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South-East Europe Fibre Infrastructure for Research and Education

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White Paper: Strategic Report on SE European Fibre Infrastructure for Research and Education

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Abstract: This deliverable is a brief executive summary of the SEEFIRE project addressing the digital divide and inhibitors of research and education networking in SEE countries as well as the potential impact of NREN-initiated efforts for dark-fibre acquisition. This deliverable is based on a preliminary version (v0) that was made available to the European Commission for comment and was distributed to participants at the SEEFIRE policy workshop held on 17 January 2006 in Bucharest, Romania.

The SEEFIRE Project

The SEEFIRE Project is a special support action co-funded by the FP6 IST programme of the European Commission. SEEFIRE builds on the success of previous activities and projects, including SEEREN, to support research and education networks in southeast Europe and will provide input for preparing the next-generation networks for research and education in the region. The 12-months' project started on 1 March 2005 and will:

- establish a benchmark of existing and potentially available optical fibre for NRENs in the region;
- make an analysis of the technical options available for the deployment of dark fibre and the management of optical transmission by NRENs in the region;
- report on economic aspects and regulations;
- disseminate information and increase awareness about dark-fibre deployment both at technical and policy-making levels.

The recent progress in technology for optical transmission at high speed has made the deployment of owned or leased fibre networks a reality for NRENs. SEEFIRE will make a first step in the direction of a cost-effective gigabit network in southeast Europe, connecting researchers and universities in the region with other research users in Europe and worldwide. In doing so, the project will contribute to reducing the digital divide that affects several countries in southeast Europe, due in part to past political and economic circumstances.

The SEEFIRE Consortium consists of:

TERENA (co-ordinating contractor)	The Netherlands
GRNET	Greece
CESNET	Czech Republic
NIIF/HUNGARNET	Hungary
AMREJ	Serbia and Montenegro
DANTE	United Kingdom
RoEduNet	Romania
ISTF	Bulgaria
MARNet	FYROM
ASA	Albania
BIHARNET	Bosnia and Herzegovina

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1. Executive Summary

The “South-East Europe Fibre Infrastructure for Research and Education” project (SEEFIRE) was a one-year project co-funded by the European Commission in the 6th Framework Programme, and studied the opportunity for the acquisition of (dark) fibre networks by National Research and Education Networking organisations (NRENs) in southeast European (SEE) countries, in particular, Albania, Bosnia and Herzegovina, Bulgaria, the Former Yugoslav Republic of Macedonia, Greece, Hungary, Romania, and Serbia and Montenegro.

The SEEFIRE project partners are the NRENs in the countries mentioned above, plus CESNET (the NREN of the Czech Republic), DANTE and TERENA (the co-ordinating partner).

Between March 2005 and February 2006, SEEFIRE has carried out a number of studies regarding the availability of optical fibre in the southeast European countries concerned, the technological and economic aspects of deploying one's own (dark) fibre and lighting fibre (optical transmission) by NRENs, as well as the regulatory and legal issues related to fibre ownership by NRENs in the region. Those studies demonstrate the feasibility for NRENs in the countries concerned to deploy a dark-fibre network infrastructure at the local, national and regional level, thereby making a significant step towards reducing the divide with other European countries.

This White Paper provides a strategic outlook on the development of research and education networks in southeast Europe and a summary of the project findings. The document incorporates the feedback received from project partners, European Commission officers and the participants in the SEEFIRE Policy Workshop, which was held on 17 January 2006 in Bucharest, Romania.

Due to the EU enlargement process, southeast European countries are closer to the European Union than they were ever before. International policies in these countries are therefore converging towards the ultimate goal of integration and approximation to the standards of the Acquis Communautaire. However, there are still huge inhibitors in place in the region, acting at the political and economic levels. The major obstacle to improving research and education network provision at international, national or university level is the extremely high pricing of telecommunication links. This is the result of the lack of competition and frequently persisting dominance of (ex-) monopoly telecommunications operators. Although the market has been formally liberalised, the situation in southeast Europe today is still very similar to the one which existed in the countries of the European Union ten years ago, and the measures which need to be taken are the same: it is vital that the market for electronic communications in the region will be fully and effectively liberalised as quickly as possible.

If measures are not taken, the research exclusion in southeast Europe will obstruct attempts to complete the realisation of the European Research Area (ERA). Stakeholders of NRENs in SEE should be aware of the risks of information exclusion and recognise the need to close the digital divide as the only way to follow the lead of eEurope in building an Information Society.

Various international initiatives have been supporting NRENs in the region through a number of past and current network infrastructure projects, like SEEREN/SEEREN2, co-funded by the European Commission, and the SEELight initiative, led by GRNET, the Greek NREN, under the Hellenic Plan for the Economic Reconstruction of the Balkans (HiPERB). Thanks to these projects, NRENs in the countries concerned are obtaining better connections to research and education networks in other countries, are able to participate in eInfrastracture research projects (like SEE-GRID) and are moving, slowly but steadily, towards a recognised international role (including TERENA membership and involvement in the GN2 project).

But international support on its own is not sufficient to make any substantial impact on the development of research and education networking in the less advanced regions in and around Europe. The responsibility for that development lies with the national stakeholders, and it is from there that the main policy impetus and the majority of the necessary resources have to come. As an example, even the very successful SEEREN project was not sufficient to ensure that the international links it had established to the GÉANT network could effectively be used by the research and education communities of Albania and Bosnia and Herzegovina because of the lack of a nation-wide university network in these countries.

A national network backbone connecting all research and education institutions in a country is a vitally important infrastructure. Governments have a special role and obligation to make an adequate communication infrastructure available to the research and education communities via the NREN. First and foremost, the SEE governments should enable, encourage and, if necessary, require NRENs to own their infrastructure for local, national, cross-border, regional and global connectivity when no suitable services are available or those available are offered at exorbitant price. SEEFIRE demonstrates that an optical fibre infrastructure provides considerable economic and technical advantages, and should be the solution of choice. To facilitate this, governments need to ensure that sufficient financial resources are made available to the NREN.

Optical fibre is accessible to NRENs in SEE. There are many fibre plants in the ground. Almost in all countries there is fibre which is owned by some utility company, railway company etc. in addition to the optical infrastructure of telecommunication operators. Because the telecom operators are not keen to sell or lease fibre, NRENs should intensify their discussions with those alternative suppliers and actively pursue the acquisition of fibre for their national network footprint. From the SEEFIRE dark-fibre footprint database it can be deduced that immediate access to dark fibre is available for the NRENs of Greece, Bulgaria, Romania, Serbia and Montenegro (parts of the country), and Bosnia and Herzegovina (parts of the country). There is actually competition along a number of routes in Greece, Bulgaria and Romania. By contrast, the NRENs of the FYR of Macedonia and Albania might face some difficulties in the immediate future and further actions to access dark fibres there have to be implemented.

The figure below shows the fibre availability in SEE. A single green line means available fibre offer on the route, a double line means competing fibre offers on that route. This figure only shows the availability of dark fibre as it results from the interest of fibre owners to offer dark fibre to NRENs; the actual availability of optical fibre in SEE is much larger and is not depicted in the figure.

Figure 1: Dark Fibre availability in SEE

The NRENs of Greece, Serbia and Montenegro and the FYR of Macedonia have already acquired dark fibre at local and/or national level and are in the process of extending their fibre footprint. As can be seen from the figure above, there are competing potential fibre offers for several routes in Bulgaria and Romania, which shows that the NRENs in these countries have a serious opportunity to leapfrog from the current situation to the latest, most advanced and cost-effective technology.

Certainly, significant funding is needed to support and sustain such developments. But the investment required for leasing dark fibre and deploying the required lighting equipment can bring a huge benefit in terms of network capacity and upgrade at marginal cost as compared to the cost of leasing network capacity from telecommunication operators.

SEEFIRE has explored a number of cost cases. Ballpark figures have been calculated for all countries in SEE, showing the order of magnitude of the investment required for leasing and lighting dark fibre on a 5-year basis. The parameters that have been used in the cost estimation are the following: 5-year fibre lease contract, including bundled fibre maintenance 3 €/m; transmission equipment at terminal node 100,000 €; in-line transmission equipment 50,000 €/100km; equipment maintenance 10% of the equipment cost per year. Co-location cost of in-line equipment was estimated for the worst case scenario (no university premises along the line and equipment hosted at carrier co-location premises) at 12,000 €/100km/year. These parameters can vary significantly, depending on the market development. They look fairly correct in the particular case of SEE and were found applicable across all countries.

The most significant parameter in estimating the cost of a dark-fibre network infrastructure is the route length, because beyond a certain distance more expensive equipment needs to be used to compensate the degradation of the optical signal. So, for instance, lighting fibre in a large country with large distances between university locations like Romania will be much more expensive than in a country like FYR of Macedonia, where a large part of the route lengths are shorter than 100km.

Indeed, as an example, 2.5 million euro is the estimated cost of leasing dark fibre and deploying transmission equipment to enable the NREN of FYR of Macedonia to leapfrog from the current situation of a core usable capacity at 2-34 Mbit/s and a lack of a national infrastructure, to a full interconnection of universities in the country at Gigabit speed. The estimated cost of a nationwide dark-fibre infrastructure in Romania, based on the same parameters, is 22.3 million euro. For a country like Bulgaria, the estimated cost of a dark-fibre infrastructure is 9.8 million euro.

Obviously these are not negligible figures, especially when considering that the full budget in 2005 of the three NRENs mentioned was 0.33, 2.6 and 0.65 million euro, respectively. But this shows that these NRENs are definitely under-resourced[1] and need significant high-profile investments by the respective governments.

The government counterparts of NRENs in SEE countries should make it a priority to speed up the process of building an Information Society in their own country, by providing appropriate computer networks for use by research and education. They should make sure that these networks are advanced and able to deliver services comparable to those in the rest of Europe in terms of quality and bandwidth, in order to enable innovative applications.

As a consequence, adequate and stable funding should be provided for the acquisition of a dark-fibre infrastructure for research and education at the local, national, regional and international level.

All countries in SEE should build on the example of those NRENs in the region that have acquired dark fibre.

To facilitate the acquisition of dark fibre it is essential to speed up the liberalisation process in the countries through appropriate regulatory and legislative intervention.

[1] As a matter of fact, many NRENs in SEE are understaffed and the staff is underpaid, with the result that staff members often migrate to the commercial sector.

2. Status of Research Networking in SEE and recommendations

The SEEFIRE project ran from March 2005 until the end of February 2006. The rationale for the SEEFIRE project lies in the digital divide that affects research and education networking in southeast Europe and in the benefits for NRENs in the region of acquiring dark-fibre networks. This chapter provides an overview of the status of research and education networking in SEE and a few recommendations for advancing it to the level of other, leading-edge European networks. These recommendations are supported by the findings described in the next chapter.

The status of research and education networking varies a lot in southeast Europe. The region includes countries that have joined the European Union a long time ago, like Greece, or more recently, like Hungary, and others like Croatia[2] that are not EU members. All these countries have very active, considerably stable and well-funded NRENs, with excellent expertise and a long-standing participation in research and education networking in Europe. There are countries in the region, like Romania and Bulgaria, which are in the process of joining the EU, but where the respective NRENs suffer from relatively low or unstable political support, partially obsolete legislation and market conditions that are not favourable to the development of research and education networking. The NRENs of all countries mentioned so far are members of CEENet, the Central and Eastern European Networking Association, and of TERENA, the Trans-European Research and Education Networking Association – with the exception of ISTF of Bulgaria, which is not a TERENA member - and participate in the GN2 project.

Another set of countries in the region includes Serbia and Montenegro and FYR of Macedonia. Although at different levels, both countries have relatively well organised NRENs and are moving fast in the deployment of their national networks. Actually AMREJ, the NREN of Serbia and Montenegro, is quite advanced in the deployment of dark fibre at metro and intercity level, and, together with the Hungarian NREN, has established the first cross-border fibre connection in the region (between Subotica in Serbia and Szeged in Hungary). MARNet, the NREN of FYR of Macedonia has built a Metropolitan Area Network in the country capital Skopje connecting university buildings by optical fibre. Both AMREJ and MARNet are members of CEENet and TERENA but do not participate in GN2, although representatives of the organisations are observers in the NREN Policy Committee, the governing body of the GN2 project.

Bosnia and Herzegovina and Albania do not have effective NRENs or proper national research and education networks in place at the moment, suffer from low political support and do not participate in either TERENA or GN2. It is also worth mentioning Turkey and Moldova here: although geographically belonging to the region and deserving appropriate attention, these two countries have not participated in the SEEFIRE project and are therefore not covered by this report.

As mentioned, in some of the countries above there is currently a lack of attention or only limited support from the respective governments for research and education networking. However, things are slowly changing. Candidate countries like Bulgaria and Romania are closer to integrating in the European Union than any other country in the region and the respective NRENs are participants in the GN2 project. Other countries find themselves at different stages of an ongoing dialogue process with the European Union. Therefore, EU integration and approximation to the EU Acquis Communautaire is a priority in the international agenda of governments in all the countries covered by the SEEFIRE studies.

In fact, some of these countries currently have direct access to GÉANT2, but many of them have no adequate national or local network infrastructure that is capable to adequately support the provision of the services that researchers, teachers and students need to collaborate with colleagues in their scientific disciplines in the country and abroad.

Based on the SEEFIRE study, the author of this report brings the following recommendations to the attention of stakeholders of NRENs in southeast Europe:

- The national stakeholders of NRENs in southeast Europe need to speed up the process of building an Information Society in their own country, by providing appropriate computer networks for use by research and education.

[2] Croatia is not directly involved in the SEEFIRE project

- These networks must be advanced and able to deliver services comparable to those in the rest of Europe in terms of quality and bandwidth, in order to enable innovative applications.
- These services cannot be supported at the level or price of connectivity that is currently offered by telecom operators or Internet Service Providers in the countries concerned.
- Incumbent telecom operators in the region are not keen to sell or lease fibre to NRENs. However, there are serious opportunities for research and education institutions and NRENs in the region to acquire optical fibre, because there are sufficient fibre plants in the ground, which are owned by, for instance, railways, oil/gas companies, power companies, and Internet Service Providers. Several alternative telecommunication operators and fibre owners are ready to offer fibre to NRENs in certain locations.
- There are no major obstacles from a regulatory point of view to the acquisition of (dark) optical fibre by NRENs, but the legislators should simplify the procedures that sometimes may make the acquisition very difficult or cumbersome.
- SEE countries now have a unique opportunity to follow the example of many countries in Europe and abroad that have been able to make giant leaps in the provision of high-speed networks, thereby enabling delivery of advanced services to users in a cost-effective way thanks to the acquisition of their own optical fibre networks.
- In particular, all countries in SEE should follow the example of those NRENs in the region that have acquired dark fibre.

3. Summary of SEEFIRE Findings

All SEEFIRE project findings, except the dark-fibre footprint database, are publicly available for download via the project website at http://www.seefire.org/publications. In this chapter we focus on the issues of market regulation, fibre availability and experiences with optical transmission in the region.

Telecommunications markets and regulations

There is a significant digital divide in the provision of computer networking services to researchers, teachers and students in Europe. Even within the EU member states there are significant differences between various regions, regarding, for instance, the network coverage of more isolated regions and/or the amount of network capacity which is available to certain universities or research facilities. In many cases this is due to the lack of business interest/competition in the provision of telecommunication services to certain, more peripheral locations.

The GÉANT2 network, co-funded by the European Commission and the National Research and Education Networks of Europe through the GN2 project, constitutes a fair model to provide the highest possible amount of capacity to the countries involved in the project. However, due to variation of the market, certain locations can be reached by dark fibre, enabling initial access capacity of at least 10 Gb/s and fast upgrades at marginal cost, whereas other locations cannot afford more than 155 Mbit/s (Bulgaria) or even 34 Mbit/s (Malta). Restricting this remark to the countries participating in the SEEFIRE project, one can say that this situation affects negatively countries like Greece, Bulgaria and Romania.

Other countries in the Balkans are much worse off. These countries are Albania, Bosnia and Herzegovina, FYR of Macedonia, and Serbia and Montenegro. Although far behind the status of EU member states, the penetration of ICT in these countries is relatively high. PCs and mobile phones are widely available and there are a number of competing Internet Service Providers. However, the market for fixed telecommunication services (and infrastructure) is still de-facto in a monopoly or quasi-monopoly situation in many of the countries concerned, and this makes access to infrastructure for non-commercial purposes practically unaffordable.

The SERENATE study[3] has identified a clear correlation between the liberalisation of the market for data communication and the prices of telecom services. The stronger the competition is in a country, the lower the prices are for network connectivity. The lack of competition is therefore one of the major components of the digital divide between different regions in Europe.

The regulatory environment in which southeast European NRENs will be operating over the next few years is changing and this will have positive implications for NRENs, with particular reference to their use of dark fibre. All countries in the region are moving towards the new EU regulatory framework for electronic communications, although they are at different stages in this process. Moves towards the new EU regulatory framework will be wholly positive for NRENs in the long term, although some discomfort may be experienced as traditional relationships are adjusted. Liberalisation will bring NRENs more choice and lower prices. Electronic communications regulations bearing directly on NRENs' operations are minimal, although care may sometimes be needed to ensure that networks do not inadvertently become classified as 'public'. More problems may be experienced in other legal and regulatory areas that are not specific to the communications industry, such as those governing the establishment of new businesses or use of rights of way. Successful transition to the new environment is mainly a matter of managing changing relationships with the incumbent telecommunications operator, ISPs, government and private-sector customers.

Optical fibre and optical transmission

The current development among NRENs in the world is that they are heading towards optical networks. These are enabled by dark fibre, i.e., optical fibre dedicated to use by a single organisation – in this case a research network organisation – where the organisation is responsible for managing the transmission equipment to 'light' the fibre. NRENs are keen to access dark fibre to improve their networks, rather than lease data transmission services from telecom operators or commercial Internet Service Providers (ISPs).

[3] The SERENATE project carried out studies into the evolution of European research and education networking. The project findings and recommendations are summarised in the report "Networks for Knowledge and Innovation": http://www.serenate.org/publications/d21-serenate.pdf

Using optical networks on a national and global scale is strategically important for the development of advanced science and research fields. These networks enable applications and projects that could not be realised using traditional telecommunication services.

In Europe an increasing number of NRENs, like SURFnet (Netherlands), SWITCH (Switzerland), DFN (Germany), CESNET (Czech Republic) and many more, have networks based on dark fibre. At the pan-European level, the new GÉANT2 backbone will have large parts of the international links based on dark fibre.

There are various possible types of dark-fibre acquisition by NRENs, including leasing fibre with or without maintenance, buying Indefeasible Right of Use (IRU) or laying one's own fibre.

The management of optical transmission by NRENs is made possible by widely available and cost-effective technology. This has proved to be the case particularly in countries with a monopolistic market environment, where leasing the fibre and lighting it has been a winning alternative compared to leasing expensive circuits from an incumbent operator.

SEEFIRE has identified more than 70 potential owners of fibre in the southeast European region from such business sectors as telecommunications, railways, transport/roads, power distribution, gas/oil distribution, cable TV and Internet Service Providers. SEEFIRE has contacted them by issuing a Request for Information about the specifications of fibre routes and spans. Responses have been provided to the participating NRENs on a confidential basis. An outlook on the fibre availability in SEE is provided in the figure in Chapter 1. The information collected was strategic for the preparation of the connectivity tender of SEEREN2 and for the preparation of the SEElight project proposal.

Experiences of fibre deployment in the region

Southeast European countries either do not have well-established NRENs and appropriate network infrastructure, like in Bosnia and Herzegovina and in Albania, or have NRENs whose networks are at the moment predominantly based on services from telecommunication operators (Romania, Bulgaria, Greece) or that are in the process of establishing dark-fibre infrastructure (Serbia and Montenegro, FYR of Macedonia, and Greece).

SEEFIRE has studied the organisational issues (staff directly involved in the operation of the dark-fibre network, their education, fibre ownership models, maintenance of the network) as well as the equipment that is needed in the operation of dark-fibre based networks. Examples from early deployments of dark fibre in European and southeast European NRENs show that the move from networks based on services from telecommunication operators to dark-fibre based networks entails some changes in the procedures of network design and maintenance, and also needs new knowledge from network designers and administrators. But the examples also show that those changes are not dramatic and can be afforded. The study demonstrates how any networking organisation, not only in SEE, which is building its network infrastructure from scratch can immediately join the latest technological wave and avoid investing in the equipment and technologies that are now a thing of the past in the developed European NRENs. Using faster telecommunication channels for an affordable amount of money is extremely important for the SEE region, as it will help to ease the digital divide and increase collaboration and knowledge transfer between researchers in SEE countries and with their counterparts world-wide.

