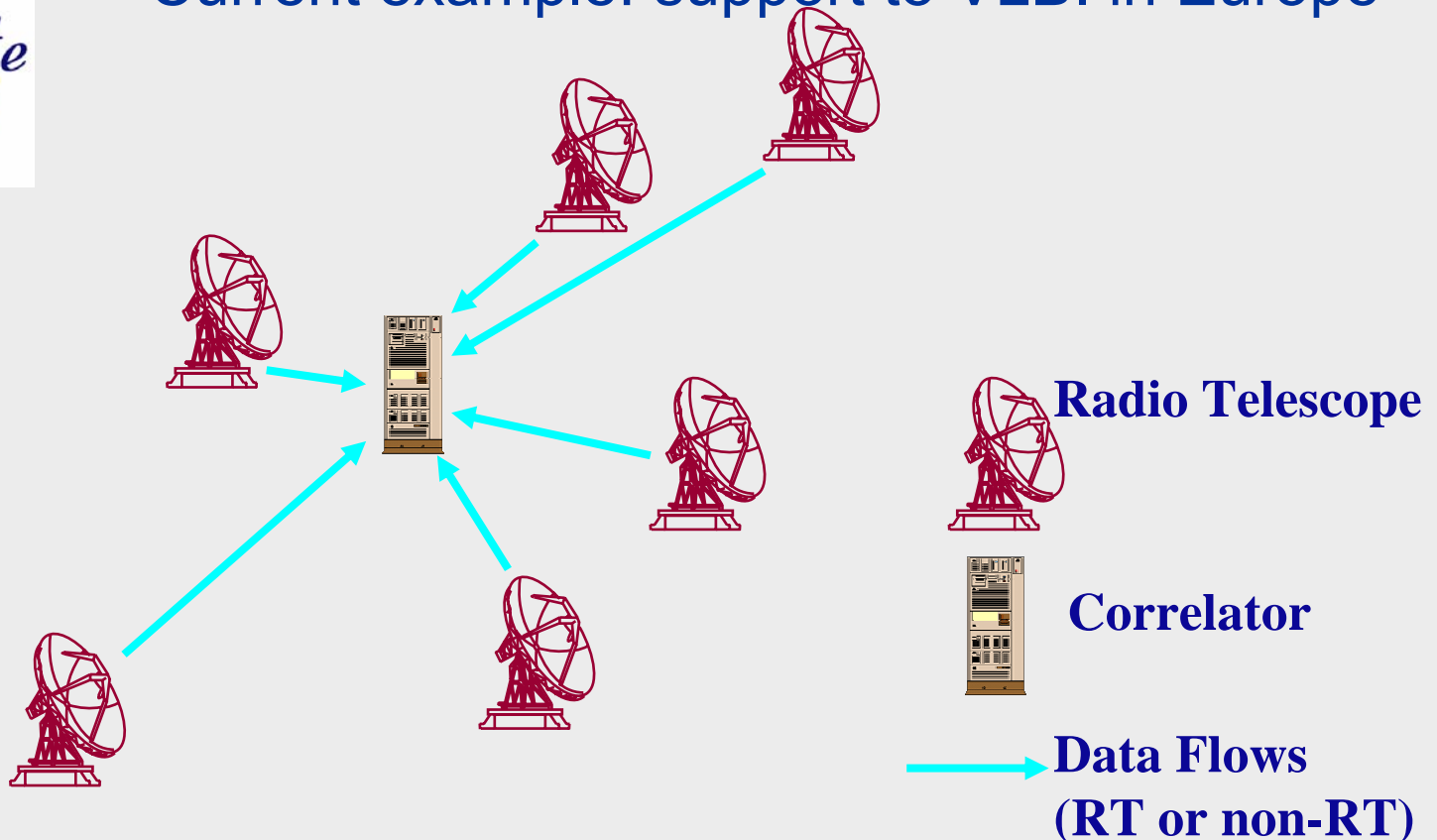
4. Very demanding applications are coming and need careful attention (1/6)

- In general, researchers appear to be satisfied with the progress in research networking in recent years.
- Network requirements will grow dramatically over the next 5-10 years, in all disciplines and in all countries.
- We heard examples where research would become much more efficient or where completely new research activities could be undertaken if networks were 10- or 100-times faster.



4. Very demanding applications are coming and need careful attention (2/6)

- Current example: support to VLBI in Europe

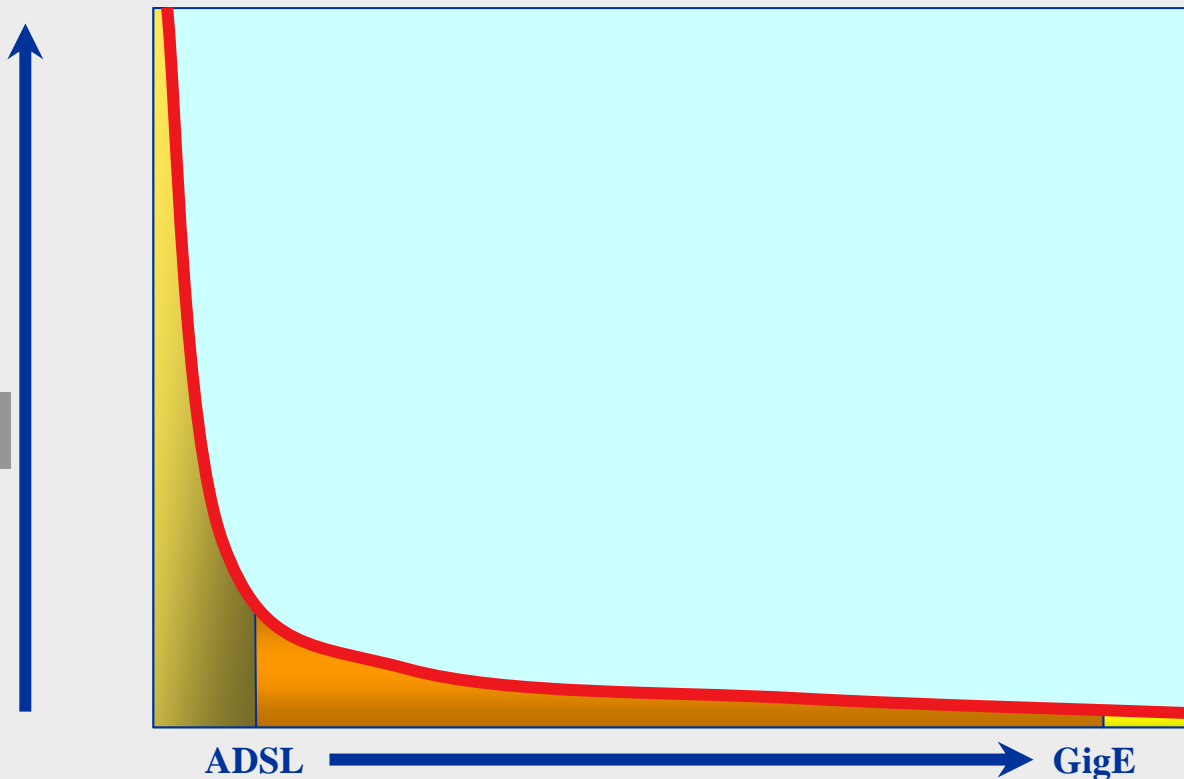




4. Very demanding applications are coming and need careful attention (3/6)

- There is a growing diversification of needs:

of users





4. Very demanding applications are coming and need careful attention (4/6)

- The most demanding scientific applications now require very high network capacities and put heavy demands on network availability and end-to-end performance.
- There are cases where a single instance of a new application (e.g. Grid transfer, remote immersive virtual-reality session) exceeds the aggregate flow that we usually see for a whole country with thousands of simultaneous users.



4. Very demanding applications are coming and need careful attention (5/6)

- In theory, a group of these most demanding users, based entirely at a small number of locations in countries with competitive pricing, might create their own private high-capacity network to serve the needs of a joint project.
- This would have very negative effects for all parties concerned.
- There is a benefit in using economies of scale, and a need to concentrate scarce resources; innovation depends on maintaining coherence.



4. Very demanding applications are coming and need careful attention (6/6)

- Existing research networks will be able to cater for the needs of the most demanding users, thanks to technical developments and market developments.
- But they will need to introduce new infrastructures, technologies and network architectures.
- And funding and cost-sharing models will need to be adjusted to accommodate the increasing diversity in network use.



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5. There is a digital divide inside the European research and education community (1/6)

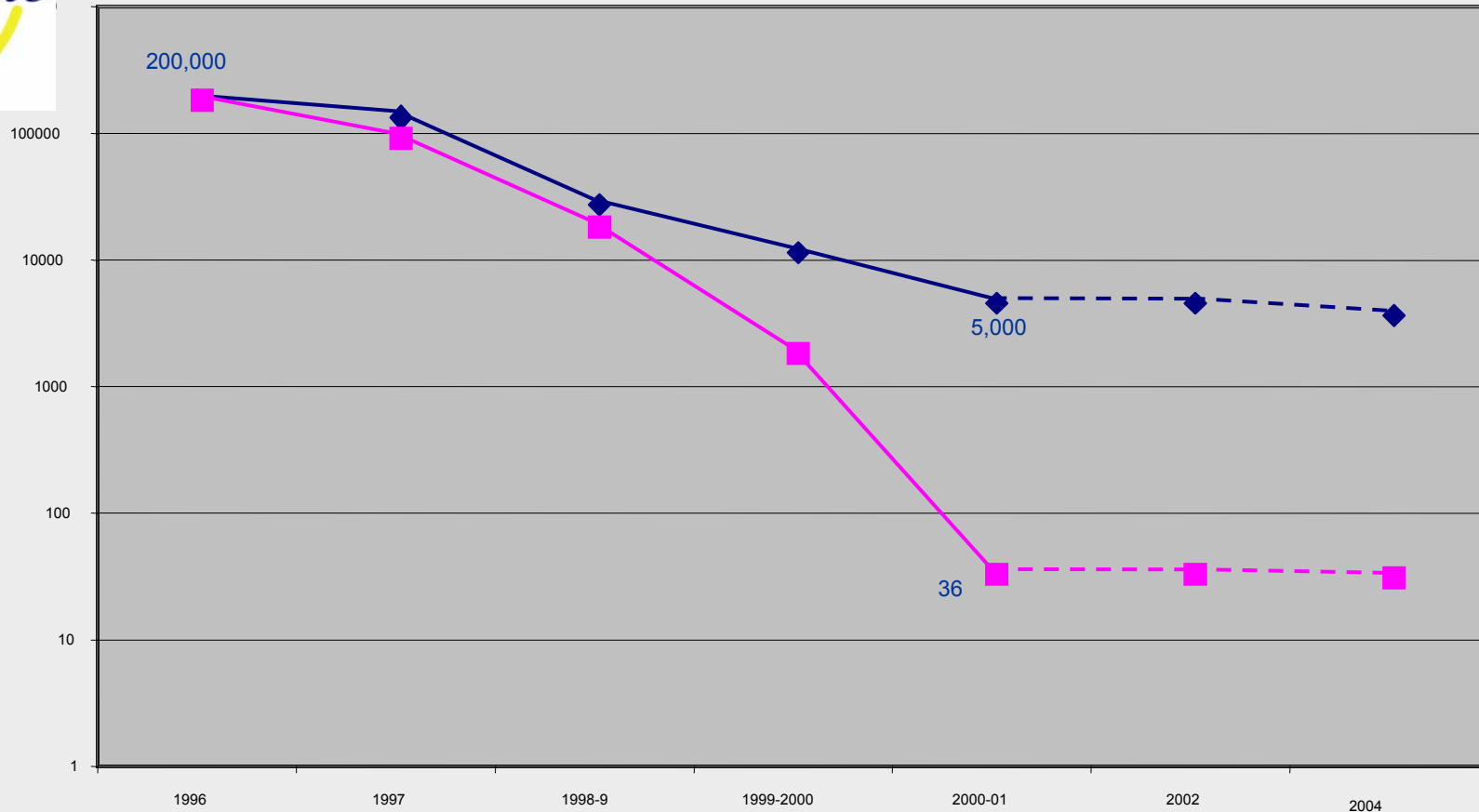
- One of the main objectives of the European Research Area and of the eEurope Action Plans is to provide equal opportunities to researchers, teachers and students, independent of location.
- Unfortunately, there is a significant digital divide between countries in Europe with respect to the network infrastructures and services that are available to the national research and education communities.
- Actually, such digital divides even exist within (otherwise advanced) countries.





5. There is a digital divide inside the European research and education community (2/6)

- Price decreases have been enormous but not uniform:





5. There is a digital divide inside the European research and education community (3/6)

- Pricing is far from uniform – between countries:

International Connectivity Costs in the Differing Market Segments

| Market segment | Number of Countries | Cost Range |
|--|---------------------|------------|
| Liberal Market with transparent pricing | 8 | 1-1.4 |
| Liberal Market with less transparent pricing structure | 7 | 1.8-3.3 |
| Emerging Market without transparent pricing | 3 | 7.5-7.8 |
| Traditional Monopolist market | 9 | 18-39 |





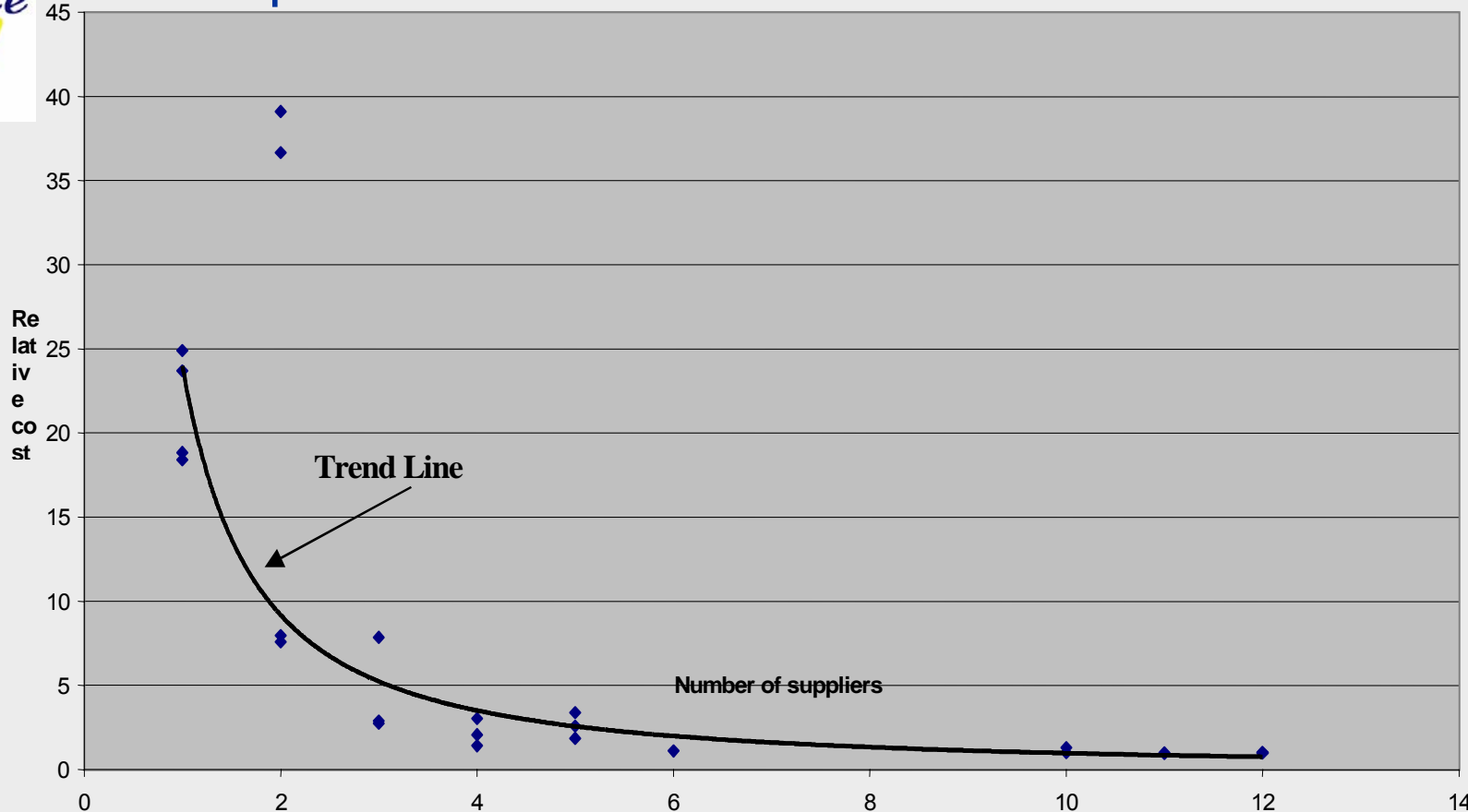
5. There is a digital divide inside the European research and education community (4/6)

- How is this possible? Officially, the EU regulations about telecommunications markets liberalisation have been implemented in all EU member states and candidate member states. In reality, the situation leaves much to be desired in a number of countries. Consequences:
 - no real competition between network carriers
 - no access to fibre for research networks (and others)



5. There is a digital divide inside the European research and education community (5/6)

- You need at least 4 operators to have real competition:





5. There is a digital divide inside the European research and education community (6/6)



- Conclusions:
 - The EU institutions and national governments should take energetic measures to reduce the digital divide.
 - Creating a truly competitive telecommunications market and access to infrastructures at reasonable prices is essential.
 - Investments in research & education networking are needed, including investments in infrastructure such as fibre. (The EU's Structural Funds should be used for this.)



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6. The campus is often the weakest link in the network chain (1/3)



- Campus networks:
 - In recent years, research networks at the national and international level have achieved substantial improvements.
 - Campus networks are now often the weakest link in the chain of end-to-end services.
 - Investments are needed.
 - In general, expenditure for ongoing technical upgrade in campus networks is best treated as a budget expense on an annual basis.



6. The campus is often the weakest link in the network chain (2/3)



- Regional networks:
 - There are positive aspects to regional networks, especially their function to facilitate and promote the use of data networks in all sectors in a region.
 - However, there are risks in introducing regional networks as an intermediate level between local and national research networks:
 - technical and managerial choices tend to be the lowest common denominator of the requirements of very different user groups
 - regional authorities with no responsibility for research and higher education will not give priority to the networking needs of those communities
 - without strict coordination, different regional authorities will opt for different, and often incompatible, technical solutions.



6. The campus is often the weakest link in the network chain (3/3)



- Regional networks:
 - In countries where the campus LANs are connected to the national research network via regional networks, the regional networks are often seen as a barrier for the provision of high-capacity transmission and end-to-end service.
 - If regional networks are used, then it is essential to have extremely close coordination between all the regional networks in a country and the NREN. The coordination must cover investment planning, policy setting, technology choices and their evolution, and operations.



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7. Users need end-to-end quality, a compatible European AAI, and value-added services (1/2)

- The expectations of network users have moved beyond the provision of pure bandwidth to more complex services.
- There are concerns about security, privacy and confidentiality.
- There will be a strong demand for authentication and authorisation services (for access to facilities, research materials etc.)



7. Users need end-to-end quality, a compatible European AAI, and value-added services (2/2)

- Increasingly, researchers and teachers want to be able to access networks and their own usual set of network and information services wherever they happen to be.
- The establishment of a pan-European Authentication and Authorisation Infrastructure will be an important contribution to meeting these requirements.



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8. Inclusiveness of the user community of an NREN is a national decision (1/3)

- Several national governments in Europe have initiated projects to provide network connections and services to schools, libraries, museums and other public institutions.
- Some of these initiatives involve the NREN, but others do not.
- Such initiatives, and the way they are implemented, have to be decided at the national level.



8. Inclusiveness of the user community of an NREN is a national decision (2/3)

- Greater “inclusiveness” is particularly important for small countries. By extending their user community beyond research and higher education, NRENs in small countries can achieve a critical mass and economies of scale that are obtained naturally by NRENs in large countries.



8. Inclusiveness of the user community of an NREN is a national decision (3/3)



- Conclusions:
 - If network connections and services are to be provided through the NREN in a given country, then adequate resources must be allocated, additional to those needed to cater for the needs of the research and higher-education communities.
 - Whatever detailed organisational and funding arrangements are made, it is essential to have excellent cooperation between all organisations providing network connections and services for primary and secondary education, for lifelong learning, for higher education and for the research community.



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9. There is a crucial role for the European Union (1/3)



- The importance of government support:
 - Research & education network organisations are most effective when they have good relations with their user community, and are recognised by their national government as an important and effective tool for advancing the pursuit of the “knowledge society”.
 - It is not easy to be a research & education network organisation, because you are the focal point for multiple tensions.



9. There is a crucial role for the European Union (2/3)

- The role of the European Commission:
 - The EC should continue to play the federating role that it has so effectively assumed over the past seven years in enabling interconnection of European national research networks.
 - The money helps, but the EC are the only people with the political authority to guide people to decisions.
 - They will also have an important role in extending the borders of “European” research networking.



9. There is a crucial role for the European Union (3/3)



- Conclusion:
 - The European Council and the European Parliament should ensure that the European Commission continues to play a significant role in enabling Europe's research & education networks to remain competitive at a global level. There will be no successful European Research Area without the long-term commitment of adequate resources to the evolution of Europe's research and education networking.



And what next?



The follow-up of SERENATE

- The conclusions and recommendations of the SERENATE studies will be used for the planning of new generations of networks
 - at the campus level
 - at the national level (the national research & education networks)
 - at the European level: GÉANT (the GN2 project proposal)



The GN2 project (1/2)

- September 2004 – September 2008 (?)
- a contribution of 93 million euro from the EU
- an Integrated Infrastructure Initiative, which combines:
 1. Specific Service Activities (the successor network to GÉANT)
 2. Joint Research Activities
 - Performance Measurement and Network Management
 - Security
 - Development of new services
 - Testbeds
 - Ubiquity / mobility
 3. Networking Activities
 - (.....)



The GN2 project (2/2)

- an Integrated Infrastructure Initiative, which combines:
 1. Specific Service Activities
 2. Joint Research Activities
 - (.....)
 3. Networking Activities
 - Dissemination, publications, demonstrations
 - User support
 - Support to research & education networking development
 - TERENA Compendium
 - Actions to reduce the digital divide
 - Collaboration through the TERENA Task Forces
 - Conferences and events
 - “SERENATE 2”



More information about TERENA activities:
www.terena.nl

And all SERENATE reports are at:
www.serenate.org/publications/

Thank you!