FP6 IST

SEEFIRE

South-East Europe Fibre Infrastructure for Research and Education

Deliverable 2.2

Support for Deployment of Customer Empowered Fibre Infrastructure

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Abstract: This deliverable gives guidelines for the deployment of customer empowered fibre infrastructure for SEE NRENs. Guidelines will show the examples and best practices of the technical organisation of the DF based NREN, L2 and L3 organisation and topology choices with new transmission technologies used with DF, transition from old Telco-based transmission technologies to new CEF based, some necessary hardware and software features of the equipment. This deliverable will also present samples of procurement documents used for successful purchase of DF and transmission equipment

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-month, project started on 1 March 2005, 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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Executive summary

What is the focus of this Deliverable?

Deliverable D2.2 gives guidelines for the establishment of the dark fibre network infrastructure based on best practices and examples of technical and organisational solutions from NRENs with early experiences with dark fibre deployment. The deliverable provides also examples of the documentation used for the procurement of dark fibre services and transmission equipment. These guidelines are of the utmost importance for SEE countries which either don't have established NRENs (Bosnia and Herzegovina, Albania) or have NRENs which are at the moment predominantly based on Telco services (Romania, Bulgaria, Greece) or are in the process of establishing a dark fibre network infrastructure (Serbia and Montenegro, FYROM and Greece).

What is next in the process to deliver the SEEFIRE results?

The document provides guidelines for the deployment of dark fibre network infrastructure and together with deliverable D2.1, published during November 2005 provides an input to a Strategic Workshop to be held in Bucharest in January 2006 and White Paper to be delivered in February 2006 about the possibilities to deploy cost-effective advanced transmission technologies.

What are the deliverable contents?

The Deliverable gives an overview of some organisational issues (staff directly involved in the operation of the dark fibre network, their education, fibre ownership models, maintenance of the network) from European NRENs with early experience with dark fibre.

The deliverable also informs the reader about these NRENs' experiences with the equipment which is needed in the operation of the dark fibre based network, and which is not transmission equipment covered in D2.1 (like splicing, cleaning, measurement equipment).

Another part of the deliverable provides examples of different technical solutions from SEEFIRE partner NRENs with dark fibre deployment. Examples cover different solutions for lighting dark fibre in metro, regional and cross-border cases.

Further on, Deliverable 2.2 gives case studies from SEE countries with the view of the future dark-fibre based national research and education networks, based on the findings published in WP1 (fibre routes, main PoPs), WP2 (transmission technologies) and technical workshop of the SEEFIRE project.

The last part of D2.2 contains model documentation used for dark fibre and transmission equipment procurement. Legislation for public tendering is similar in all SEE countries, and examples of such procurements can be of the greatest importance during the preparation of own tendering documentation for SEE NRENs, especially about the way to specify technical details of the equipment that is to be purchased or contract conditions for SLA and payments in case of dark fibre lease.

Conclusions

The information provided in this deliverable is meant to help NRENs who are moving or consider moving to own or lease optical fibre networks. Examples from early deployments of dark fibre in European and SEE NRENs show that the move from a Telco based NREN to a dark fibre based NREN entails some changes in the procedures of network design and maintenance and also needs new knowledge from network designers and administrators, but also that those changes are not dramatic and big. This deliverable gives examples of how SEE and other networks which are building its infrastructure from scratch can immediately jump into the latest technological wave and try to avoid investing into the equipment and technologies which are now past in the developed European NRENs. Using faster telecommunication channels for an affordable amount of money is extremely important for the SEE region and will help easing the digital divide and improve collaboration and knowledge transfer between researchers in SEE countries and abroad.

1. Introduction

Latest changes in technologies and mediums used in backbone of the European GÉANT2 network as well as in the growing number of European NRENs moving towards dark fibre give a clear sign of the direction in which other NRENs should move. Customer-empowered or dark-fibre networks give the users the opportunity to use reliable large telecommunication capacities, much easier upgrades, change topologies and different traffic protection solutions, which can be suitable for different applications, for a relatively small amount of money.

The idea of moving from leased digital telecommunication services, which where used in the majority of European NRENs, towards leased or owned dark-fibre based networks raises many questions about the changes in the way the NREN is functioning, required new profile of the network engineers, new knowledge needed for network operation, need to learn new technologies that such move might produce, etc. The aim of this Deliverable is to give some examples of different technical and organisational options that might inspire SEE NRENs to find the best solution for the deployment of the dark fibre in their environment. It can also be used as a collection of experiences with dark fibre from other NRENs for those NRENs considering transition to dark fibre or for those NRENs which don't have network infrastructure at all. For the latter it is very important to plan investments and have an overview of the latest technologies, equipment and technological trends.

At the beginning of the SEEFIRE project a questionnaire was sent to European NRENs with a consolidated experience in dark fibre network deployment (PIONEER, SURFnet, SWITCH, ARNES, SANET, CESNET, AMREJ). The questionnaire covered issues about fibre ownership and maintenance models used in those NRENs, number of dark fibre specialists and their education, equipment used in everyday network maintenance and monitoring, apart from transmission equipment and different technical solutions.

The second part of this document (Chapter 3) provides examples of dark fibre deployment in project partners' networks. Those examples cover dark-fibre based lines connecting institutions from metro to regional and international (cross-border) level. This part of the document also gives some examples of the transition from a network based on digital telecommunication services to a dark fibre infrastructure.

Chapter 4 gives case studies of the possible ways SEE networks based on dark fibre might develop and the cost estimation of such development. SEE NRENs prepared case studies based on the findings of the SEEFIRE project in WP1 and WP2, like available dark fibre in SEE countries, dark fibre lease prices in European countries, transmission technologies and equipment.

The last part of the document is procurement documentation gathered from project partners with experience in dark fibre and transmission equipment procurements. This documentation is very useful because it can give NRENs directions for the preparation of their own tendering documentation, especially the technical part covering the descriptions of technical characteristics and service level agreements.

2. Survey of the organisation of European dark-fibre based NRENs

The shift from operator based services to dark fibre introduces partially different model of the NREN functioning at a technical level, and a set of new problems and tasks that the NREN should cope with. This is especially obvious with new OSI Layer 1 issues which do not exist in a network based on operator services.

This chapter aims to cover some of the topics in optical networking which are essential for the reliable functioning of a network based on dark fibre, apart from the transmission equipment and technology issues, which are covered in D2.1. The content of this chapter can help NRENs in planning the organisation of the network and additional expenses to those required for purchase and maintenance of transmission equipment and dark fibre leasing. It will also give deeper insight into the equipment which might be useful for the efficient functioning of a dark-fibre based NREN.

The survey was made through a questionnaire which was given to European NRENs which have consolidated experience in dark-fibre deployment. The questionnaire which was sent to NRENs is presented in Appendix 2.

2.1. NREN organisation

European NRENs operate in different environments and with various models of financing, organisation, scope of covering research and education institutions and positions in society. Also, the status of telecommunication markets is different from country to country. In spite of the general direction to move towards dark fibre infrastructure, this diversity of environments in which NRENs are developing has led to different models of ownership, maintenance and other aspects of dark fibre networking. This chapter will show that there is no “one size fits all” solution for dark fibre based networks, and that each NREN can choose the model which best suits its needs.

2.1.1. Fibre ownership and maintenance model

Table 2-1 shows models of ownership and maintenance in European NRENs that went farther in the deployment of dark fibre. On the one side is the Polish PIONEER network, with the majority of intercity lines being owned or co-owned by the NREN, while most NRENs in other countries typically lease dark fibre or have IRU for them.

Maintenance of the fibre, whether it is leased or owned is never done by the NREN itself, but by the owner of the fibre or some maintenance company.

The length of lease or IRU and its impact on the expenses and performance of the network are covered in detail in D3.2 of this Project.

NREN	Owned DF	Leased/IRU DF	Length of lease/IRU	Plan to own new DF lines	DF Maintainer
PIONEER	3000km	440km	N/A	Yes	Fibre owner, maintenance company for owned fibre
SANET	30km (metropolitan)	1660km	10 years lease/IRU	Yes	Fibre owner, maintenance company for

					owned fibre
SWITCH	5km (metropolitan)	1350km	20 years for 350km, 10years for 910km	No	Fibre owner or maintenance company for owned
CESNET	No	4200km	Contract 2-5 years or undefined period of time	No	Fibre owner
SURFnet	No	6000km	IRU 15 years	No	Fibre owner
ARNES	No	Yes (length N/A)	Contract which ARNES can terminate in 6 months if the price on the market changes	No	Fibre owner
AMREJ	5km (metropolitan)	400km in operation, 1700km under contract	Contract 3 years	No	Fibre owner

Table 2-1 The amount of owned and leased dark fibre in European NRENs

2.1.2. Staff

Network maintenance in a NREN based on traditional telecommunication services mainly consists of configuration of different layer 2 and layer 3 protocols needed for the proper network functioning. The introduction of dark fibre demands that engineers working for the NREN have deeper insight in many optical layer 1 issues. Some questions that arise during the process of planning dark fibre based network are how many dark fibre specialists are needed (in total and per PoP), and which skills they should have.

This section shows that the number of engineers specialized for fibre technologies is not very big and that there is no need for some expensive specialist courses in order to have reliable networks based on dark fibre. Of course, as a start, engineers need to have at least university level knowledge of optical telecommunications and then to catch up with recent developments in the field. Answers on the question about the number of specialists are different probably due to the fact that the term “fibre specialist or expert” is understood differently in different NRENs. Some networks declared that they don’t have any dark fibre specialists, while their dark fibre networks are functioning well, because engineers that are installing and maintaining the network are the same ones that were maintaining and installing the network before the introduction of dark fibre. Also all NRENs declared that engineers responsible for the dark fibre have other duties, such as configuration of higher layer protocols.

Table 2-2 shows the number and knowledge of engineers in NRENs which have dark fibre deployed in their networks.

NREN	Total number of employees or included in NREN	Number of DF specialists in NREN	Other duties (L2 or L3 configuration)	Special courses
PIONEER	30	6	Yes	No
SANET	16	0	Yes	No
SWITCH	65	3	Yes	No
CESNET	52	3	Yes	No
SURFnet	60	2	Yes	OTDR course
ARNES	30	2	Yes	Seminar on fibre technologies
AMREJ	15	0	Yes	No

Table 2-2 Number of employees vs. dark fibre specialists

2.2. Measurement equipment

The theoretical basics of optical measurement are described in detail in Chapter 9 of Deliverable 2.1 of the SEEFIRE Project. This chapter shows the measurement equipment which is used in different European NRENs. The choice of different measurement equipment largely depends on the model of dark fibre maintenance, and the amount of research activities that NREN has in the field of optical networking. Almost all NRENs have at least OTDRs and power meters, except SURFnet, which has a contract for measurements with the company which maintains the fibre and ARNES, which current policy is to borrow such equipment when needed and which stated that some kind of measurement equipment would be highly appreciated. Anyway, optical measurement equipment is desirable in NRENs and especially useful in case of resolving eventual disputes with fibre providers. The equipment for CD and PMD measurement is rarely used at the moment. However, with higher transmission speeds and new G.655 fibre such measurement equipment will probably be needed too.

Table 2-3 shows which measurement equipment is used in European NRENs which took part in this survey.

NREN	OTDR	Power meter	Spectrum analyzers	PMD measurement	CD measurement
PIONIER	+	+	-	-	-
SANET	+	+	-	-	-
SWITCH	+	+	-	-	-
CESNET	+	+	+	-	+
SURFnet	-	-	-	-	-
ARNES	-	-	-	-	-
AMREJ	+	-	-	-	-

Table 2-3 Measurement equipment used in European NRENs

2.3. Other equipment (splicing, fibre-end cleaning etc)

2.3.1. Splicing equipment

Optical fibres are produced in finite lengths. If there is a need for a long dark fibre span, or a need for the reparation of a broken cable, or a need for the termination of the fibre on the optical distribution frame, the fibres have to be joined together. Unlike electrical cables, the process of joining two fibres (splicing) or terminating the end of a fibre is a complex matter and requires special equipment.

There are two main types of splicing: Fusion Splicing and Mechanical Splicing

2.3.1.1 Fusion Splicing

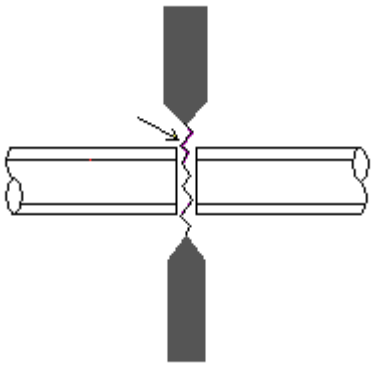

Figure 2-1 Fusion Splicing

In fusion splicing the ends of the fibres are aligned either manually using micro-manipulators and a microscope system for viewing the splice, or automatically, either using cameras or by measuring the light transmitted through the splice and then adjusting the positions of the fibres to optimize the transmission. All protective layers of the cable must be removed from the ends of each fibre. The ends of the fibres are then melted together using a gas flame or more commonly an electric arc. Fusion splices are made by using an electric arc to ionize the space between prepared fibres to eliminate air and to heat the fibres to more then 1000ºC. The heated fibres take a semi-liquid form and melt together, producing a single fibre (rather than two joined fibres) when done properly. The splice is then covered with a plastic sleeve or other protective device. Splice loss is a direct function of the angles and quality of the two fibre-end faces.

Near perfect splices can be obtained with losses as low as 0.02 dB (best mechanical splice 0.2 dB).

One of the top systems in the range of fusion splicers is called Profile Alignment System (PAS). This system uses a TV camera to view the splice before it is fused. The image is sent to a microcomputer inside the splicer which is programmed to recognize when the cores of the two fibres form a continuous straight line. An adjustment is made to bring the fibres form a continuous straight line. An adjustment is made to bring the fibres into alignment in that plane. The camera then moves to a new position to view the splice in an orthogonal plane. The same process aligns the fibres in this plane too. The camera then goes back to the original view and starts to make fine adjustments in that plane. It goes to the second plane

and makes fine adjustments in that plane too. This goes on until the alignment is as close as possible. At this point the arc is fired and the heat form the arc melts the fibres together locally.

2.3.1.2 Mechanical Splicing

In mechanical splicing the two fibre ends are held together in a splice. This consists of some device usually made of glass which by its internal design automatically brings the two fibres into alignment. The openings at each end of the device are usually fluted to allow the fibres to be guided into the capillary where the alignment takes place. The splice is first filled with optical cement whose refractive index is the same as that of the core of the fibre. After the fibres have been entered into the splice they are adjusted to give the optimum transmission of light. At this point they are clamped in position and the whole assembly is exposed to ultra-violet light which cures the cement.

Mechanical splices are best used for multimode fibre. Some splices now exist which are suitable SM fibre, but have a loss of 0.1dB. This is five times the loss of the best fusion splice.

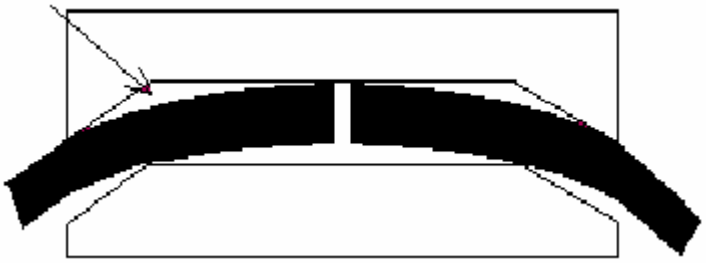

Figure 2-2 Mechanical splicing

Which method is better? There are advantages and disadvantages for both methods, but the choice depends upon the application, customer's preference, volume of fibre splicing, as well as the installer's equipment, preference and level of training. Both methods are in use and have considerable reliability. The typical reasons for choosing one method over the other are economics and the introduced attenuation of splice. Mechanical splicing requires a low initial investment ($1,000 - $2,000) but costs more per splice ($12-$40 each). While the cost per splice for fusion splicing is lower ($0.50 - $1.50 each), but the initial investment requires is much higher ($10,000 - $50,000 depending on the accuracy and features of the fusion splicing machine being purchased). The price increases with the possibility of the machine to better align fibres.

Fusion splicing produces lower loss and less back reflection than mechanical splicing because the resulting fusion splice points are almost seamless. Fusion splices are used primarily with single mode fibre whereas mechanical splices work with both single and multi mode fibre.

2.3.2. Cleaning equipment

In transmission links, single mode optical fibre cores are typically 9µm in diameter. Dust and other particles can range from tenths to hundredths of microns in diameter, and can cover a part or the whole of the end of the optical fibre, therefore causing significant degradation of the performance of the link. Also, power density in case of strong optical signal may burn dust into the fibre or connector and cause additional damage (for example 0dBm optical power in single mode fibre is approximately equivalent to 16MW/m^2) [1]

This chapter will cover some standard cleaning equipment that might be used by NRENs.

2.3.2.1 Dust and shutter caps

Patch cables and optical interfaces usually come with covers which protect them from damage and contamination. Good practice suggests that caps should be kept on the equipment at all times except when it is not in use. Also patch cable caps and covers should not be pressed too tightly against the end of the fibre, as it might pollute it if there is any dust in the cap.

2.3.2.2 Isopropyl alcohol

Isopropyl alcohol can usually be found in any local pharmaceutical or chemist shop. It is recommended to use 99% pure isopropyl alcohol without any other solvents which might damage plastic materials, claddings or connectors.

Dust can be removed using a soft tissue saturated with isopropyl alcohol. It is recommended to use soft tissues made from non-recycled cellulose rather then cotton ones, because cellulose tissues are very absorbent and soft, and will not scratch the surface of the connector. Use always only clean soft tissues, and never reuse it. After this cleaning procedure, remove the alcohol with a dry soft tissue, as it can leave behind filmy deposits (from the dissolved dirt) if it evaporates.

2.3.2.3 Compressed air

Compressed air can also be used for fibre cleaning. It can be bought as a spray in any laboratory supplier. It is very important that the air is clean and dry.

2.3.2.4 Microscope

Microscopes with magnification ranges between 50X and 300X can be useful in the examination of fibre ends and the estimation of the degree of dirt or damage on the device. Special fibre scopes can be purchased from suppliers of splicing equipment.

2.3.2.5 Review of the splicing and cleaning equipment used in some European NRENs

Table 2-4 shows which splicing and cleaning equipment is used in European NRENs that responded to thequestionnaire.

NREN	Splicing equipment	Isopropyl alcohol	Cotton swabs, soft tissues	Compressed air	Microscope
PIONIER	+	+	+	+	-
SANET	-	+	+	-	-
SWITCH	-	+	+	-	+
CESNET	+	+	+	-	+
SURFnet	-	-	-	-	-

ARNES	-	-	-	-	-
AMREJ	-	-	-	-	-

Table 2-4 Specific technical solutions used for cleaning fibres in European NRENs

2.4. Types of fibres and other technologies used in NRENs

2.4.1. Types of fibres, multiplexing and amplification

In all European countries the majority of planted fibres are G.652 fibre type. The G.655 fibre type, which is suitable for use with DWDM at higher speeds, is currently used in minor percentages. For detailed comparison of those fibre types and their physical and optical characteristics, please refer to D2.1.

Amplification or signal regeneration is needed if the attenuation of the signal of the fibre span is bigger then the optical budget of the interfaces used on that span. Some NRENs (AMREJ, SANET) have used a cheap solution for 1Gbps Ethernet using optical-electrical-optical signal regeneration with L2 or L3 switches, while other NRENs use optical amplifiers.

Table 2-5 shows the current situation in European NRENs which have deployed dark fibre, regarding the fibre types in use and the multiplexing and amplification equipment.

NREN	Fibre type used in NREN	Longest DF span between PoPs	Multiplexing	Amplification
PIONIER	G.652, G.655	305 km	DWDM	Yes, EDFA
SANET	G.652	112 km	CWDM	OEO regeneration
SWITCH	G.652 – 92% G.655 – 8%	110 km	DWDM, CWDM	Yes, EDFA
CESNET	G.652 – 94% G.655 – 6%	300 km	DWDM, CWDM	EDFA, Raman, PDFA, SOA
SURFnet	G.652 – 90% G.655 – 10%	100 km	DWDM, CWDM	Yes, EDFA
ARNES	G.652	100 km	DWDM experimental, CWDM	No
AMREJ	G.652	120 km	CWDM	OEO regeneration

Table 2-5 Types of fibre, longest spans between PoPs in European NRENs

2.4.2. L2 technologies over DF lines used in European NRENs

The appearance on the market of relatively low-cost long-range gigabit Ethernet and 10G Ethernet interfaces (described in detail in D2.1 of this Project) introduced Ethernet technology into the backbone of many NRENs. Ethernet technology with VLAN tagging enables new possibilities for the Layer 3 organisation of the network, because now PoPs can be interconnected in various ways (by access switched ports, by trunk switched ports or by routed ports) allowing NRENs to find the most suitable solution to their needs.

On the other hand, the use of Ethernet technology in the backbone of the NREN brings several problems, like slow convergence when spanning tree is used on switched ports between PoPs, or the problem with the limited diameter of the network (7 switches) if spanning tree protocol with default timer values is used. Therefore some NRENs (SANET for example) decided to switch-off spanning tree on the backbone with backbone split into more then one LAN. This of course requests careful planning, design and configuration of the network in order to avoid loops.

Ethernet over MPLS, as a technology which enables seamless connections between remote VLANs, is deployed in testing phase in some NRENs.

Table 2-6 shows L2 technologies used in NRENs which responded to the questionnaire.

NREN	Ethernet technologies	Other L2 Technologies
PIONIER	10GE, 1GE, 802.1q	-
SANET	1GE, 802.1q	-
SWITCH	10GE, 1GE, no tagging	EoMPLS
CESNET	10GE, 1GE, 802.1q	EoMPLS, PoS
SURFnet	10GE, 1GE, 802.1q	-
ARNES	10GE, 1GE, 802.1q	-
AMREJ	1GE, 802.1q	-

Table 2-6 Layer 2 technologies used in NRENs based on dark fibre

2.5. Use of single fibre

The most common practice is to lease fibre pairs from the lessor. However, single fibre transmission is possible, either as a solution when there is no possibility to lease a fibre pair, or as a solution to increase bandwidth or to multiplex traffic over fibre pair.

One example of single fibre transmission is provided by SWITCH [2], which uses passive optical couplers (POC) (Figure 2-3) to connect GBICs to a single fibre. POCs used in this example introduce about 1dB attenuation to the signal. On the end sites there are GBICs with different wavelengths (1530nm and 1550nm). This set-up exploits the fact that the receiver of the GBIC interface is able to detect a wide range of wavelengths' signal.

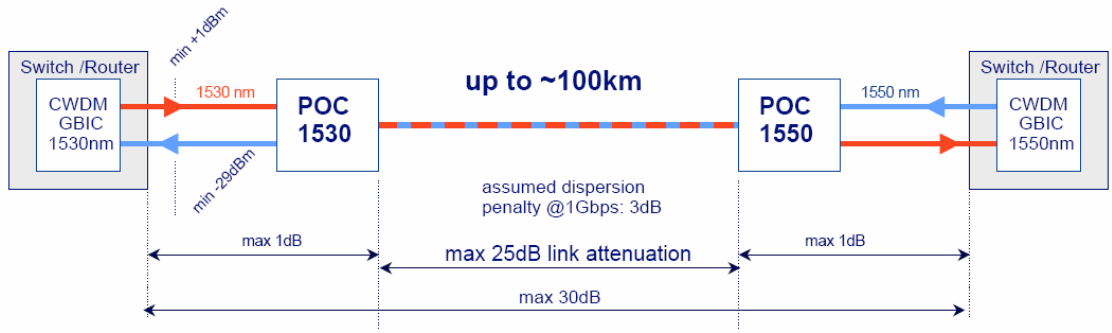

Figure 2-3 SWITCH example: 1Gbps Ethernet over single fibre

Some vendors have equipment which ports are ready for single fibre communication. In such case POCs are not needed. (Figure 2-4)

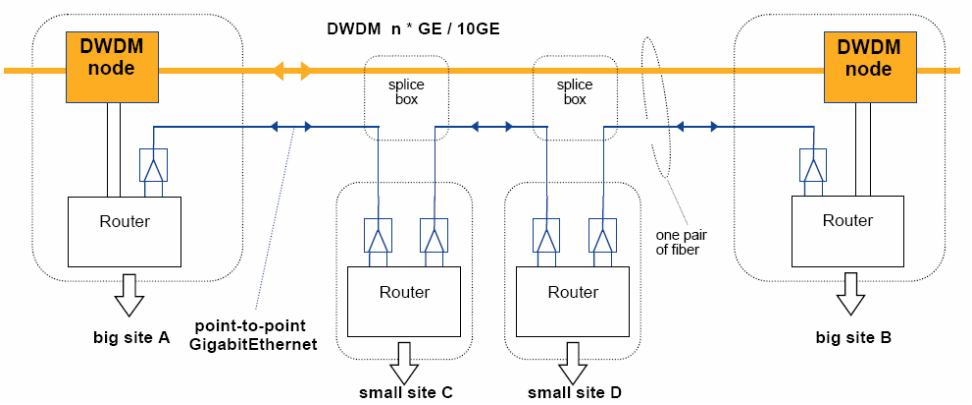

Figure 2-4 SWITCH example: multiplexing backbone and local traffic over fibre pair

By using single fibre transmission when a fibre pair is available it is possible to cost-effectively engineer various traffic patterns over the dark fibre lines and to separate, for example, backbone traffic (over one fibre) from traffic in the distribution layer (over the other fibre).

2.6. DF based NREN topologies

The physical topology of the network depends on the fibre topology of the provider's network. However, with different multiplexing technologies it is possible do develop various higher layer topologies with high redundancy and resiliency to outages. One such example is the SURFnet5 network [3], which physical and logical topologies are shown in Figure 2-5. Experience from NRENs shows that in case of cable breaks it is more important to have a redundant topology then a good SLA with fast response time.

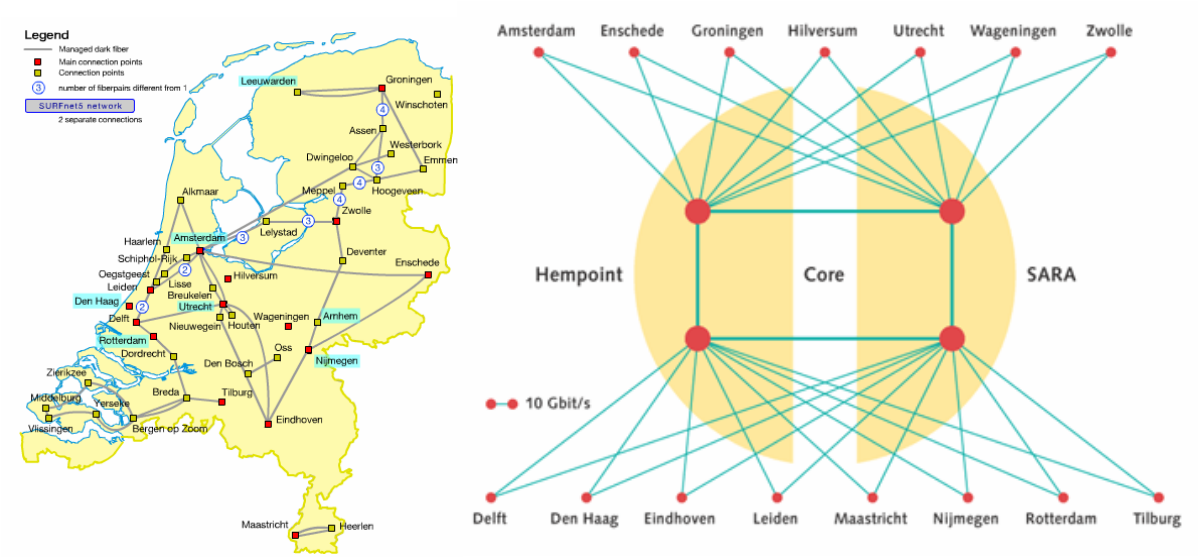

Figure 2-5 SURFnet 5 physical and logical topology

3. Existing solutions: Transmission equipment used in SEEFIRE member networks based on Dark Fibre

3.1. CESNET solutions

3.1.1. Example of the cross border connection: Brno - Bratislava

Current solution of line connecting Brno in the Czech Republic and Bratislava in Slovakia is based on dark fibre type G.652 and CWDM-GBIC-1550 on the both sides and L2 switch Catalyst 3524XL in line, see figure 3-1. This line is a part of connection Pionier - CESNET2 – SANET – ACONET.

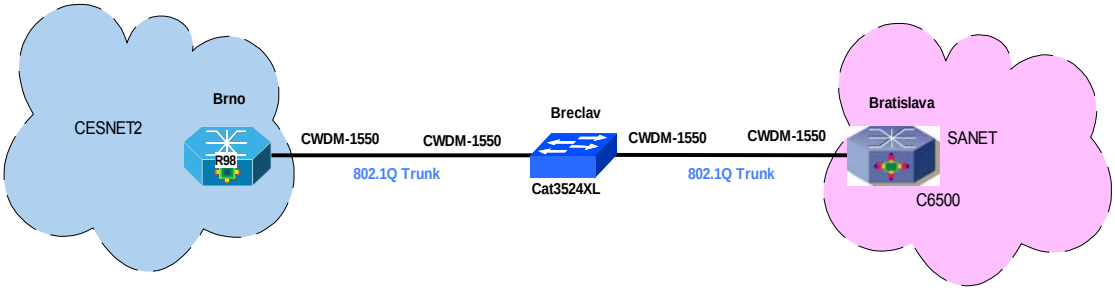

Figure 3-1 Current topology Brno – Bratislava

New 10 GE proposal of line Brno – Bratislava is based on NIL and cost-effective solution using CLA PB01. We performed experiments targeted to verify a new CD compensation approach – to use FBG instead of DCF. We have successfully transported 4 DWDM wavelengths over 276 km of G.652 fibre reels in lab. Interesting fact is, that this setup (using FBGs) worked as NIL and with EDFAs only.

We plan to utilize results of these experiments for lighting of CESNET2 line Brno (CZ) - Bratislava (SK) (187,6 km of G.652 fibre, attenuation of 45 dB approximately), designed to allow simultaneous transmission of up to four DWDM wavelengths.

New solution is expected in February 2006. The figure 3-2 shows the equipment for this solution.

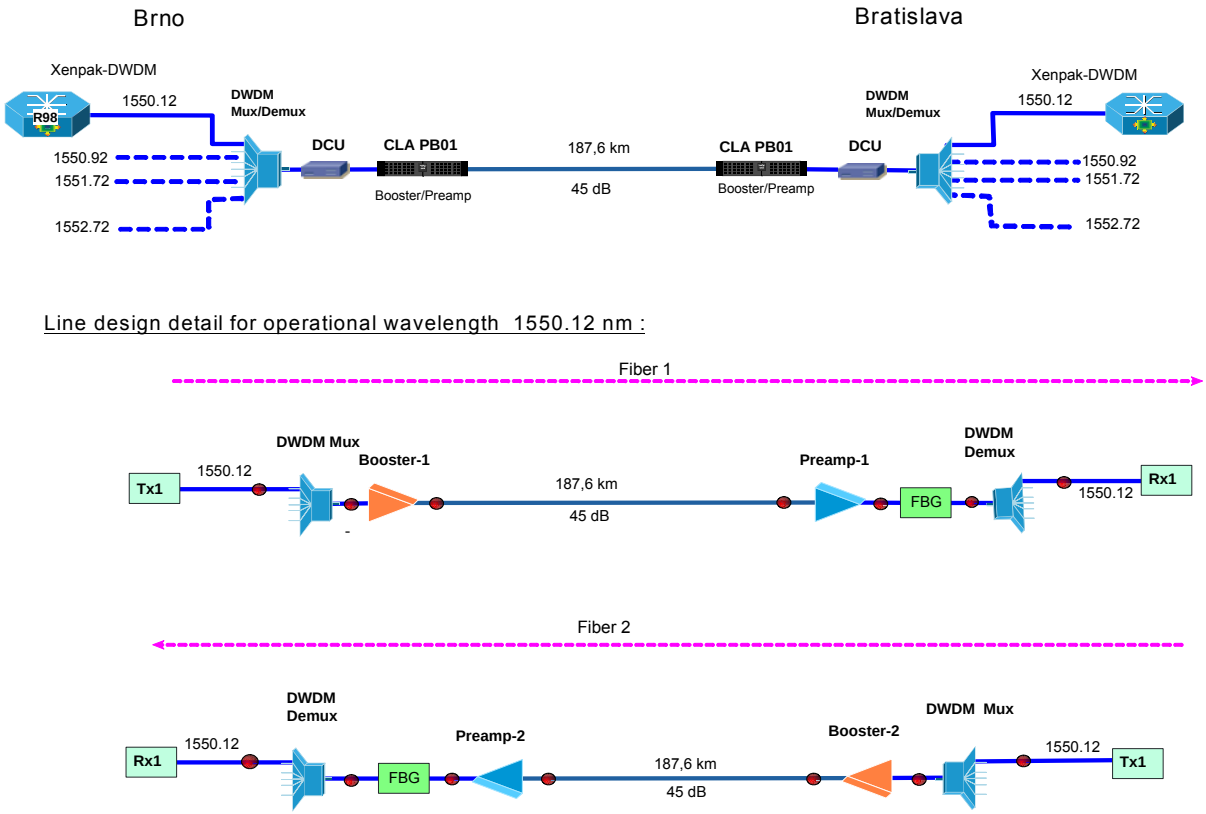

Figure 3-2 Planed physical interconnection of the equipment on the line Brno – Bratislava

3.1.2. Example of the intercity connection

The table No. 3-1 describes advanced and interesting examples of CESNET lines. There are technically interesting and cost effective lines. Cost effective solutions use CESNET-designed equipment, CzechLight Amplifiers CLA PB01 and CLA DI01.

Line No.	A	B	km	Attenuation (dB at 1550nm)	Testbed/ Network	Operational	Transmission rate (Gb/s)	Lighting
1	Praha	Plzeň	159	36,7	CzechLight	1.9.2004	1	2 * ZX GBIC, 1 * CLA PB01 + tunable optical filter, NIL, One Side Amplification in Praha only
2	Praha	Brno	284	66,37	CzechLight	15.3.2005	10	2 * 10 G DWDM SONET card in ONS15454, 2 * 21dBm Keopsys Booster, 2* 10 dBm Keopsys Preamp, 1x CLA DI01 in-line

3	Praha	Brno	327	81	CESNET2	10.1.2000	10	supplier´s 10 G DWDM system, 3x ONS15454 in-line for amplification
4	Praha	Hradec Králové	150	35,69	CESNET2	15.12.2004	1	2 * DWDM GBIC, 1 * CLA PB01 + fixed optical filter. One Side Amplification in Praha only.
5	Brno	Ostrava	235	50,55	CESNET2	6.6.2003	1**	2 * CWDM GBIC, 2 * 27 dBm Keopsys hi-power booster, 2 * 10 dBm Keopsys Preamp
6	Olomouc	Hradec Králové	197	42,96	CESNET2	1.2.2004	2,5	2 * POS LR 2,5 G card, 2 * 27 dBm Keopsys hi-power booster

CCLA PB01 means Preamplifier + Booster

CLA DI01 means Dual In-line Amplifier

** used also with 2.5 POS

Table 3-1 *Examples of the intercity connection*

Line No.1 describes solution with CzechLight Amplifier only on CzechLight testbed (breakable network).

Lines No.2 and 3 present two 10 G lines using quite different technical solution.

Line No.2 is experimental line with only one amplifier in-line.

Line No.3 is operational line with supplier's DWDM system containing 3 amplifiers in-line. The solution enables expanding up to 32 x 10 Gbps transmission channels. CESNET2 uses 10G DWDM ring containing 4 PoPs since December 15, 2005.

Line No.4 is example of very interesting and cost effective solution with CzechLight Amplifier.

Lines No.5 and 6 are examples of one 2.5G line with Keopsys amplifiers.

Price lists of Cisco components are widely available. Final price depends on research and quantity discounts. Used Keopsys equipments are 3 year old and now for new lines we use CLA devices instead. Preliminary price of CLA PB01 is about 11 500 Euro. Preliminary price of CLA DI01 is about 16 500 Euro. We suppose commercial availability in 1Q 2006.

Cesnet is preparing CLA DI02 device (expected price is about 12 000 Euro) with parameters comparable with CLA DI01.

3.1.3. Examples of single fibre connection

Single fibre transmission is usually the most cost effective solution, if is possible to lease single fibre instead of fibre pair. Cost of single fibre lease should be about 60% of fibre pair lease cost. This cost difference usually overrides cost possible defences of equipment.

Comparison of reliability of bi-directional transmissions on single fibre with two unidirectional transmission on fibre pair depends mainly on used lighting equipment, but we should take into account, that probability of failure of fibre pair is a little higher then probability of failure of single fibre (both fibres in pair are needed for successful transmission). In practice, reliability of transmission on single fibre pair in CESNET is equal.

In CESNET2 there are five intercity single fibre lines. Two single fibre lines using different transmission equipment are shown on the table EE. One line uses 1 GE transmission with passive optical splitters and CWDM GBIC and SFP, the other is one of the longest NIL single-fibre operational lines world-wide..

A	B	km	Attenuation (dB at 1550nm)	Network	Operational	Transmission rate (Gb/s)	Lighting
Ostrava	Karviná	77	20,27	CESNET2	29.8.2005	1	CWDM GBIC + SFP (1550/1590nm), 2 * passive optical splitter
Plzeň	Cheb	127	35,65	CESNET2	16.7.2003	0,1	MRV 2x EM 316WFC/S5 & WFT/S5, 40-125km

Table 3-2 ***Examples of the one fibre connection***

3.2. AMREJ solutions

3.2.1. An example of the cross border connection – Subotica – Szeged

3.2.1.1 Overview

A dark fibre line between Subotica and Szeged has been established during the second half of October 2005. The dark fibre pair is approximately 52km long: approximately 32km in Serbia and the rest in Hungary. The dark fibre is leased by AMREJ/University of Belgrade from two operators, Telekom Srbija, on the Serbian side and Pantel on the Hungarian side.

Figure 3-3 Cross border dark fibre connection Subotica – Szeged

3.2.1.2 Equipment used

The equipment used on both sides of the line is described in the following table:

Node	Equipment
Szeged	Cisco Catalyst 6509 with SUP720 (WS-SUP720), 16xGBIC (WS-X6816-GBIC with WS-F6K-DFC3A) cards, and corresponding Cisco 1000BaseZX interface
Subotica	Cisco Catalyst 3550-12G with 1000BaseZX GBICs for the connection towards HUNGARNET

Table 3-3 Equipment used on Subotica – Szeged line

3.2.1.3 Logical organisation

The logical connection between AMREJ and HUNGARNETis established through a VLAN which is ended in Belgrade and in Szeged. Cisco Catalyst 6509 switches in Belgrade and Szeged are BGP peers. Part of the line between Subotica and Belgrade with detailed logical description is presented in the following chapter.

3.2.2. An example of the intercity connection – Belgrade – Subotica

3.2.2.1 Overview

The line between Belgrade and Subotica consists of two G.652 dark fibre pair spans: Belgrade – Novi Sad (approx. 95km) and Novi Sad – Subotica (approx. 110km). This line is important because it is on the main route from Serbia towards Hungary. The equipment in Subotica is hosted at the Faculty of Economy which is part of the University of Novi Sad. For this reason, there was a request to separate the logical connection between the University of Novi Sad and the Faculty of Economy in Subotica. Figure 3-4 shows the topology of the part of the network which is described in this chapter.

Figure 3-4 Intercity connection Belgrade - Subotica

3.2.2.2 Equipment used

in the Belgrade, Novi Sad and Subotica nodes AMREJ has the following equipment in place:

Node	Equipment
Belgrade	Cisco Catalyst 6509 with SUP720 (WS-SUP720), 2x16xGBIC (WS-X6816-GBIC with WS-F6K-DFC3A) cards, and corresponding Cisco CWDM GBICs (CWDM-GBIC-1xx0=)
Novi Sad	Cisco Catalyst 3550-12G with CWDM GBICs (CWDM-GBIC-1xx0=)
Subotica	Cisco Catalyst 2950-24-EI with CWDM GBIC (CWDM-GBIC-1xx0=)
Subotica	Cisco Catalyst 3550-12G with CWDM GBICs (CWDM-GBIC-1xx0=)

Table 3-4 Equipment used on Belgrade – Subotica line

Along the Novi Sad – Subotica span AMREJ has two CWDM OADMs which are now used for testing purposes on that span, and for one intra-AMREJ connection. OADMs are Cisco CWDM-MUX-4 with the following lambdas: 1470nm, 1510nm, 1550nm and 1590nm.

Figure 3-5 shows the physical interconnection of the equipment used in this connection.

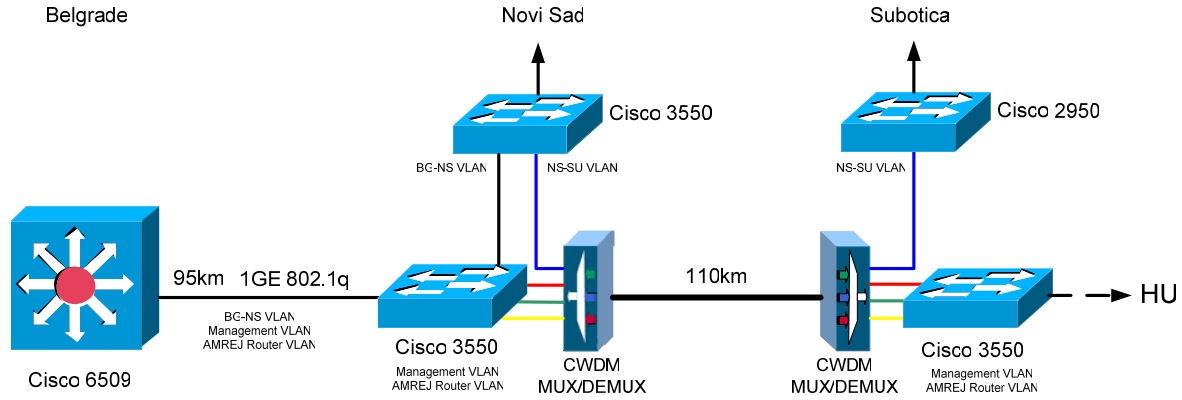

Figure 3-5 Equipment used on Belgrade – Subotica line

3.2.2.3 Logical organisation

One Cisco 3550 in Novi Sad (the one connected to the Cisco 6509 in Belgrade) and the Cisco 3550 in Subotica are part of the AMREJ backbone. The other Cisco 3550 in Novi Sad and the Cisco 2950 in Subotica are used for internal connections in Novi Sad and Subotica respectively and are a part of the metropolitan area networks in those cities.

One wavelength between Subotica and Novi Sad is used for the direct connection of the Faculty of Economy in Subotica (the institution where the equipment is located) to the Novi Sad node. The ports on the switches which end that wavelength are configured as access ports.

More wavelengths (since there will be no multiplexing towards Hungary only one wavelength will be used at first) will be used upon the establishment of the connection with Hungary.

They are used now only for testing the link reliability.. Ports with those wavelengths are configured as 802.1q trunk ports, which carry management and AMREJ-router VLAN.

The line between Belgrade and Novi Sad is a 802.1q trunk, which carries management and AMREJ-router VLAN and VLANs for the Belgrade - Novi Sad connection and AMREJ – HUNGARNET VLAN. Such configuration enables clear separation of the international and internal traffic over the same fibres. Logical connections over this equipment are depicted in Figure 3-6.

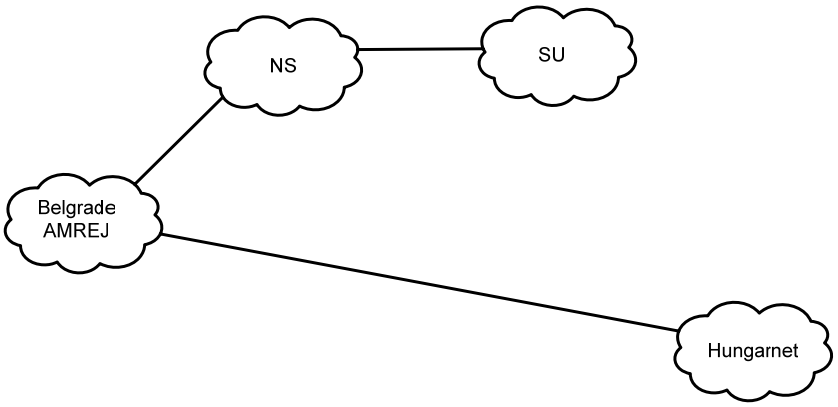

Figure 3-6 Logical connection on Belgrade – Subotica line

3.2.3. An example of the metro connection

3.2.3.1 Overview

At the time of writing this deliverable the topology of the dark fibre network in Belgrade is an expanded star. This is one line which shows how three institutions in Belgrade are connected to the main node of the AMREJ – RCUB (Belgrade University Computer Centre): the Faculty of Management (FON), the Faculty of Political Sciences (FPN) and the Alternative Academic Education Network (AAEN). Those three institutions are close to each other and are connected by single mode G.652 fibre pairs, as can be seen on the Figure 3-7

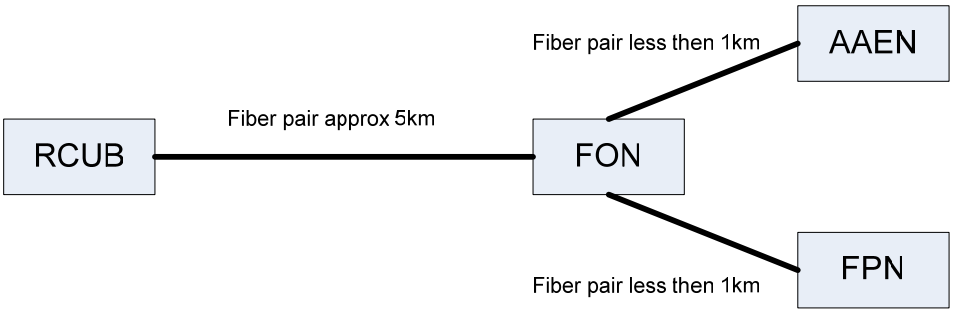

Figure 3-7 Topology of a metro connection in Belgrade

3.2.3.2 Equipment

The following equipment is used for this connection:

Node	Equipment
RCUB	Cisco Catalyst 6509 with SUP720, 2x16xGBIC card, and 1000BaseLX GBICs (WS-G5486)
FON	Cisco Catalyst 3550-12G with 1000BaseLX GBICs (WS-G5486)
FPN	Allied Telesyn Rapier Layer 3 switch with 1000BaseLX module AT-A35LX/SC
AAEN	Allied Telesyn Layer 2 switch (model No) with 1000BaseLX GBIC(AT-G8LX10)

Table 3-5 Equipment used in metro connection in Belgrade

The equipment is connected as presented in the Figure 3-8

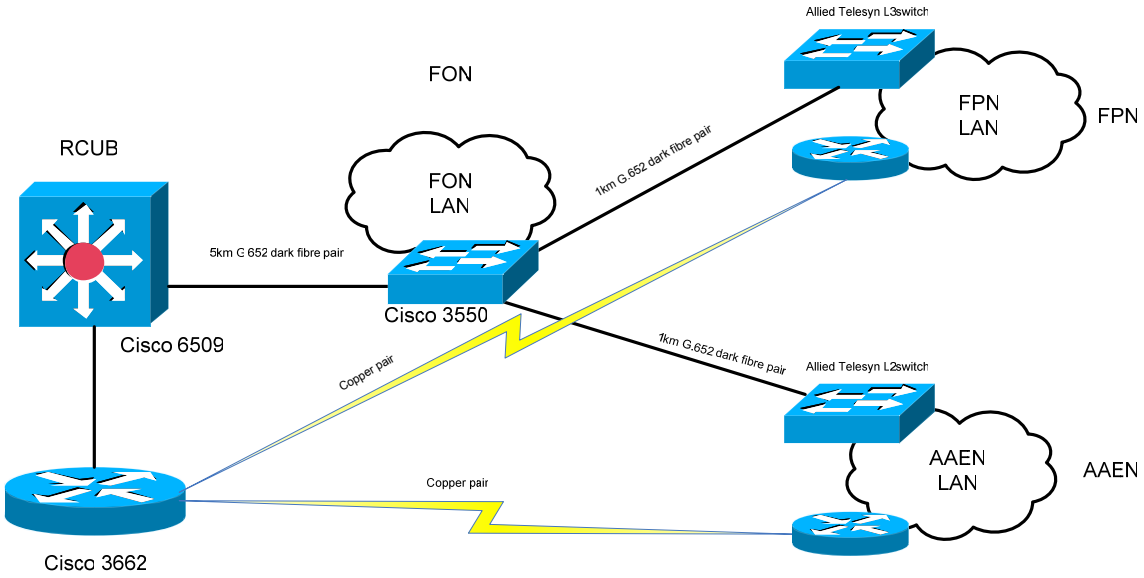

Figure 3-8 Equipment used in metro connection in Belgrade

All the institutions have kept their previous serial connections (DSL modem over leased copper cables) to RCUB, the computer centre of the University of Belgrade. They are now used as backup connections in case of the interruption on some dark fibre lines. Routers and modems that are used for this purpose are rather old and are of no interest for this projec, therefore they are not described here in greater detail.

3.2.3.3 Logical organisation

The FPN and AAEN local area networks are connected over switched access ports on Catalyst 3550 in FON. Each institution has its own VLAN for this connection. There is also a separate VLAN for the LAN network in FON. The interior routing protocol is OSPF and the activation of redundant links relies on it. Despite the fact that FPN and AAEN are physically connected to FON, logically it appears as if they are connected directly to RCUB, as can be seen in Figure 3-9.

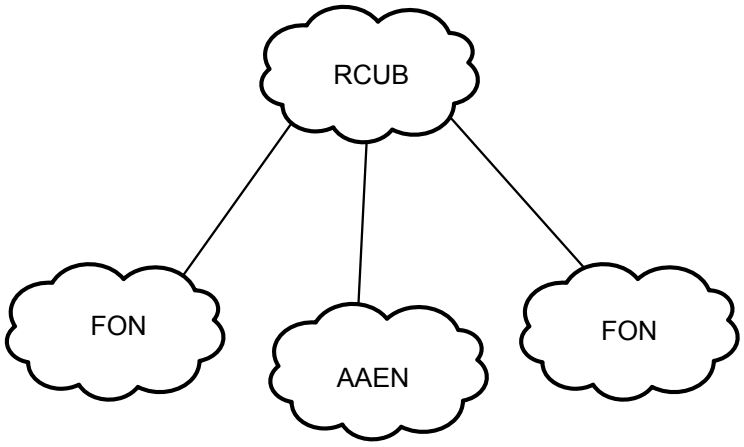

Figure 3-9 Logical connection in metro connection in Belgrade

3.3. MARNET solution

3.3.1. An example of the metro connection

3.3.1.1 Overview

The University St's Kiril and Metodij (MARNet) owns a fully operational Gigabit Metro Optical Network (GMON) since September 2005. The physical topology of the single-mode fibre optics is an extended star, with a central node at the MARNet Network Operation Centre (NOC). The total length of the installed fibre is 17 km. It connects almost all faculties and institutes within the University in the metro area of Skopje, as depicted in Figure 3-10.

More than 95% students and academic staff of the University are covered with GMON. All users can exploit a number of potential applications, including, among others:

- Internet with high speed and quality
- e-Learning, Distance Learning
- Online Content
- Multimedia capabilities
- Converged Voice, Video and Data Applications
- GRID applications

Besides the GMON, MARNet also operates a wireless and copper network, which is used for connecting the facilities without optical connection and as a back-up connection for the ones already connected to GMON.

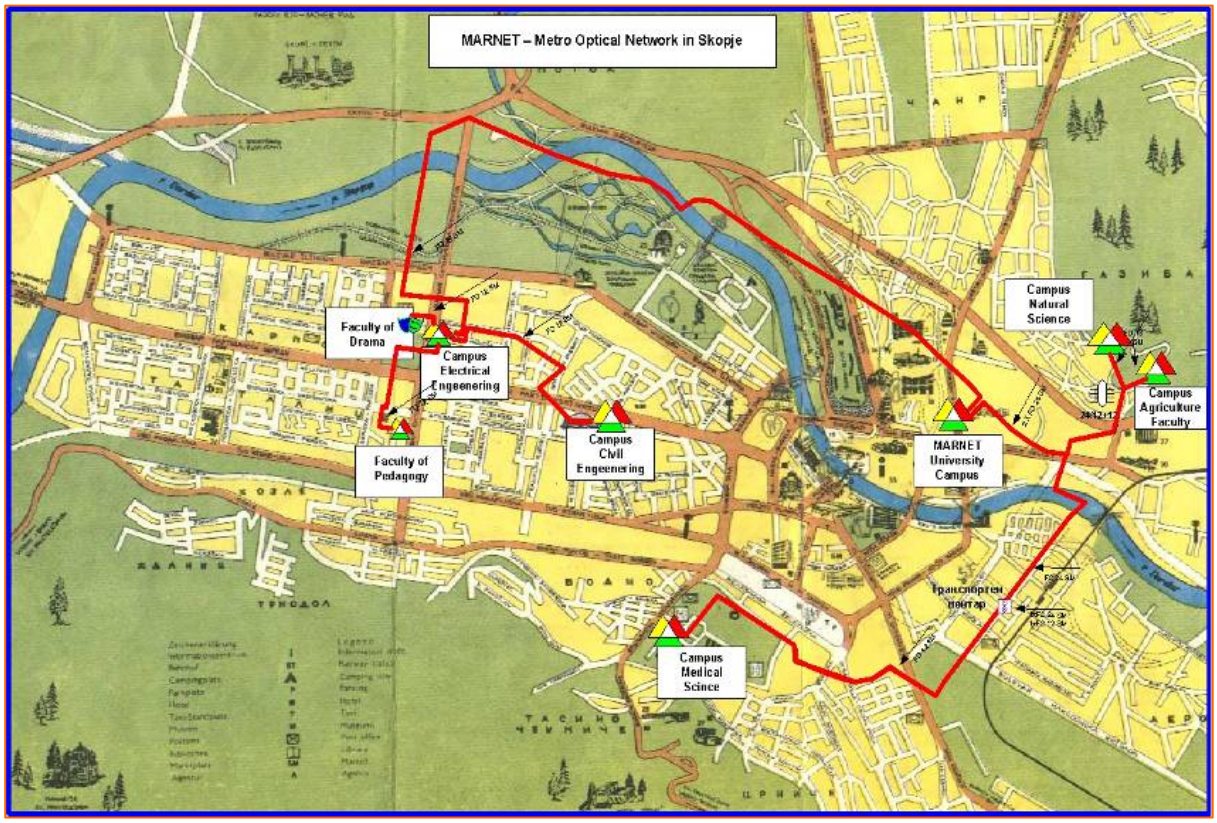

Figure 3-10 GMON Network in Skopje

3.3.1.2 Equipment used

The following table lists the equipment installed at MARNet's GMON nodes and sub-nodes:

Node	Sub-node	Equipment
Rektorate, MARNet NOC and Social Sciences Campus	MARNet NOC	CISCO 7304 router ▪ 2xNPE-G100, 1GB memory (3x1000BASE-T or Small Form Pluggable (SFP) ports for installation of optical GBICs ▪ 7300-CC-PA carrier card with module 4xE1 G.703/G.704-120Ohm, ▪ 7300-CC-PA carrier card with module 1xE3 serial (34Mbps link to GÉANT)

		CISCO 4507R multilayer switch ▪ 2xSUPERVISOR ENGINE IV (with 2 GBIC slots) ▪ 2x1000BASE-X switching module (6 GBIC slots each), populated with 3 1000BASE-SX and 5 1000BASE-LH/LX GBICs ▪ 1xMULTISPEED GIGABIT ETHERNET SWITCHING MODULE (48 x 1000BASE-T ports)
	Faculty of Philology	CISCO 2950 L2 switch (12x100BASE-TX, 2 GBIC slots, both of them populated with 1000BASE-SX GBICs)
	Faculty of Philosophy	CISCO 2950 L2 switch (12x100BASE-TX, 2 GBIC slots, one of them populated with 1000BASE-SX GBIC)
	Faculty of Economics	CISCO 2950 L2 switch (48x100BASE-TX, 2 GBIC slots, one of them populated with 1000BASE-SX GBIC)
	Iustinianus Primus Faculty of Law	CISCO 2950 L2 switch (48x100BASE-TX, 2 GBIC slots, one of them populated with 1000BASE-SX GBIC)
Technical Engineering Campus	Faculty of Electrical Engineering	CISCO 3570 L3 switch (12xSFP GBIC slots) populated with 1x1000BASE-LH/LX, 1x1000BASE-T and 3x1000BASE-SX SFP GBICs)
		CISCO 2950 L2 switch (12x100BASE-TX, 2 GBIC one of them populated with 1000BASE-SX GBIC)
	Faculty of Mechanical Engineering	CISCO 2950 L2 switch (12x100BASE-TX, 2 GBIC slots, one of them populated with 1000BASE-SX GBIC)
	Faculty of Technology and Metallurgy	CISCO 2950 L2 switch (12x100BASE-TX, 2 GBIC slots, one of them populated with 1000BASE-SX GBIC)
Civil Engineering and Architecture Campus	Faculty of Civil Engineering and Faculty of Architecture	CISCO 3570 L3 switch (12xSFP GBIC slots) populated with 1x1000BASE-LH/LX, 3x1000BASE-T SFP GBICs)
Medical Campus	Faculty of Medicine	CISCO 3570 L3 switch (12xSFP GBIC slots) populated with 1x1000BASE-LH/LX, 1x1000BASE-T and 3x1000BASE-SX SFP GBICs)
		CISCO 2950 L2 switch (12x100BASE-TX, 2 GBIC slots, one of them populated with 1000BASE-SX GBIC)
	Faculty of Pharmacy	CISCO 2950 L2 switch (12x100BASE-TX, 2 GBIC slots, one of them populated with 1000BASE-SX GBIC)
	Faculty of Dentistry	CISCO 2950 L2 switch (12x100BASE-TX, 2 GBIC slots, one of them populated with 1000BASE-SX GBIC)
Natural Sciences and	Faculty of Natural Sciences and	CISCO 3570 L3 switch (12xSFP GBIC slots) populated with 2x1000BASE-LH/LX, 1x1000BASE-T and 1x1000BASE-SX SFP GBICs)

Mathematics Campus	Mathematics	CISCO 2950 L2 switch (12x100BASE-TX, 2 GBIC slots, one of them populated with 1000BASE-SX GBIC)
		CISCO 2950 L2 switch (12x100BASE-TX, 2 GBIC slots, one of them populated with 1000BASE-LH/LX GBIC)
Agriculture and Forestry Campus	Faculty of Agricultural Sciences and Food	CISCO 3570 L3 switch (12xSFP GBIC slots) populated with 1x1000BASE-LH/LX, 1x1000BASE-T and 3x1000BASE-SX SFP GBICs)
		CISCO 2950 L2 switch (12x100BASE-TX, 2 GBIC slots, one of them populated with 1000BASE-SX GBIC)
	Faculty of Forestry	CISCO 2950 L2 switch (12x100BASE-TX, 2 GBIC slots, one of them populated with 1000BASE-SX GBIC)
	Faculty of Veterinary Medicine	CISCO 2950 L2 switch (12x100BASE-TX, 2 GBIC slots, one of them populated with 1000BASE-SX GBIC)

Table 3-6 Equipment used in GMON in Skopje

Besides the listed equipment, the faculties and institutes use additional equipment for other connections (wireless and copper) and for (non-optical) internal network infrastructure.

3.3.1.3 Logical organisation

The logical topology of the MARNet GMON, which is presented in the following figure, is also an extended star. Each node is equipped with a Layer 3 switch, whilst all sub-nodes are equipped with Layer 2 switches.

Although the optics reache the sub-nodes at the Faculty of Pedagogy and the Institute of Sociological, Political and Juridical Research, these institutes are not yet equipped with active optical equipment. At the time of writing this Deliverable they are still connected to the existing wireless network.

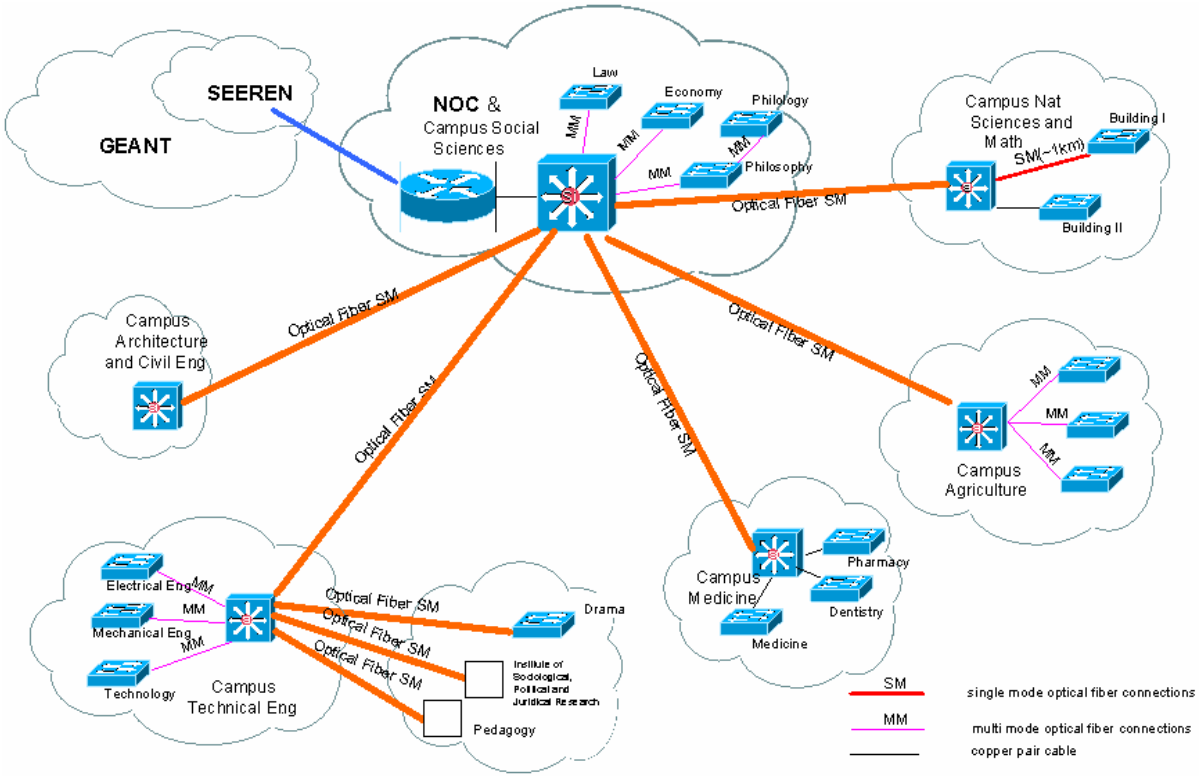

Figure 3-11 Topology of the GMON in Skopje

3.4. NIIF/HUNGARNET solutions

3.4.1. An example of a metro connection

NIIF/HUNGARNET uses a high number of leased dark fibre connections in the Budapest metropolitan area, where several dark fibre suppliers are present and competing on the market, and offering reasonable prices and various cable footprints to almost all locations in the city. On the map below (Figure 3-12), the NIIF/HUNGARNET Budapest backbone and the corresponding line data rate can be seen. On the Layer 2 level, only Ethernet technology is deployed.

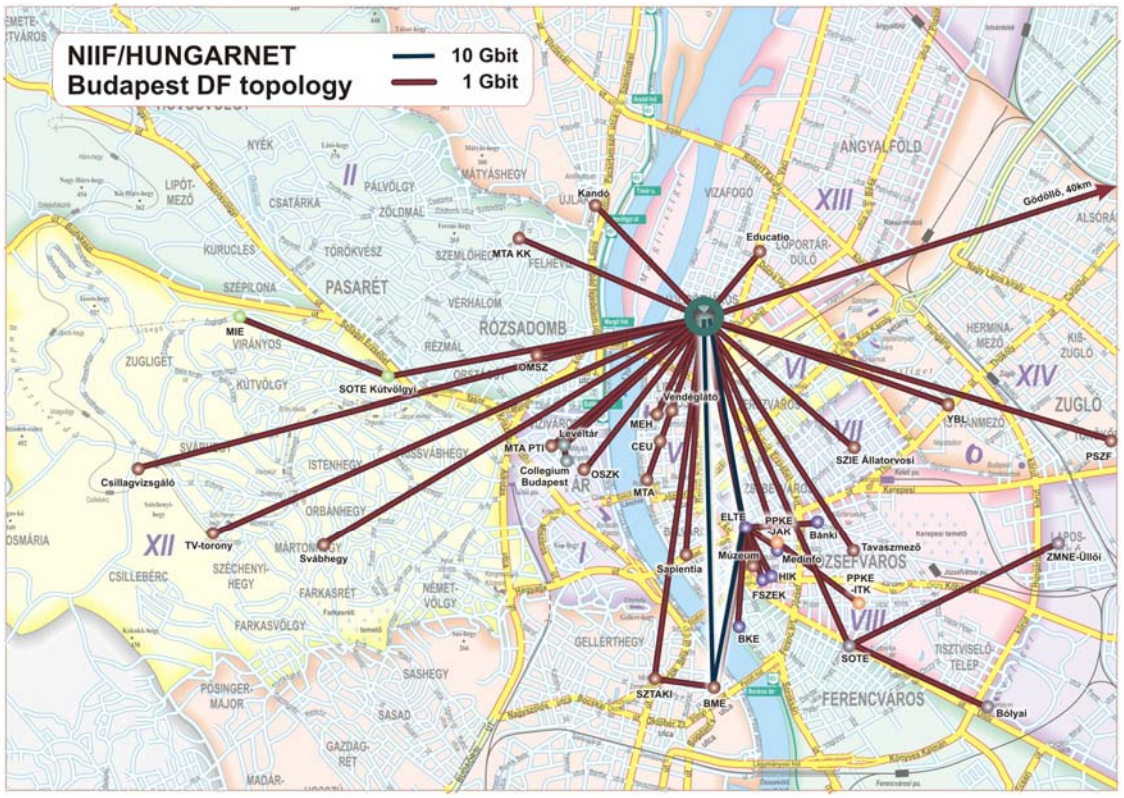

Figure 3-12 Institutions connected with dark fibre in Budapest

All the fibres used in the Budapest metro area are G.652 fibres without any additional inline equipment (i.e. amplifiers). Fibres are lit using normal LX and ZX GBICs and LX XENPAK interface connectors to cover 2km-40km distances.

The following diagram (Figure 3-13) shows two types of dark fibre interconnection schemes used in the Budapest metropolitan area. All the Budapest PoP equipments are connected to the NIIF/HUNGARNET Network Central, terminated in two redundant Cisco 6500 + sup720-3BXL boxes.

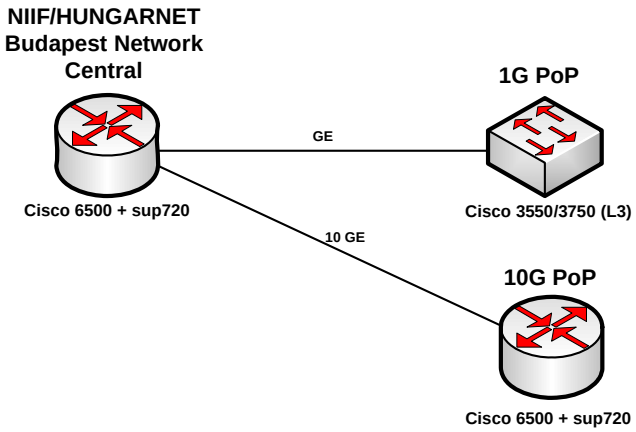

Figure 3-13 An example of metro connection in Budapest

At PoPs connected by Gigabit Ethernet, a Cisco 3550 or 3750 switch is used in Layer 3 mode, providing basic routing/switching facilities. 10 Gigabit Ethernet connections are

terminated on Cisco 6500 + sup720 3BXL routers with corresponding LX XENPAK interface connectors.

3.4.2. An example of an intercity connection

Although the backbone network of NIIF/HUNGARNET in Budapest is entirely based on a dark fibre infrastructure, there are only a few dark fibre based backbone connections outside the capital.

Intercity fibres are lit using normal ZX GBICs (no 10GE used on these fibres). However, there is one location, the PoP at Gödöllő city (40km away from Budapest) with a different layout. See Figure 3-14. DWDM transponders/multiplexers were installed at both Budapest and Gödöllő locations in order to transmit 2 Gigabit Ethernet circuits in the 1550nm window. The two circuits are coupled using port channeling facilities of the terminating switching equipments.

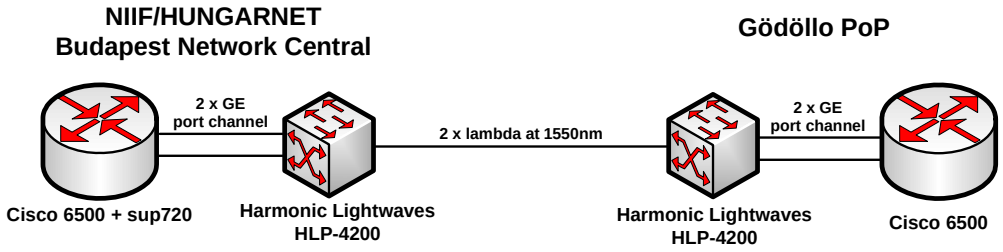

Figure 3-14 An example of intercity connection in Hungary

4. Existing solutions: Transition processes from Telco-based services to customer empowered fibre

4.1. CESNET solutions

4.1.1. Line before the dark fibre introduction

CESNET leased services from telco operators and microwave company up to 1999. Topology of this old CESNET research network, TEN-155 CZ, shows on Figure 4-1.

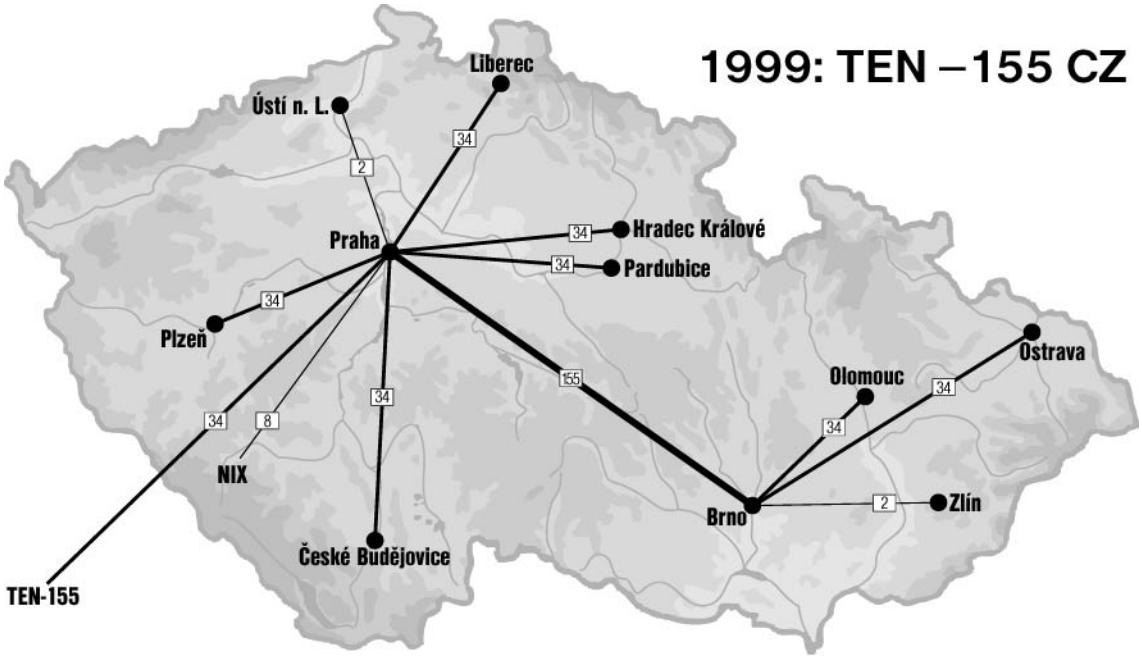

Figure 4-1 ***TEN-155 CZ topology***

4.1.2. Line after the dark fibre introduction

As one of the first organizations CESNET set off direction of development using leased dark fibre. CESNET leased the 323 km long dark fibre Praha – Brno line in 1999 and started operation of this circuit at 2.5Gbit/s in 2000. Migration of the mentioned line from STM-1 to OC-48 shows Figure 4-2.

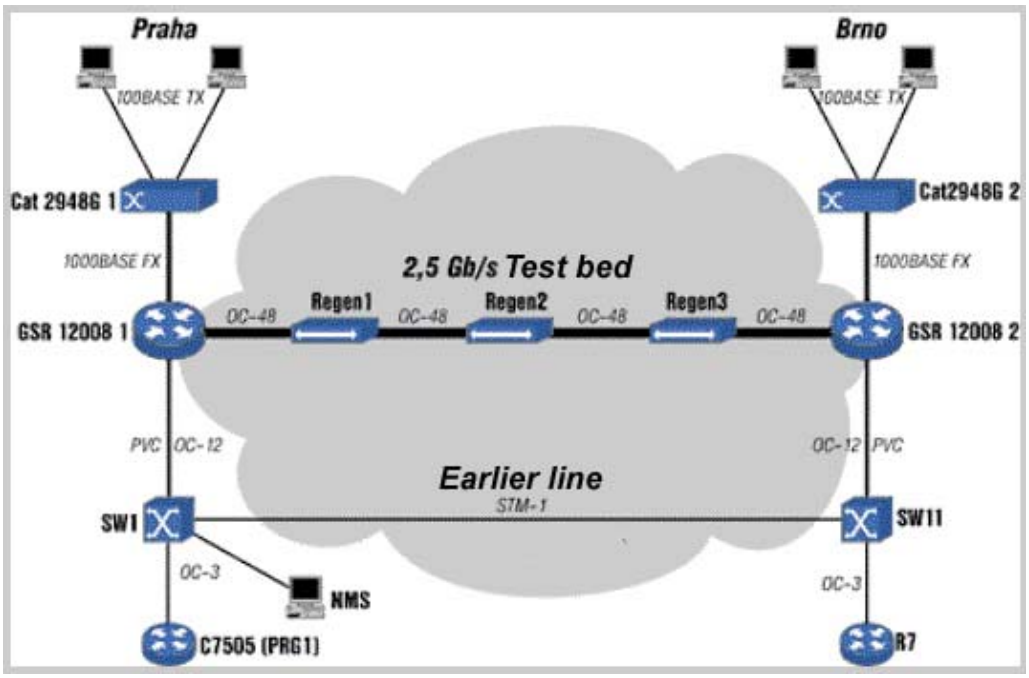

Figure 4-2 ***Physical interconnection of the equipment on Praha - Brno***

Since 2002, CESNET2 production network converts to optical technologies. Experiments with EDFA amplifiers carried out during the first half of 2002 resulted in establishing two lines utilizing state-of-the-art technology created with a method called NIL (Nothing-In-Line): a 189 km-long line between Praha and Pardubice and a slightly shorter line between Praha and Ústí nad Labem, with transfer rate of 1Gbit/s (2.5Gbit/s was tested as well) in the CESNET2 production network. The upgrade of the CESNET2 production network to a customer empowered dark fibres (CEF) was mostly completed in 2003. In August 2005 all gigabit lines of NREN in the Czech Republic are dark fibre lines empowered by CESNET.

Use of optical fibres and lambdas on a national and global scale is strategically important for development of important scientific fields. CESNET started building an experimental CEF network named CzechLight, which is dedicated to research in optical transmission technologies and connected to GLIF, the Global Lambda Integrated Facility via a 10Gbit/s lambda to NetherLight in Amsterdam.

In 1999 CESNET leased services from 5 providers. Oil transit company provided us with the only one dark fibre in our use. Other providers were telco operators. In 2002 we had three lessors for our 1000 km of dark fibres; oil transit company, power distribution company and TV cable company. Other lines we leased from telco operators and microwave company. Now we use 11 lessors for all our lines. 10 of them provide 4 380 km dark fibre for CESNET2 network and CzechLight testbed; railway company, oil distribution company, TV cable company, and 7 telco operators. CESNET2 December topology is shown on the Figure 4-3.

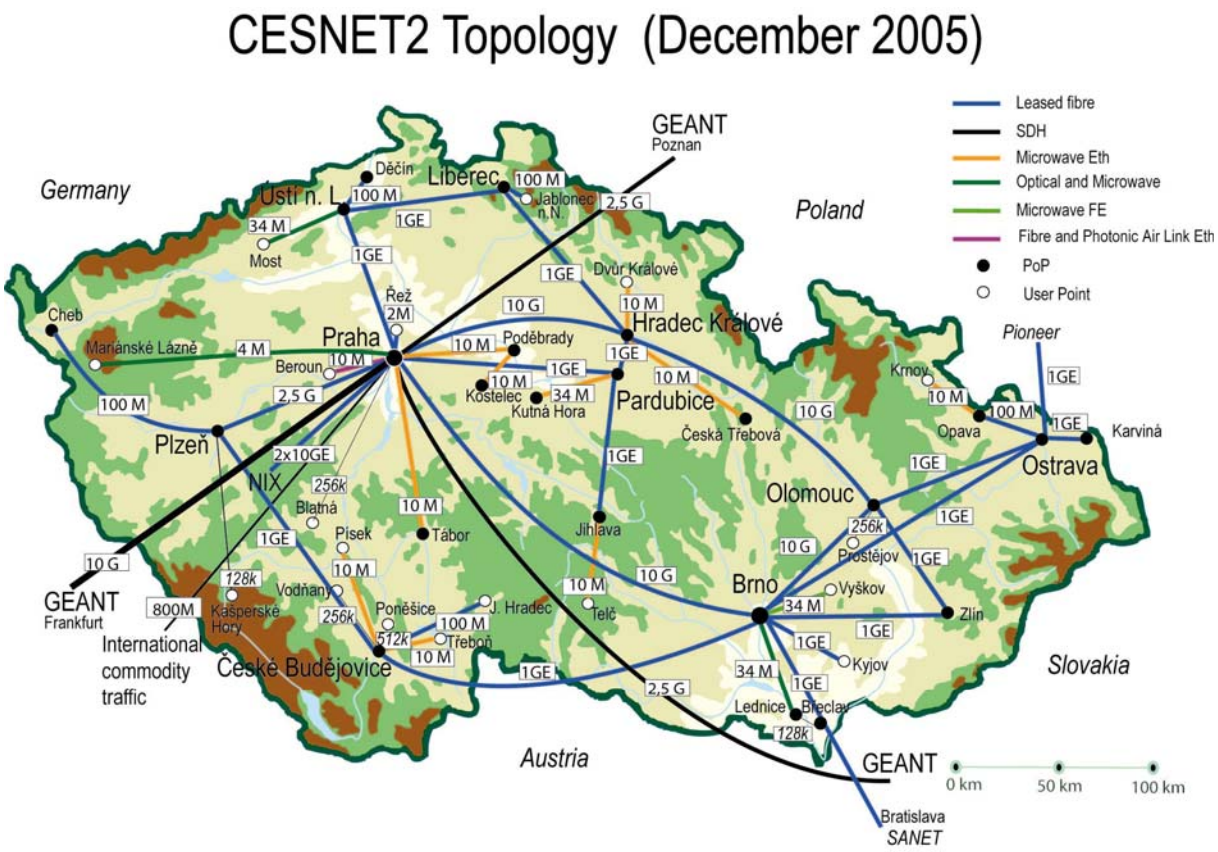

Figure 4-3 CESNET2 December 2005 topology

4.2. AMREJ solutions

AMREJ didn't have a network with significant capacities before the introduction of dark fibre into its backbone and metropolitan lines (for a brief history of AMREJ see deliverable D1.2 of the SEEFIRE project). The only technology that was used was 2Mbps E1 on few intercity and metro lines. Now dark fibre with gigabit Ethernet connections are established on some of those lines, while old 2Mbps E1 links are kept as a backup in case of the interruption on dark fibre links. One such example is the link between Belgrade and Kragujevac which is shown in the following sections.

4.2.1. Line before the dark fibre introduction

Figure 4-4 shows the E1 line between Belgrade and Kragujevac.

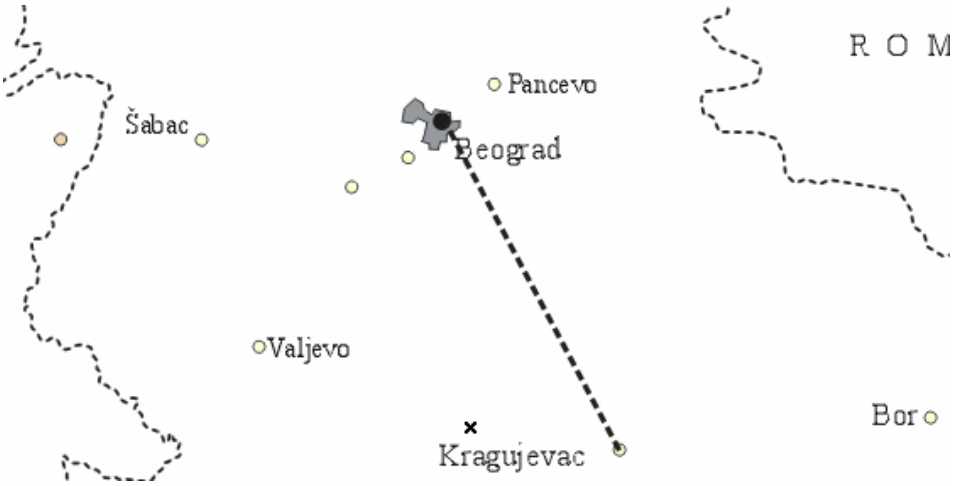

Figure 4-4 Line between Belgrade and Kragujevac

The equipment used for this E1 connection is described in the following table:

Location	Equipment used
Belgrade	Router Cisco 3662 with serial interfaces (NM-4T modules)
Belgrade	X.21 to G703 converter Telindus (CROCUS 2M CNV TWIN)
Kragujevac	Router Cisco 2620 with serial interface (WIC-1T)
Kragujevac	Modems Schmid Watson 3 with E1 and X.21 interfaces

Table 4-1 Equipment used on line between Belgrade and Kragujevac

The connection is a simple serial connection with PPP encapsulation.

4.2.2. Line after the dark fibre introduction

The single dark fibre span between Belgrade and Kragujevac is around 155km long with attenuation too large to connect Belgrade and Kragujevac without some kind of signal regeneration. The decision was to put an OEO regeneration point in Velika Plana in the Telekom Srbije central office. Velika Plana is 100km (in fibre length) from Belgrade. This is the only case in which AMREJ holds its equipment in Telekom Srbije's premises, and this is a temporary solution until the completion of the local loop in the High school in Velika Plana, which will be connected to AMREJ, and which will become one of its network nodes. Then the equipment will be transferred into the High school. The situation is described in the Figure 4-5.

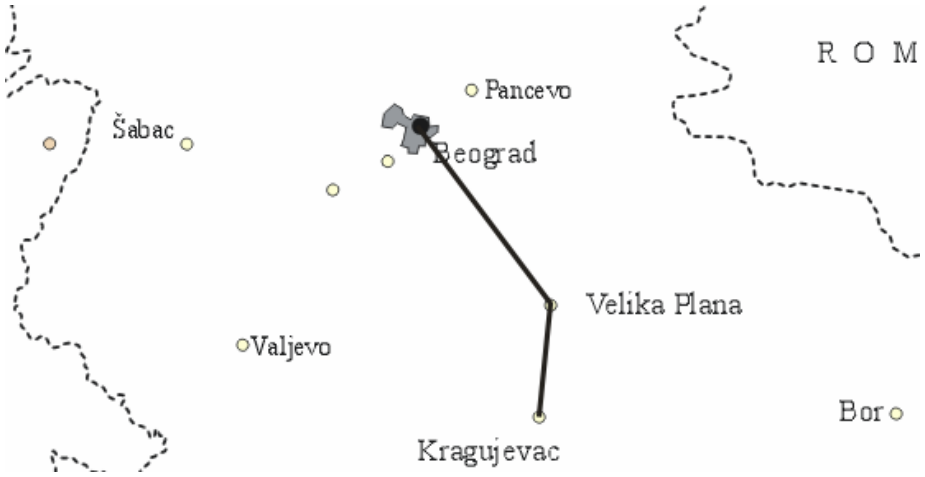

Figure 4-5 Current line between Belgrade and Kragujevac

The equipment used for this connection is the following:

Location	Equipment used
Belgrade	Cisco 6509 with SUP720 and Cisco CWDM GBIC at 1550nm
Velika Plana	Cisco 3550-12G with Cisco CWDM GBICs at 1550nm
Kragujevac	Cisco 3550-12G with Cisco CWDM GBIC at 1550nm

Table 4-2 Equipment currently used between Belgrade and Kragujevac

The way the equipment is interconnected is shown in Figure 4-6.

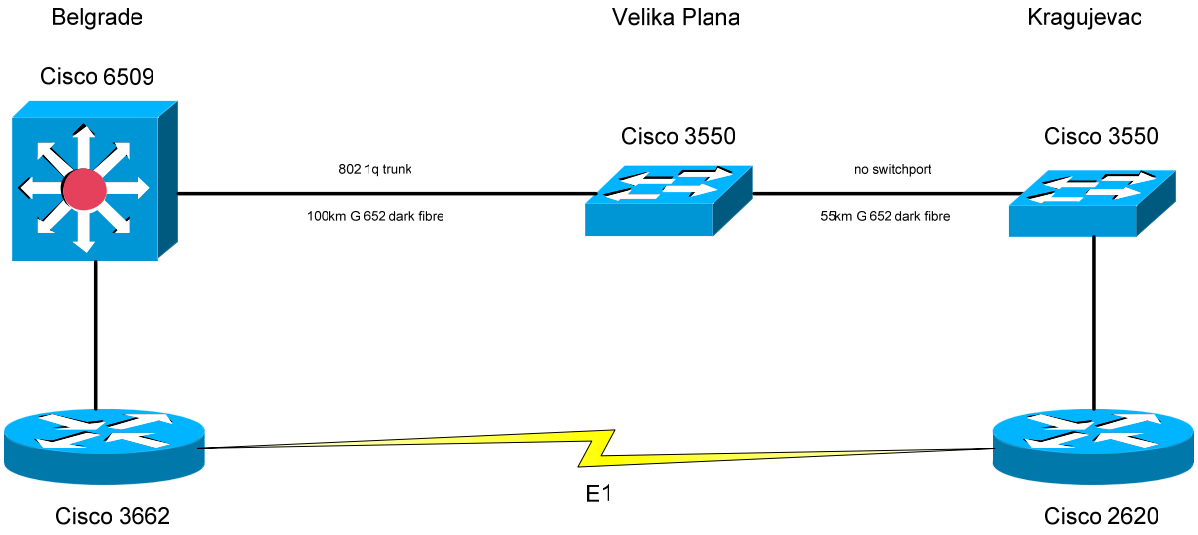

Figure 4-6 Interconnection of the equipment between Belgrade and Kragujevac

The Catalyst 3550 in Velika Plana works as signal regenerator and is under the central management from Belgrade. The other Catalyst 3550 and Cisco 2620 router are managed by the University of Kragujevac. A backup over E1 line is activated whenever there is an interruption on the dark fibre line between Belgrade and Kragujevac.

The Catalysts 6509 and 3550 are connected with 802.1q trunk, while switches in Velika Plana and Kragujevac are connected with routed ports (`no switchport` command), with point to point Ethernet link.

The activation of the backup line relies on the OSPF routing protocol which is used in AMREJ. ABR routers are Cisco 3662 and Catalyst 3550 in Velika Plana, and the equipment in Kragujevac is all in one area.

4.3. NIIF/HUNGARNET solutions

The backbone network of NIIF/HUNGARNET is depicted in Figure 4-7. This topology will be implemented by the spring of 2006. Nearly all the connections are based on leased managed services. Cross Border Fibre connection to AMREJ in Subotica is also shown at the South-East border.

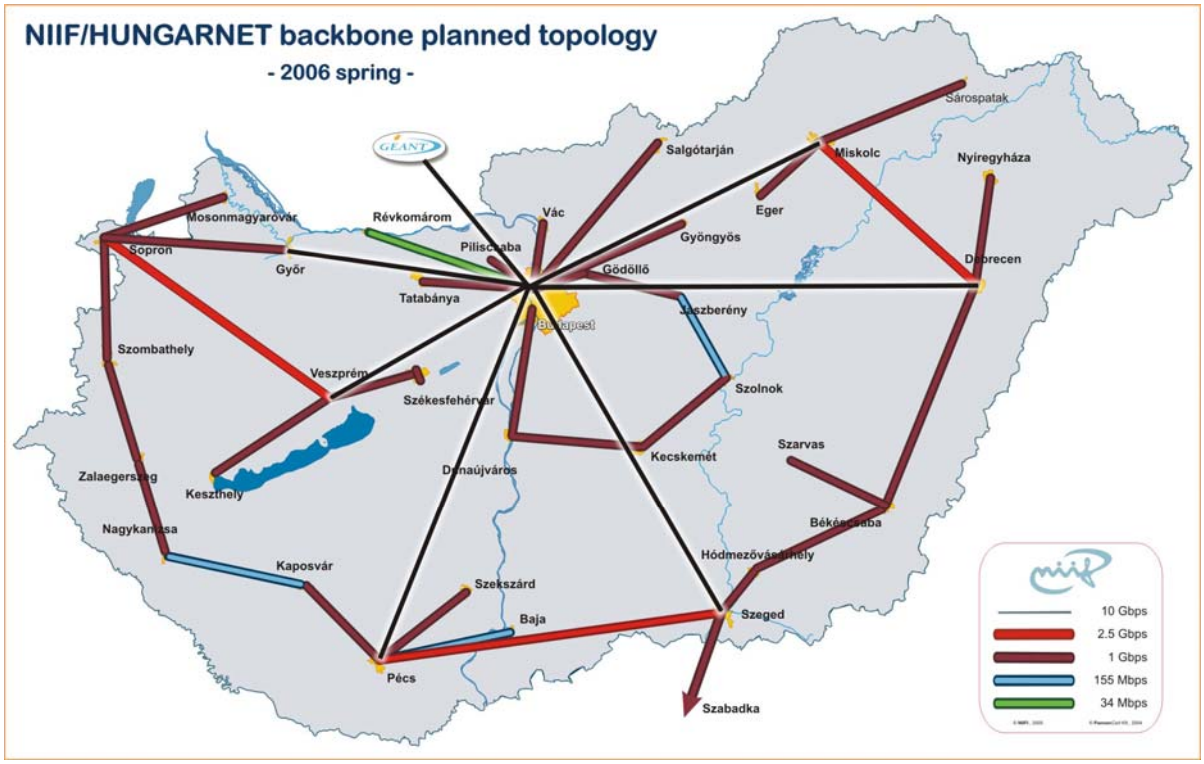

Figure 4-7 Hungarnet planned topology

Although the Hungarian telecommunication market was de-regulated several years ago, it is still difficult to obtain long-distance dark fibre lines from the telecommunication providers, especially with the following conditions:

- Short period of time (3-4 years) leasing
- Leasing in countryside

The explanation of the behaviour of the telecom operators is disappointing. There is only a limited amount of fibres laid down and owned by the alternative providers in countryside of Hungary. These providers are more willing to sell the fibres *with* services than selling only the

infrastructure. The alternative providers consider their laid fibres as their untouchable "heirloom".

The incumbent provider would be capable of selling fibres but it does not sell them because dark fibre is not considered as a product according to the internal regulation of T-Com Hungary (owned by T-Systems DE, and formerly known as MATAV). Therefore, currently the almost only viable option for NIIF/HUNGARNET to provide high-speed connectivity to universities in countryside is to lease appropriate lambdas from different telecommunication providers. The leased lambda market in Hungary is well developed, and in many cases NIIF/HUNGARNET could get reasonably priced lambda offers to any region of the country.

5. Guidelines for the design of the future SEE NREN's backbones based on dark fibre

This Chapter shows a view on possible solutions for SEE NREN backbones based on dark fibre. Backbones are designed upon data obtained in previous phases of the SEEFIRE Project (WP 1 and D2.1). All the solutions described in this Chapter do not necessarily present a way that SEE NRENs will move into, but rather one possible view with some cost estimations that can help SEE NRENs in planning new network infrastructure.

5.1. Albania and Bosnia and Herzegovina

The most difficult situation in National research and education networking in SEE region is in Albania and Bosnia and Herzegovina. Albania doesn't have established NREN as an institution and networking infrastructure is worse then in other SEE countries. INIMA in cooperation with the Ministry of Education and Science (MES), Academy of Sciences of Albania (ASA), Polytechnic University of Tirana (UPT) and Tirana University (UT) are striving to make all the necessary efforts for the creation of the Albanian NREN. In Bosnia and Herzegovina, there is a legal entity (Biharnet), but there is no proper NREN in place at the moment.

The absence of an official NREN in Albania is the reason that no studies for DF lighting are undertaken till now. Nevertheless, INIMA has made some studies of the Tirana, Interurban& International connections of POPs. The majority of institutions that are going to be connected to the future Albanian NREN, are in Tirana (described in D1.1 of this Project,), while the other possible PoPs with the estimated distances (or fibre lengths) between them are given in table 5-1.

No.	PoP1	PoP2	Approx. Distance [km]
1	Tirana	Shkodra	120
2	Shkodra	Border to Montenegro	20
3	Tirana	Durres	40
4	Durres	Lushnje	40
5	Lushnje	Fier	30
6	Fier	Vlore	35
7	Durres	Elbasan	85
8	Elbasan	Pogradec	85
9	Pogradec	Border to FYROM	8
10	Pogradec	Korce	50

Table 5-1 Main Albanian PoPs

Biharnet was also able to list the main Universities in Bosnia and Herzegovina that will be connected to the future NREN. Their main premises are located in the following cities: Sarajevo, East Sarajevo, Mostar (two universities), Banja Luka, Tuzla, Zenica, and Bihać. One of the problems in Bosnia and Herzegovina is that some Universities are not located in one city, but are dispersed over several smaller cities, which makes technical solution more difficult. Some proposed routes can be Sarajevo-East Sarajevo, Sarajevo-Mostar (both universities), Sarajevo-Zenica. Route Sarajevo-Zenica could then be split in Doboj with one

end point in Tuzla and the other in Banja Luka. And point in Banja Luka would then be extended to reach Bihać.

Both networks might use low cost technical solution for the transmission equipment, similar to the solution described in AMREJ, MARNET or ISTF cases in subsequent sections.

5.2. Bulgaria

ISTF currently is leasing lines with the incumbent national telecom operator - BTC. However, in the last 2-3 years, since the liberalization of 1st January 2003, the telecommunications market in the country is being rapidly developing and many alternative operators have laid down their own fibre-optic infrastructure. On that basis new opportunities have emerged, including possibilities for long-term leasing of fibre, which is now considered as the best financially advantageous long-term strategy for the development of the national research network.

Taking into account the relatively big number of universities (42) for the size of the country and their complex location in 13 towns spread all over Bulgaria, the NREN development plan is to be envisioned at least in 3 stages. The fist two stages have to provide an overall solution for the national backbone, which is the most expensive component of the network. The next stage is to be focused on the metropolitan networks in Sofia, Varna and Plovdiv, where more than 5 universities are located in each of the towns.

Below a possible solution strategy for the national backbone procurement is provided, based on long-term dark fibre leasing, i.e. 15-years IRU contracting with local fibre optic owners. High capacity and international connectivity is gained at relatively cheap cost using Gigabit Ethernet equipment (also CWDM equipment could be used).

5.2.1. Situation – main PoPs, routes and budget dark fibre cost

The PoPs of the network are listed in Table 5-2, which also describes the estimated length of the different spans and dark fibre budget cost, under a two-stage initial development plan for the network.

No.	PoP1	PoP2	Fibre type	Approx. Distance [km]	Dark fibre cost [Euro/year**]
1	Sofia	Plovdiv	G.652	149	59 600
2	Plovdiv	Stara Zagora	G.652	93	37 200
3	Sofia	Veliko Tarnovo	G.652	223	89 200
4	Veliko Tarnovo	Pleven	G.652	126	50 400
5	Veliko Tarnovo	Svishtov	G.652	90	36 000
6	Veliko Tarnovo	Rousse	G.652	105	42 000
7*	Sofia	Blagoevgrad	G.652	99	39 600
8*	Sofia	Pravetz	G.652	60	24 000
9	Veliko Tarnovo	Gabrovo	G.652	46	18 400
10*	Rousse	Shumen	G.652	114	45 600
11*	Shumen	Varna	G.652	92	36 800
12*	Varna	Burgas	G.652	128	51 200

13	Veliko Tarnovo	Varna	G.652	229	91 600
TOTAL Stage 1:					**424 400**
TOTAL Stage 2:					**197 200**
TOTAL:					**621 600**
Contingencies – 10%:					**62 160**
TOTAL with contingencies:					**683 760**

*Spans marked with * are second stage topology spans.*

*Prices marked with ** are for 15 years IRU without included VAT.*

Table 5-2 Main PoPs and dark fibre routes in Bulgaria

The network topology for the first two stages is shown on Figure 5-1.

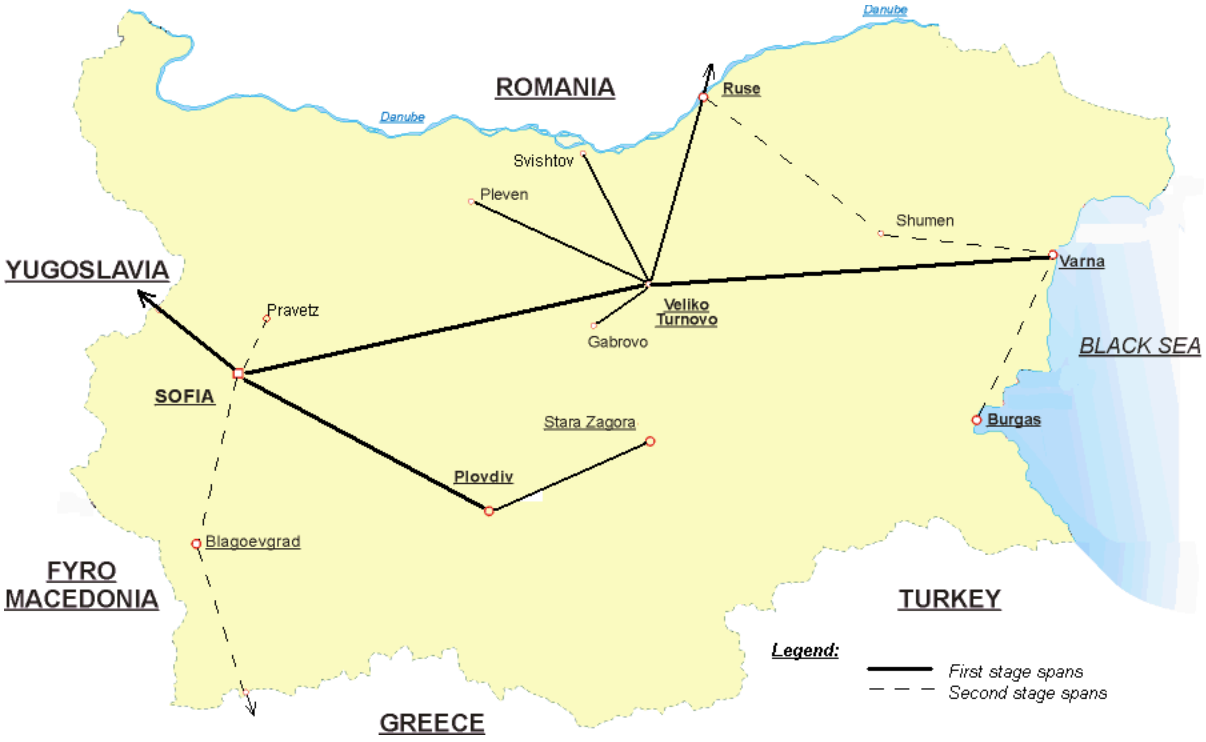

Figure 5-1 Bulgarian NREN network topology

5.2.2. Solution

The strategy is to build a dark fibre backbone. The main advantages of this solution are:

- Cheap equipment for lighting the dark fibre could be used;
- High capacities technologies;
- Very fast line provisioning;
- Possibilities of future migration and upgrade;
- Compatibility with IPv6.

Relatively cheap Layer 2 and Layer 3 switches with long range 1 Gbit/s Ethernet GBIC and SFP interface in each PoP. Most of the spans between the PoPs are shorter than the long-range Gigabit interface and amplification or regeneration is needed only on some spans.

5.2.2.1 Equipment

Table 5-2 shows the equipment needed for lighting dark fibre with rough budget price of the network (based on prices published in Internet). In the main cities (Sofia, Plovdiv, Veliko Tarnovo, Varna, Rousse and Blagovgrad) high performance Layer 3 switches will be used, in other cities Layer 3 access switches (IPv6 compatible) will be used. All switches are specified only with the basic equipment and interface needed to interconnect PoPs. In the towns located near the national borders, the interfaces for connecting neighbouring NRENs are taken into account (1Gbit/s Ethernet). Also CWDM technology could be used to separate national and cross border traffic but is not included in Table 5-3. Note that equipment and interface for connecting LANs or MANs in each PoP, power supply and air conditioning equipment in the PoPs are not included.

PoP	Equipment	Quantity (Stage 1)	Quantity (Stage 2)	Unit Price [EUR]	Total price (Stage 1)	Total price (Stage 2)
Sofia	L3 switch – High performance	1		46,775	46,775	
	SFP interface	3	2	3,400	10,200	6,800
	EDFA Amplifier	2		21,000	42,000	
Plovdiv	L3 switch – High performance	1		46,775	46,775	
	SFP interface	2		3,400	6,800	
	EDFA Amplifier	1		21,000	21,000	
Veliko Tarnovo	L3 switch – High performance	1		46,775	46,775	
	SFP interface	6		3,400	20,400	
	EDFA Amplifier	3		21,000	63,000	
Pleven	L3 switch	1		4,930	4,930	
	SFP interface	1		3,400	3,400	
	EDFA Amplifier	1		21,000	21,000	
Svishtov	L3 switch	1		4,930	4,930	
	SFP interface	1		3,400	3,400	
Varna	L3 switch – High performance	1		46,775	46,775	
	SFP interface	1	2	3,400	3,400	6,800
	EDFA Amplifier	1	1	21,000	21,000	21,000
Gabrovo	L3 switch	1		4,930	4,930	
	SFP interface	1		3,400	3,400	
Rousse	L3 switch – High performance	1		46,775	46,775	
	SFP interface	2	1	3,400	6,800	3,400
	EDFA Amplifier		1	21,000		21,000

Stara Zagora	L3 switch	1		4,930	4,930	
	SFP interface	1		3,400	3,400	
Blagoevgrad	L3 switch – High performance		1	46,775		46,775
	SFP interface		2	3,400		6,800
Pravetz	L3 switch		1	4,930		4,930
	SFP interface		1	3,400		3,400
Burgas	L3 switch		1	4,930		4,930
	SFP interface		1	3,400		3,400
	EDFA Amplifier		1	21,000		21,000
Shumen	L3 switch		1	4,930		4,930
	SFP interface		2	3,400		6,800
	EDFA Amplifier		1	21,000		21,000
TOTAL Stage 1:					**482,795**	
TOTAL Stage 2:						**182,965**
TOTAL:					**665,760**	

Table 5-3 Equipment needed for Bulgarian NREN in case study

Figure 5-2 shows how the equipment is interconnected.

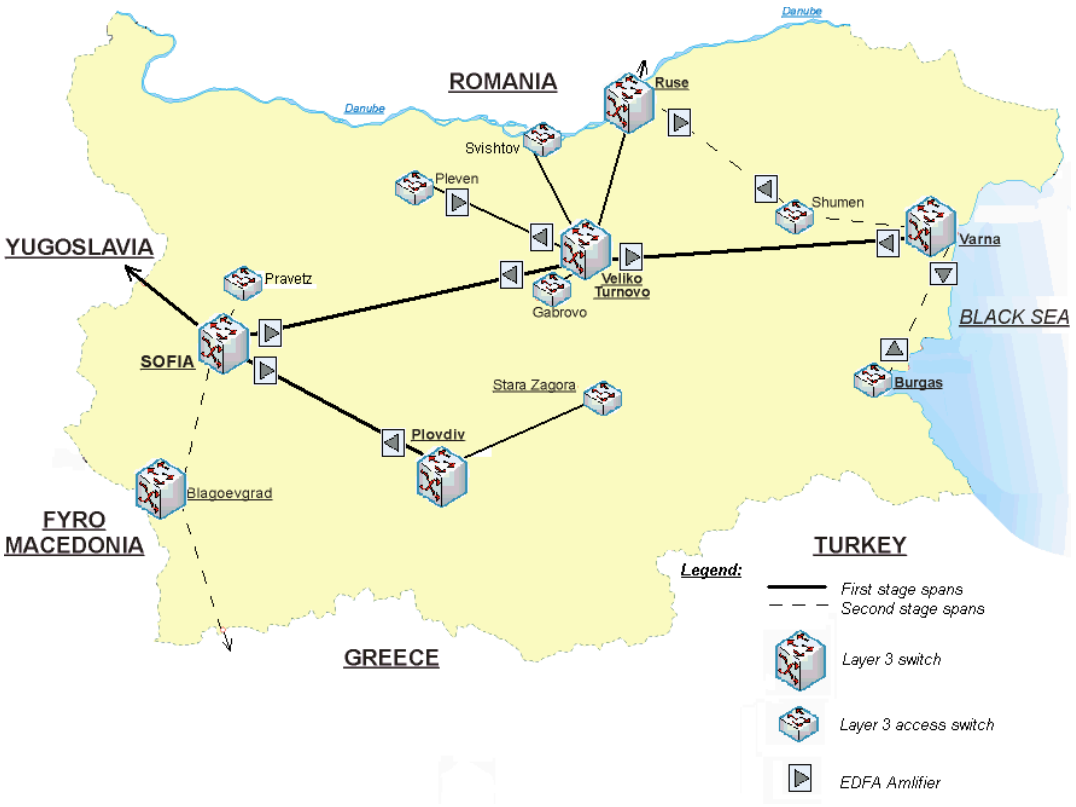

Figure 5-2 Interconnection of the equipment in Bulgarian NREN

5.3. Former Yugoslav Republic of Macedonia

At the moment, dark fibre is not available on the Macedonian telecommunication market. Makedonski telekomunikacii has the biggest optical backbone network in the country, but they only offer digital leased lines. MEPSO, an electric power transmission company, owns an optical network installed along its transmission lines, but fibres that are not used for their own communication system are still not offered on the market.

MARNet's vision is to build a nationwide optical backbone network based on leased dark fibres, connecting all the university cities in the country. International optical connections to neighbouring countries are also planned.

The case study presented below gives an estimate of the links and the equipment needed to build such network.

5.3.1. Main PoPs and routes

The PoPs listed in D1.1 will be used in this case study. These PoPs are located in all university cities in Macedonia: Skopje, Bitola, Prilep, Ohrid, Stip and Tetovo.

Table 5-4 lists the optical links that will be used for future MARNet optical nationwide backbone network. The provided distance figures are approximate, taken by either road/railroad network distances or distances along the power transmission lines with installed optical cables (where appropriate).

Table 5-4 also lists the envisioned international connections to NRENs in neighbouring countries: Ohrid to Albanian border, Bitola to Greek border, Stip to Bulgarian border, Skopje to the border with Serbia and Montenegro and a direct link from Skopje to the Greek border.

No.	PoP1	PoP2	Approx. Distance [km]
1	Skopje	Prilep	100
2	Prilep	Bitola	45
3	Bitola	Ohrid	65
4	Prilep	Stip	120
5	Skopje	Tetovo	50
6	Stip	Border to Bulgaria	80
7	Skopje	Border to Serbia and Montenegro	60
8	Skopje	Border to Greece	150
9	Bitola	Border to Greece	25
10	Ohrid	Border to Albania	30

Table 5-4 Planned optical links between PoPs in MARNet's backbone network (including cross-border optical links)

All the links listed in Table 5-3 are also depicted on Figure 5-3 below.

5.3.2. Equipment

The required equipment for lighting the dark fibre links listed in the previous subsection is estimated considering the following assumptions:

- Each dark fibre link will operate on a single lambda framed with 1 Gigabit Ethernet
- Each PoP will be equipped with a layer-3 switch (with SFPs)
- The maximum distance that a SFP can cover is expected to be 110km.

Table 5-3 shows the equipment needed at each PoP. All PoPs will have access-class Layer 3 switches except Skopje which is planned to be equipped with a higher class Layer 3 switch. In the initial phases, Layer 3 switches will have only the necesarry SPFs to provide optical connectivity needed for the operation of 1 Gigabit Ethernet backbone network.

Amplification or regeneration might be needed only on few spans within the country. Depending on the actual link distances, it might be needed on the links Skopje – Prilep and Prilep – Stip. Regarding the international links, amplification or regeneration will be most probably needed between Skopje and Vranje (Serbia and Montenegro), Stip and closest PoP in Bulgaria, and Skopje – closest PoP in Greece. EDFA amplifiers have been chosen as an example for this case study.

Table 5-5 also gives a cost estimate for the listed equipment (based on publicly available prices).

PoP	Equipment	Quantity	Unit price [EUR]	Total Price [EUR]
Skopje	L3 switch high performance	1	50,930	50,930
	SFP interface	4	4,240	16,960

	EDFA	3	15,000	45,000
Prilep	L3 switch	1	10,178	10,178
	SFP interface	3	4,240	12,720
	EDFA	2	15,000	30,000
Bitola	L3 switch	1	10,178	10,178
	SFP interface	3	4,240	12,720
Ohrid	L3 switch	1	10,178	10,178
	SFP interface	2	4,240	8,480
Stip	L3 switch	1	10,178	10,178
	SFP interface	2	4,240	8,480
	EDFA Amplifier	2	15,000	30,000
Tetovo	L3 switch	1	10,178	10,178
	SFP interface	1	4,240	4,240
TOTAL				**270,420**

Table 5-5 Equipment needed at each PoP

Figure 5-3 Planned optical backbone network of MARNet

Further phases of development of the MARNet infrastructure should include:

- Implementation of WDM (multiple lambda) operation in the backbone and international links
- Introducing new PoPs in the backbone located at prospective university cities
- Building optical metro networks in all PoPs (following the example in Skopje, described in Section 4.3 of this Deliverable)

5.4. Greece

In this section a case study is analysed for lighting dark fibre links which connect major GRNET PoPs. A “minimal” approach is followed by using a single static CWDM lambda per dark fibre link. Note that what is stated in this section by no means states GRNET’s plans for next-generation GRNET network (GRNET3) design.

5.4.1. Situation – main PoPs and routes

For this case study, the GRNET PoPs listed in D1.1 will be used; in order to make things as simple as possible it is assumed that the 3 GRNET PoPs in Athens (Koletti, Illissos and Acropolis) are consolidated into a single PoP.

Table 5-6 lists the dark fibre links that will be used for this exercise. Note that for terrestrial links, the distance figures provided were taken by the road network distances, where feasible.

No.	PoP1	PoP2	Approx. Distance [km]
1	Thessaloniki	Larissa	186
2	Athens	Larissa	326
3	Athens	Patras	216
4	Thessaloniki	Ioannina	368
5	Athens	Syros	170
6	Syros	Heraklio	360
7	Heraklion	Rethymno	100
8	Rethymno	Chania	70
9	Chania	Athens	375
10	Patra	Ioannina	301
11	Thessaloniki	Ksanthi	221

Table 5-6 Dark fibre links used for case study

Figure 5-4 shows these DF links at the map of Greece.

Figure 5-4: GRNET links

5.4.2. Equipment

In order to define the required equipment for lighting the particular dark fibre routes, the following assumptions were made:

1. Each dark fibre link contains a single CWDM lambda.
2. Lambda's framing is 1 Gigabit Ethernet.
3. Each PoP will be equipped with a layer-2 switch along with CWDM SFPs.
4. Each PoP will be equipped with a passive CWDM mux/demux so as to be ready for multilambda upgrade.
5. The attenuation value for dark fibre links is expected to be 0.25dB/km. The attenuation tolerance value for a typical CWDM SFP is assumed to be 30dB. Hence the maximum distance that a CWDM SFP can cover is about 120km.

As shown in table 5-7 most of the links are beyond the barrier of 120km that a CWDM SFP can cover; this opens two possibilities:

1. To deploy EDFAs at intermediate sites

2. To regenerate (3R) CWDM lambdas at intermediate sites by using layer-2 switches with CWDM SFPs.

However, due to the fact that CWDM multiplexing is deployed, EDFAs can impose an upper limit on the number of the multiplexed lambdas. More specifically, in most cases EDFAs cannot amplify more than two lambdas. For this reason the proposed design is heavily based on intermediate regeneration PoPs with the exception of submarine links where there is limited flexibility in defining intermediate PoPs.

The following table provides the list of the intermediate PoPs for each of the defined links. Intermediate links were chosen on the basis of the distance as well as the possibility of providing services to extra GRNET clients.

No.	PoP1	PoP2	Approx. Distance [km]
1	Thessaloniki	Larissa	186
	Thessaloniki	Katerini	100
	Katerini	Larissa	86
2	Athens	Larissa	326
	Athens	Livadia	97
	Livadia	Lamia	112
	Lamia	Larissa	117
3	Athens	Patras	216
	Athens	Kiato	103
	Kiato	Patras	113
4	Thessaloniki	Ioannina	368
	Thessaloniki	Veria	76
	Veria	Grevena	114
	Grevena	Metsovo	79
	Metsovo	Ioannina	99
5	Athens	Syros	170
	Athens	Lavrio	60
	Lavrio	Syros	110
6	Syros	Heraklio	360
	Syros	Naxos	95
	Naxos	Santorini	105
	Santorini	Heraklio	160
7	Heraklion	Rethymno	100
8	Rethymno	Chania	70
9	Athens	Chania	395
	Athens	Lavrio	60
	Lavrio	Milos	160
	Milos	Chania	175

10	Patra	Ioannina	301
	Patra	Agrinio	85
	Agrinio	Preveza	99
	Preveza	Ioannina	117
11	Thessaloniki	Ksanthi	221
	Thessaloniki	Asprovalta	99
	Asprovalta	Kavala	85
	Kavala	Ksanthi	56

Table 5-7 Intermediate points on lines specified in Table 5-5

Figure 5-5 shows the terminal and intermediate PoPs at the map of Greece.

Figure 5-5: GRNET terminal and intermediate PoPs

The following table illustrates the equipment that will be deployed at each GRNET PoP as well as some cost indication.

PoP	Type	Equipment	Quantity	Unit price [EUR]	Total Price
Agrinio	Intermediate	L2 switch	1	10,178.00	10,178.00
		SFP interface	2	4,240.00	8,480.00
		CWDM 4-lambda OADM with chassis	2	8,480.00	16,960.00
Asprovalta	Intermediate	L2 switch	1	10,178.00	10,178.00
		SFP interface	2	4,240.00	8,480.00
		CWDM 4-lambda OADM with chassis	2	8,480.00	16,960.00
Athens	Terminal	L2 switch	1	10,178.00	10,178.00
		SFP interface	4	4,240.00	16,960.00
		CWDM 4-lambda OADM with chassis	4	8,480.00	33,920.00
Chania	Terminal	L2 switch	1	10,178.00	10,178.00
		SFP interface	2	4,240.00	8,480.00
		CWDM 4-lambda OADM with chassis	2	8,480.00	16,960.00
		EDFA	2	15,000.00	30,000.00
Grevena	Intermediate	L2 switch	1	10,178.00	10,178.00
		SFP interface	2	4,240.00	8,480.00
		CWDM 4-lambda OADM with chassis	2	8,480.00	16,960.00
Heraklion	Terminal	L2 switch	1	10,178.00	10,178.00
		SFP interface	2	4,240.00	8,480.00
		CWDM 4-lambda OADM with chassis	2	8,480.00	16,960.00
		EDFA	2	15,000.00	30,000.00
Ioannina	Terminal	L2 switch	1	10,178.00	10,178.00
		SFP interface	2	4,240.00	8,480.00
		CWDM 4-lambda OADM with chassis	2	8,480.00	16,960.00
Katerini	Intermediate	L2 switch	1	10,178.00	10,178.00
		SFP interface	2	4,240.00	8,480.00
		CWDM 4-lambda OADM with chassis	2	8,480.00	16,960.00
Kavala	Intermediate	L2 switch	1	10,178.00	10,178.00
		SFP interface	2	4,240.00	8,480.00
		CWDM 4-lambda OADM with chassis	2	8,480.00	16,960.00
Kiato	Intermediate	L2 switch	1	10,178.00	10,178.00
		SFP interface	2	4,240.00	8,480.00
		CWDM 4-lambda OADM with chassis	2	8,480.00	16,960.00
Ksanthi	Terminal	L2 switch	1	10,178.00	10,178.00
		SFP interface	1	4,240.00	4,240.00
		CWDM 4-lambda OADM with chassis	1	8,480.00	8,480.00
Lamia	Intermediate	L2 switch	1	10,178.00	10,178.00

		SFP interface	2	4,240.00	8,480.00
		CWDM 4-lambda OADM with chassis	2	8,480.00	16,960.00
Larissa	Terminal	L2 switch	1	10,178.00	10,178.00
		SFP interface	2	4,240.00	8,480.00
		CWDM 4-lambda OADM with chassis	2	8,480.00	16,960.00
Lavrio	Intermediate	L2 switch	1	10,178.00	10,178.00
		SFP interface	4	4,240.00	16,960.00
		CWDM 4-lambda OADM with chassis	4	8,480.00	33,920.00
		EDFA	2	15,000.00	30,000.00
Livadia	Intermediate	L2 switch	1	10,178.00	10,178.00
		SFP interface	2	4,240.00	8,480.00
		CWDM 4-lambda OADM with chassis	2	8,480.00	16,960.00
Metsovo	Intermediate	L2 switch	1	10,178.00	10,178.00
		SFP interface	2	4,240.00	8,480.00
		CWDM 4-lambda OADM with chassis	2	8,480.00	16,960.00
Milos	Intermediate	L2 switch	1	10,178.00	10,178.00
		SFP interface	2	4,240.00	8,480.00
		CWDM 4-lambda OADM with chassis	2	8,480.00	16,960.00
		EDFA	4	15,000.00	60,000.00
Naxos	Intermediate	L2 switch	1	10,178.00	10,178.00
		SFP interface	2	4,240.00	8,480.00
		CWDM 4-lambda OADM with chassis	2	8,480.00	16,960.00
Patras	Terminal	L2 switch	1	10,178.00	10,178.00
		SFP interface	2	4,240.00	8,480.00
		CWDM 4-lambda OADM with chassis	2	8,480.00	16,960.00
Preveza	Intermediate	L2 switch	1	10,178.00	10,178.00
		SFP interface	2	4,240.00	8,480.00
		CWDM 4-lambda OADM with chassis	2	8,480.00	16,960.00
Rethymno	Terminal	L2 switch	1	10,178.00	10,178.00
		SFP interface	2	4,240.00	8,480.00
		CWDM 4-lambda OADM with chassis	2	8,480.00	16,960.00
Santorini	Intermediate	L2 switch	1	10,178.00	10,178.00
		SFP interface	2	4,240.00	8,480.00
		CWDM 4-lambda OADM with chassis	2	8,480.00	16,960.00
		EDFA	2	15,000.00	30,000.00
Syros	Terminal	L2 switch	1	10,178.00	10,178.00
		SFP interface	2	4,240.00	8,480.00
		CWDM 4-lambda OADM with chassis	2	8,480.00	16,960.00
Thessaloniki	Terminal	L2 switch	1	10,178.00	10,178.00
		SFP interface	3	4,240.00	12,720.00

		CWDM 4-lambda OADM with chassis	3	8,480.00	25,440.00
Veria	Intermediate	L2 switch	1	10,178.00	10,178.00
		SFP interface	2	4,240.00	8,480.00
		CWDM 4-lambda OADM with chassis	2	8,480.00	16,960.00
TOTAL					**1,121,330.00**

Table 5-8 Equipment needed for Grnet case study

5.5. Romania

RoEduNet does not use yet dark fibre or lambda services for the national backbone. All national links use classic SDH service provided by various telecom companies in Romania.

However, there are some projects to deploy high speed connections using dark fibre or, at least, leased lambdas.

5.5.1. Situation - main PoPs and routes

The communication infrastructure for research and education in Romania uses a layered data communication system:

- **Level 0** Backbone links (including GÉANT connections) and RoEduNet NOCs (Network Operation Centres) located in:
    - Bucharest - Splaiul Independentei, "Politehnica" University, Rectorate Building, R506-507, +40-21-410-1639
    - Iaşi - Carol I, 11, "Alexandru Ioan Cuza" University, Building A, room 169, +40-232-201-001
    - Târgu-Mureş - N. Iorga, 1, Technical University, room 204, +40-265-215-843
    - Cluj Napoca - Baritiu, 26-28, Technical University, room 22, +40-264-194-684
    - Timişoara - V.Parvan, 2, Technical University, room B251, +40-256-403-283
    - Craiova - Lapusului 5, Craiova University, room 308, +40-252-436-699
    - Galati - Domneasca 47, "Dunarea de Jos" University, Building Y, room 010, +40-236-414-112
- **Level 1** RoEduNet POPs (Points of Operation) from all county capitals and communication lines between NOCs and POPs. Every RoEduNet NOC has a number of connected POPs, overall there are 33 distinct POPs. RoEduNet NOCs are acting also as POP for the county in which they are located. This level includes also Metropolitan Area Networks: until now just two - Iaşi and Bucharest;
- **Level 2** RoEduNet connected institutions: universities, high schools and schools, research institutes and other non-profit organisations.

RoEduNet offers connectivity to the GÉANT network and to the Internet, using national communication infrastructure, to a few hundred institutions. Some approximate figures about the distribution by type of institution follows: 39 Universities, 32 Research Institutions, about 500 Colleges, High Schools and Schools and 40 other cultural and non-profit institutions.

In addition, RoEduNet owns two Metropolitan Area Networks based on optic fibre (Iasi and Bucharest). There is also another MAN in Cluj, but this one is only operated by RoEduNet

staff from corresponding NOC located in Cluj Technical University (part of Universities Consortium, which owns the CAMAN - Cluj Academic MAN).

The topology and the location of the main NOCs (main POPs of RoEduNet) for Layer 0 is presented in the picture below:

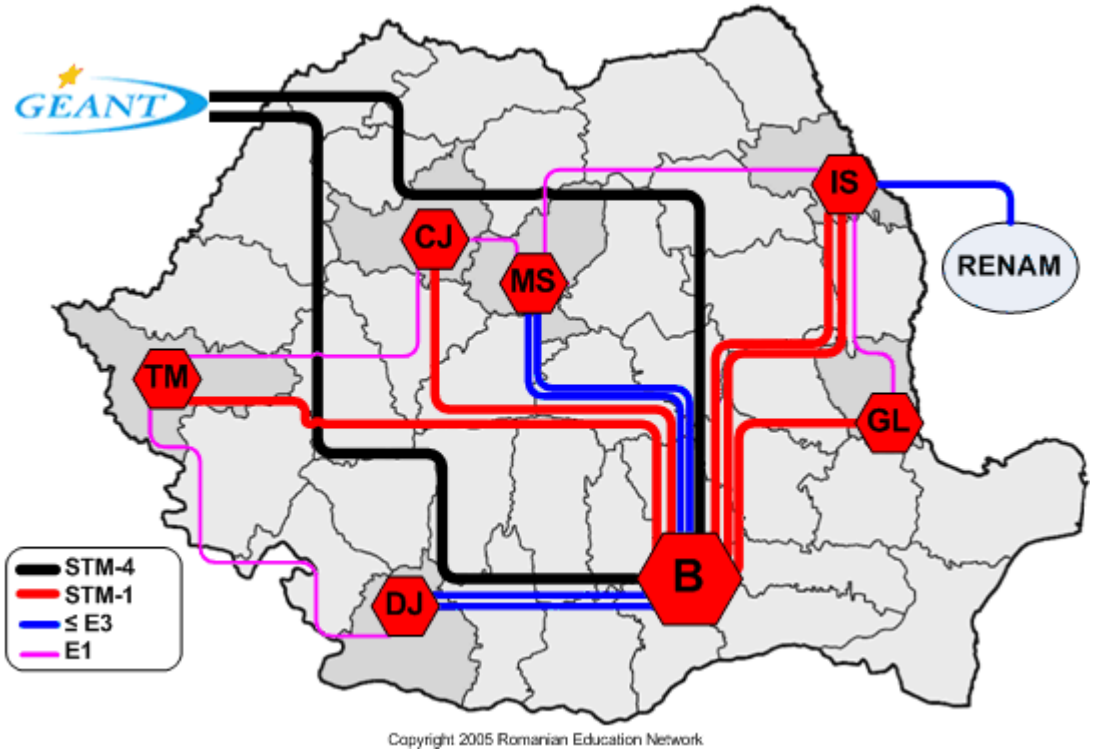

Figure 5-6 RoEduNet – Layer 0 topology including NOCs (main POPs)

The main connections for layer 1 consist of the links between NOCs and POPs and almost all of them uses 10 Mbit/s Ethernet technology. The picture showing the topology of Layer 1 is presented below.

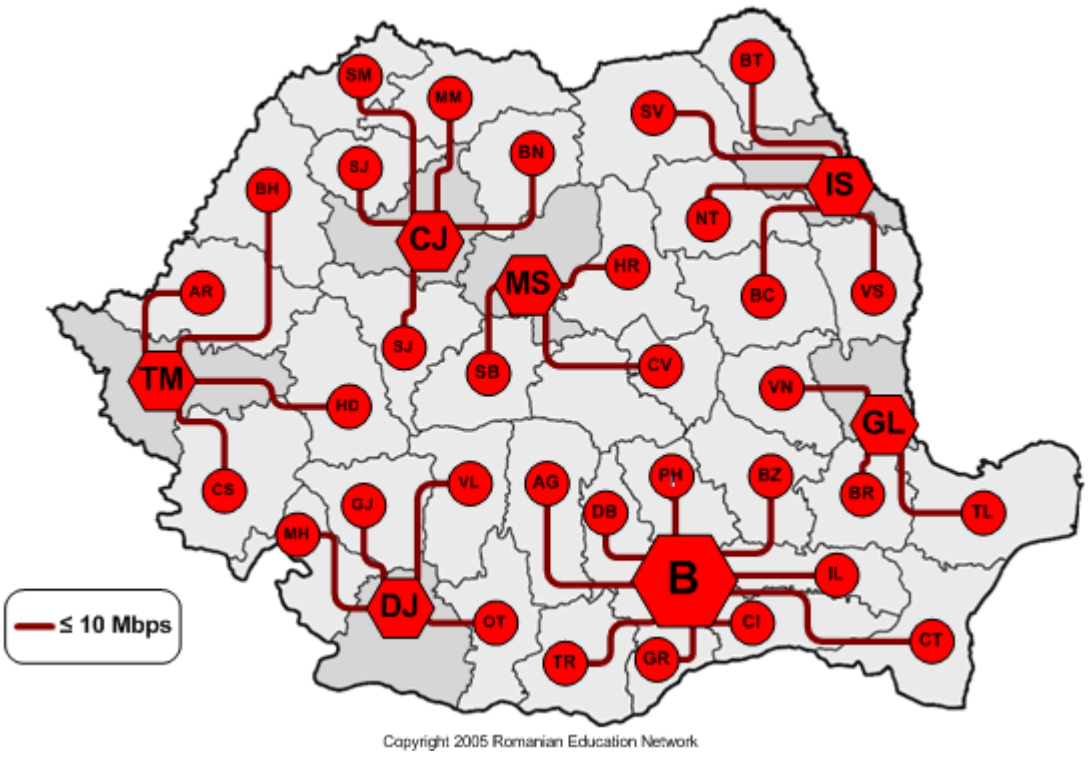

Figure 5-7 RoEduNet – Layer 1 topology including all NOCs and POPs

5.5.2. Situation - main PoPs and routes

RoEduNet already proposed to the Ministry of Education and Research a project to move the main NOCs to dark fibre (layer 0 of the RoEduNet infrastructure) in the first stage and the POPs in a second stage. To minimise the costs DWDM technology has been proposed for the Layer 0 and CWDM for the Layer 1 links.

A study has been conducted to identify the potential providers for the dark fibre along all routes. The results of the SEEFIRE WP1 has been used for this research, also negotiations have been started with state owned companies to minimise the costs for the links and to provide long term stability for the whole investment. Two potential fibre owners were identified; a formal collaboration agreement has been signed.

According to this agreement, the topology of the dark fibre to be used by RoEduNet is shown in the picture below.

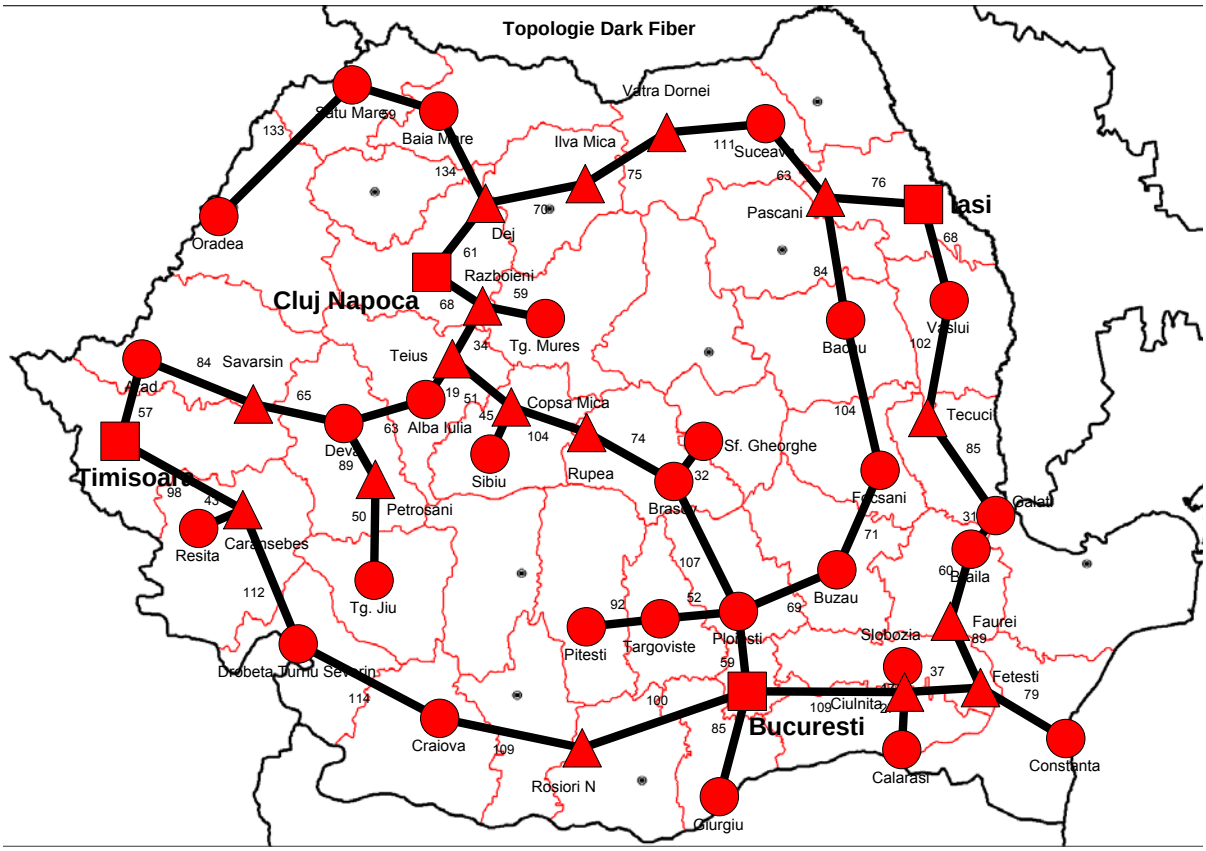

Figure 5-8. Proposed complete dark fibre topology.

Each span length is included in the picture. It should be mentioned that in the first phase of the project we intend to connect only the NOCs (red squares in the pictures above). There are two drawbacks of the proposed project:

a. There are seven POPs not covered with dark fibre and either another provider should be identified or others solutions for each POP should be explored. However, some of the locations will be connected in the near future.

b. Another problem is that one span is longer that 120 km. To overcome this problem the connection will be moved to another POP when the fibre will be available. According to the providers' plans, this should happen next year.

The first stage of the project involves the connections of the NOCs. The proposed topology to cover all NOCs and to provide redundancy consists of two main national rings using DWDM. The picture of this topology is presented below.

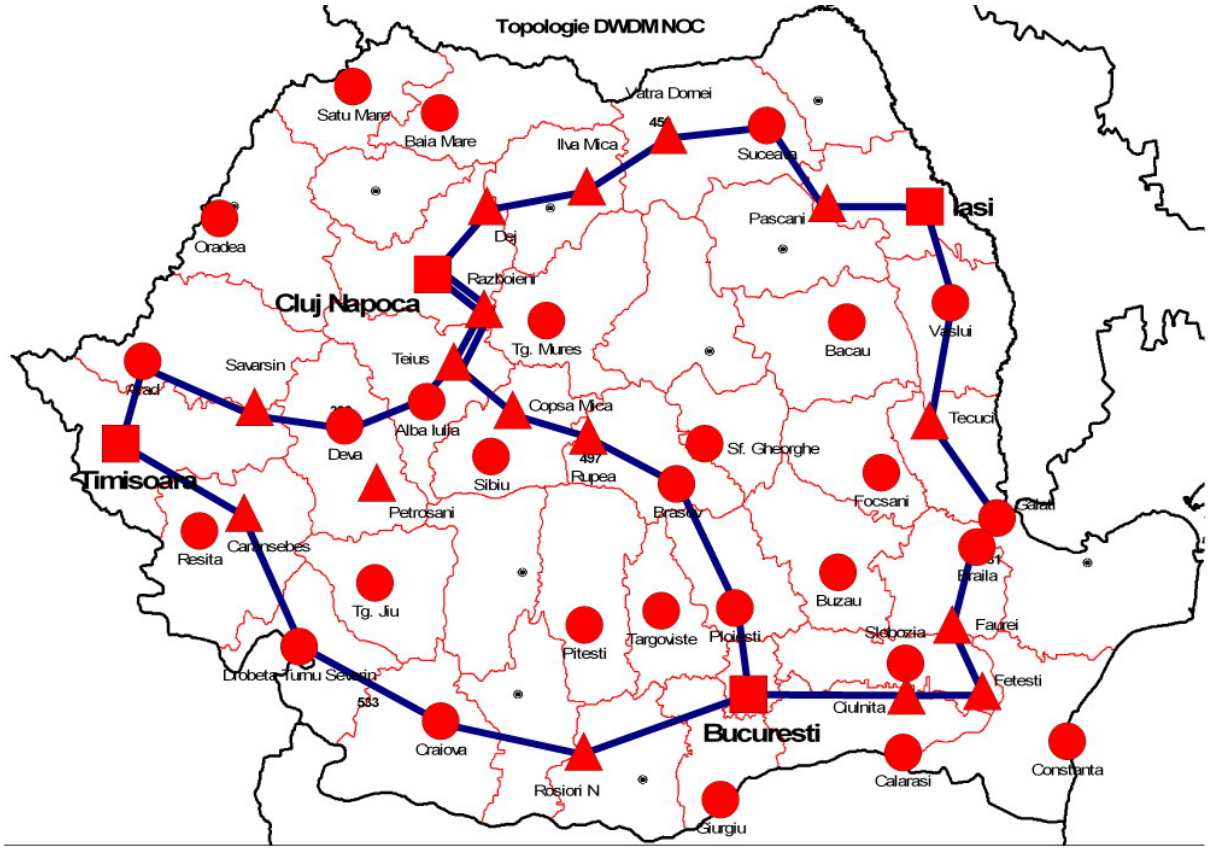

Figure 5-9 DWDM proposed topology

The red squares represent the NOCs, the red circles the POPs along the dark fibre routes and the red triangles the possible locations for optical amplifiers where the carrier is able to provide equipment collocation and access to electrical power and security.

In the table below the length of each link between NOCs is provided:

From NOC	To NOC	Length (km)
Bucharest	Iasi	581
Bucharest	Cluj	497
Bucharest	Timisoara	533
Iasi	Cluj	456
Timisoara	Cluj Napoca	390
T O T A L		**2457**

Table 5-9 Main links of the Layer 0 topology

For the NOC to POPs connections CWDM technology is proposed but to reduce the entire cost of the project different solutions should be explored. The main idea is to use only CWDM for all POPs but it seems that if DWDM optical equipments will be available some POPs along the main routes (between NOCs) will use also DWDM. The whole topology for all NOCs and POPs requires about 4000 km of dark fibre but because of different technologies used, some spans should use two pairs of fibre. This could result in very high costs for the fibre and we are looking for some alternative solutions as mentioned above.

The identified solutions are:

1. Use DWDM for all NOCs and for the POPs along the path of the DWDM rings. This could lead to high costs for the equipments to extract lambdas at each POP. Twelve POPs are located on the main rings.
2. Use optical equipments that can operate using only one fibre full duplex. This possibility should be explored, also the impact of this option on the entire costs for the optical switching equipments is yet unknown.

The table below shows information about all fibre segments for the entire infrastructure.

No.	From:	To:	Length (km)
1	Bucuresti N	Ploiesti S	59
2	Bucuresti N	Ciulnita	109
3	Bucuresti	Giurgiu N	85
4	Bucuresti	Rosiori N	100
5	Ploiesti S	Buzau	69
6	Ploiesti	Brasov	107
7	Ploiesti	Targoviste	52
8	Buzau	Focsani	71
9	Focsani	Bacau	104
10	Bacau	Pascani	84
11	Iasi	Pascani	76
12	Iasi	Vaslui	68
13	Vaslui	Tecuci	102
14	Galati	Braila	31
15	Galati	Tecuci	85
16	Braila	Faurei	60
17	Ciulnita	Calarasi Sud	27
18	Ciulnita	Slobozia Veche	17
19	Ciulnita	Fetesti	37
20	Fetesti	Constanta	79
21	Pascani	Suceava V	63
22	Suceava V	Vatra Dornei	111
23	Cluj Napoca	Dej	61
24	Cluj Napoca	Razboieni	68
25	Copsa Mica	Sibiu	45
26	Alba Iulia	Deva	63
27	Teius	Alba Iulia	19
28	Brasov	Sf. Gheorghe	32
29	Brasov	Rupea	74
30	Razboieni	Tg. Mures	59
31	Targoviste	Pitesti	92
32	Rosiori N	Craiova	109
33	Craiova	Drobeta Turnu Severin	114
34	Timisoara	Caransebes	98
35	Timisoara	Arad	57

36	Petrosani	Tg. Jiu	50
37	Drobeta Turnu Severin	Caransebes	112
38	Caransebes	Resita	43
39	Arad	Savarsin	84
40	Satu Mare	Oradea	133
41	Baia Mare	Satu Mare	59
42	Dej	Baia Mare	134
43	Savarsin	Deva	65
44	Deva	Petrosani	89
45	Faurei	Fetesti	89
46	Rupea	Copsa Mica	104
47	Teius	Copsa Mica	51
48	Dej	Ilva Mica	70
49	Vatra Dornei	Ilva Mica	75
50	Razboieni	Teius	34
T O T A L			**3679**

Table 5-10 All RoEduNet case study fibre segments

There are two types of equipments to be used: OADM and IP routers/switches. At the moment the estimated cost for the entire network is about 9 million Euro, including also the local loop. State owned companies able to provide low costs dark fibre do not own local loops and this could be a major problem because RoEduNet should install them. A study is conducted now to obtain the most accurate information about the possible solutions to install or lease fibre for the local loops.

5.6. Serbia and Montenegro

AMREJ has provided two alternative solutions. The first one is based on a present strategy for lighting dark fibre lines under contract with Telekom Srbija, with the cheapest possible equipment, while the second is a view on a future backbone with DWDM equipment. The AMREJ network is currently under development according to the first solution, and some parts of it are in production.

5.6.1. Situation - main PoPs and routes

The main AMREJ PoPs are listed in D1.1. Possible routes between them and the estimation of the length of different spans are given in Table 5-11, according to data gathered in WP1 of the SEEFIRE Project. For the purpose of calculation of the costs of dark fibre lease the unit price of 40 Euros per kilometre per month (or 0.48 €/m/year) was considered. This price is among the highest prices according to the findings of the SEEFIRE project [4] and the authors of this report believe that it can give the upper bound of the expected costs for dark fibre lease.

No.	PoP1	PoP2	Fibre type	Approx. Distance [km]	Unit price per month per km	Total price per month
1	Beograd	Novi Sad	G.652	100	40	4000
2	Novi Sad	Subotica	G.652	110	40	4400
3	Novi Sad	Sombor	G.652	90	40	3600
4	Subotica	Szeged	G.652	55	40	2200
5	Novi Sad	Zrenjanin	G.652	80	40	3200
6	Beograd	Pančevo	G.652	25	40	1000
7	Beograd	Šabac	G.652	95	40	3800
8	Šabac	Bosnian border	G.652	85	40	3400
9	Beograd	Valjevo	G.652	100	40	4000
10	Valjevo	Užice	G.652	70	40	2800
11	Užice	Čačak	G.652	60	40	2400
12	Čačak	Kraljevo	G.652	50	40	2000
13	Kraljevo	Kruševac	G.652	70	40	2800
14	Kraljevo	Novi Pazar	G.652	100	40	4000
15	Kruševac	Niš	G.652	115	40	4600
16	Beograd	Kragujevac	G.652	155	40	6200
17	Beograd	Niš	G.652	270	40	10800
18	Niš	Bor	G.652	135	40	5400
19	Niš	Pirot	G.652	75	40	3000
20	Pirot	Bulgarian border	G.652	35	40	1400
21	Niš	Leskovac	G.652	55	40	2200
22	Leskovac	Vranje	G.652	80	40	3200
23	Vranje	FYROM border	G.652	45	40	1800
TOTAL				**2010**		**80400**

Table 5-11 Routes between PoPs with their distances and lease cost estimation

Figure 5-10 shows potential physical topology of the backbone of Serbian NREN.

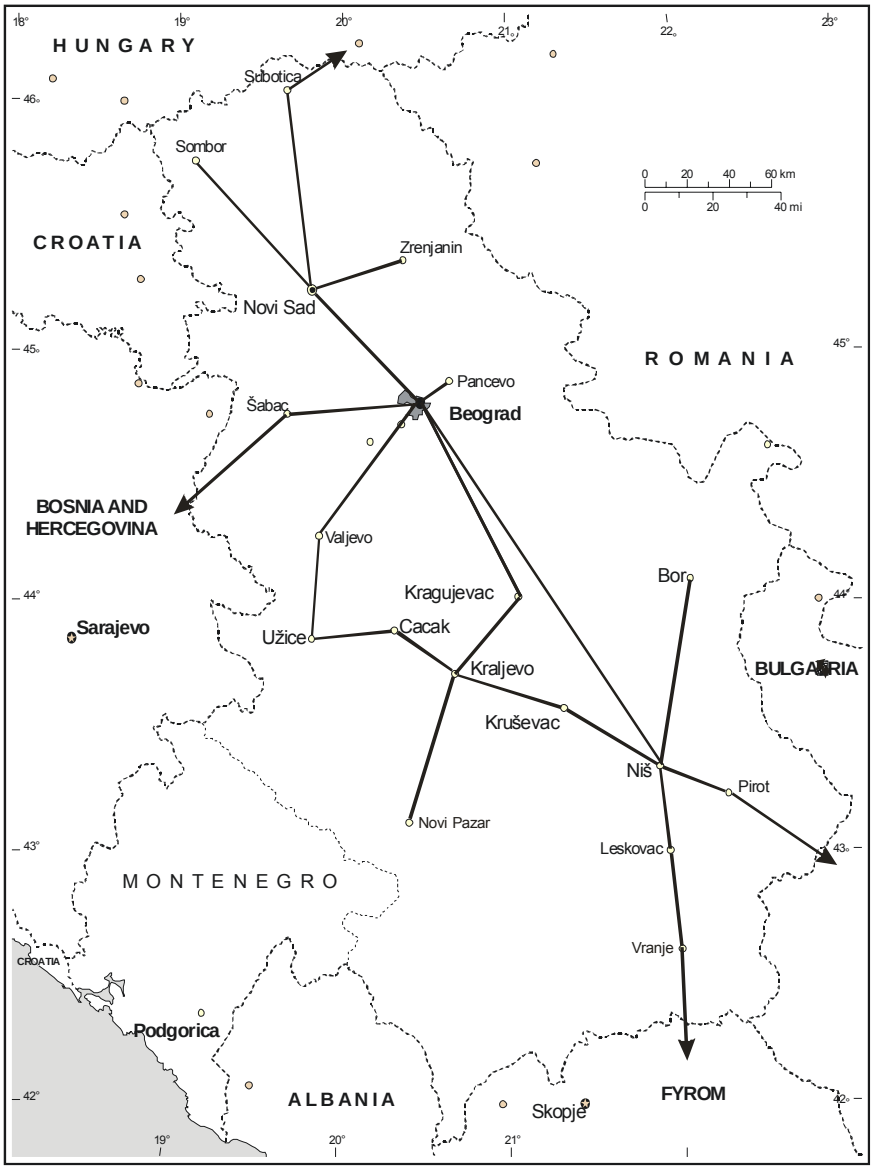

Figure 5-10 AMREJ dark fibre topology

5.6.2. Solution 1

AMREJ's first strategy for building a new, dark-fibre based backbone was to:

- Light the dark fibre with the cheapest possible equipment
- Use well known high capacity technologies
- Have very fast line provisioning – almost immediately after dark fibre establishment by fibre provider
- Possibility of future migration of the equipment to other parts of the network when new technologies are deployed in the backbone.

With that strategy in mind, AMREJ chose relatively cheap L2 and L3 switches with long range 1Gbit/s Ethernet GBIC or SFP interfaces in each PoP. Almost all spans between PoPs are shorter then the limit of long range 1Gbit/s interfaces (around 110km), so the amplification or regeneration is needed only on a few spans. At this moment the AMREJ network has only OEO regeneration points (one such example is the line between Belgrade and Kragujevac, explained in Section 4.2).

5.6.2.1 Transmission equipment

Table 5-12 shows the equipment needed for lighting dark fibre with the rough estimation of the cost of such network. All PoPs have access-class L3 switches except PoPs in 3 main cities (Beograd, Niš and Novi Sad) which have L3 switches with much higher throughput and better performance. All switches are specified only with the equipment needed to interconnect PoPs. Specification of the equipment doesn't include interfaces towards LANs or MANs in each PoP or other equipment needed in each PoP, like the equipment for uninterruptable power supply, etc. Also in near-border cities, the interfaces for connecting NRENs of neighbouring countries are specified, assuming that the connection is going to be 1Gbit/s Ethernet. AMREJ intends to use CWDM technology on some spans in order to separate cross border and internal traffic. The cost estimation is based on list prices of some vendors that are available on the Internet.

PoP	Equipment	Quantity	Unit price [EUR]	Total Price
Subotica	L3 switch	1	10,178	10,178
	SFP interface	4	4,240	16,960
	CWDM 4-lambda OADMwith chasis	1	8,480	8,480
Sombor	L3 switch	1	10,178	10,178
	SFP interface	1	4,240	4,240
Zrenjanin	L3 switch	1	10,178	10,178
	SFP interface	1	4,240	4,240
Novi Sad	L3 switch - high performance	1	50,930	50,930
	SFP interface	10	4,240	42,399
	CWDM 4-lambda OADMwith chasis	2	8,480	16,960
Sombor	L3 switch	1	10,178	10,178
	SFP interface	1	4,240	4,240
Beograd	L3 switch - high performance	1	50,930	50,930
	SFP interface	9	4,240	38,159
	EDFA Amplifier	2	15,000	30,000
	CWDM 4-lambda OADMwith chasis	1	8,480	8,480
Pančevo	L3 switch	1	10,178	10,178
	SFP interface	1	4,240	4,240
Šabac	L3 switch	1	10,178	10,178
	SFP interface	2	4,240	8,480
Valjevo	L3 switch	1	10,178	10,178
	SFP interface	2	4,240	8,480
Užice	L3 switch	1	10,178	10,178
	SFP interface	2	4,240	8,480
Čačak	L3 switch	1	10,178	10,178
	SFP interface	2	4,240	8,480
Kraljevo	L3 switch	1	10,178	10,178
	SFP interface	4	4,240	16,960
Kragujevac	L3 switch	1	10,178	10,178
	SFP interface	2	4,240	8,480
	EDFA Amplifier	1	15,000	15,000
Kruševac	L3 switch	1	10,178	10,178
	SFP interface	2	4,240	8,480
Niš	L3 switch - high performance	1	50,930	50,930
	SFP interface	5	4,240	21,200
	EDFA Amplifier	2	15,000	30,000
Bor	L3 switch	1	10,178	10,178
	SFP interface	1	4,240	4,240
	EDFA Amplifier	1	15,000	15,000
Vranje	L3 switch	1	10,178	10,178
	SFP interface	2	4,240	8,480
Pirot	L3 switch	1	10,178	10,178
	SFP interface	2	4,240	8,480
Leskovac	L3 switch	1	10,178	10,178
	SFP interface	2	4,240	8,480
Novi Pazar	L3 switch	1	10,178	10,178
	SFP interface	1	4,240	4,240
TOTAL				**687,165**

Table 5-12 Cost estimation for the transmission equipment in Solution 1

Figure 5-11 shows the way the equipment specified in the previous table is interconnected.

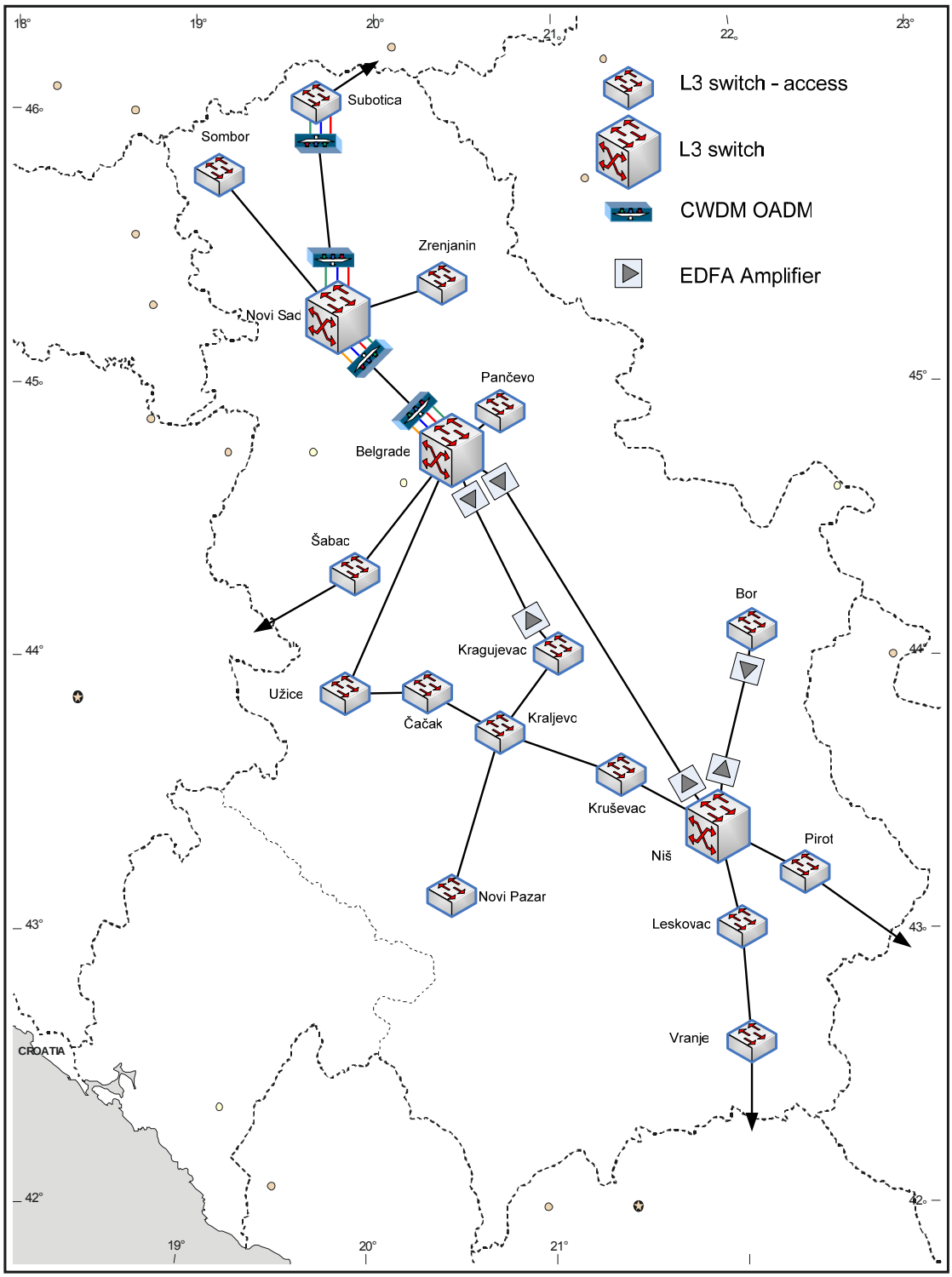

Figure 5-11 Interconnection of the equipment for the first phase

5.6.3. Solution 2

The second solution is the next possible stage in the development of Serbian NREN. This solution aims to give an example of one possible way to introduce DWDM technology into the backbone and main links in Serbian NREN. DWDM deployment is divided into two phases.

5.6.3.1 Phase 1

In phase 1, two main backbone directions are covered with DWDM equipment, one towards the north of the country (Subotica), and one towards the south (Niš), as shown in Figure 5-12 with the possibility to carry both internal traffic (channels marked with A, D, E and F) and international (X channels). The assumption for this case study is that internal lambdas are 1Gbit/s Ethernet, while international lambdas are 10G Ethernet.

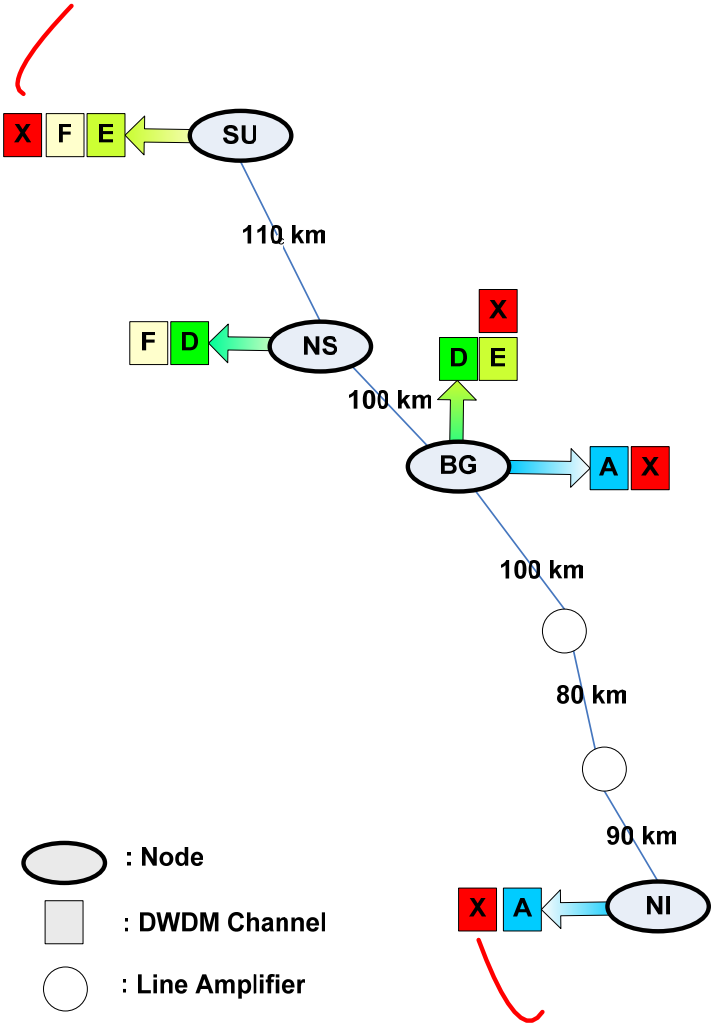

Figure 5-12 Desired topology of the DWDM part of the network in the first phase

5.6.3.1.1 Transmission equipment

AMREJ studied in detail the equipment of two vendors, and made two similar configurations based on such equipment. The topology in the first phase is a chain network with the possibility to add/drop some lambdas in intermediate nodes. 1Gbit/s channels are not multiplexed optically but are multiplexed through muxponders, and sent as an aggregate wavelength at 10Gbit/s. Other 10Gbit/s channel is optically multiplexed with the aggregated Nx1Gbit/s wavelength. All main nodes are configured as OADM nodes with optical amplification and dispersion compensation. There are also two line amplification nodes between Belgrade and Niš. The specification of the equipment in this case study doesn't include client side equipment, which can be almost fully reused from the previous solution

(except 10G Ethernet client side interfaces). Table 5-13 shows the estimation of the price of this solution according to the available price list from one vendor.

PoP	Equipment	Quantity	Unit price [EUR]	Total Price
Subotica	DWDM OADM node	1	165,718.5	165,718.5
Novi Sad	DWDM OADM node	1	147,977.8	147,977.8
Beograd	DWDM OADM node	1	306,706.1	306,706.1
Line amplifier node	DWDM line amplifier equipment	2	110,637.4	221,274.9
Niš	DWDM OADM node	1	152,141.3	152,141.3
TOTAL				**993,819**

Table 5-13 Cost estimation for the equipment in the first phase

5.6.3.2 Phase 2

The AMREJ's optical backbone in its full configuration will have several redundant paths, which enable the introduction of different topologies, redundancy and protection into the backbone of AMREJ. One possible solution is shown in Figure 5-13, depicting the equipment connected in Unidirectional Path Switched Ring configuration (UPSR). According to that solution 10 Gbit/s Ethernet lambdas are used for international connections towards north and south, while several 1Gbit/s Ethernet lambdas are used for internal connections.

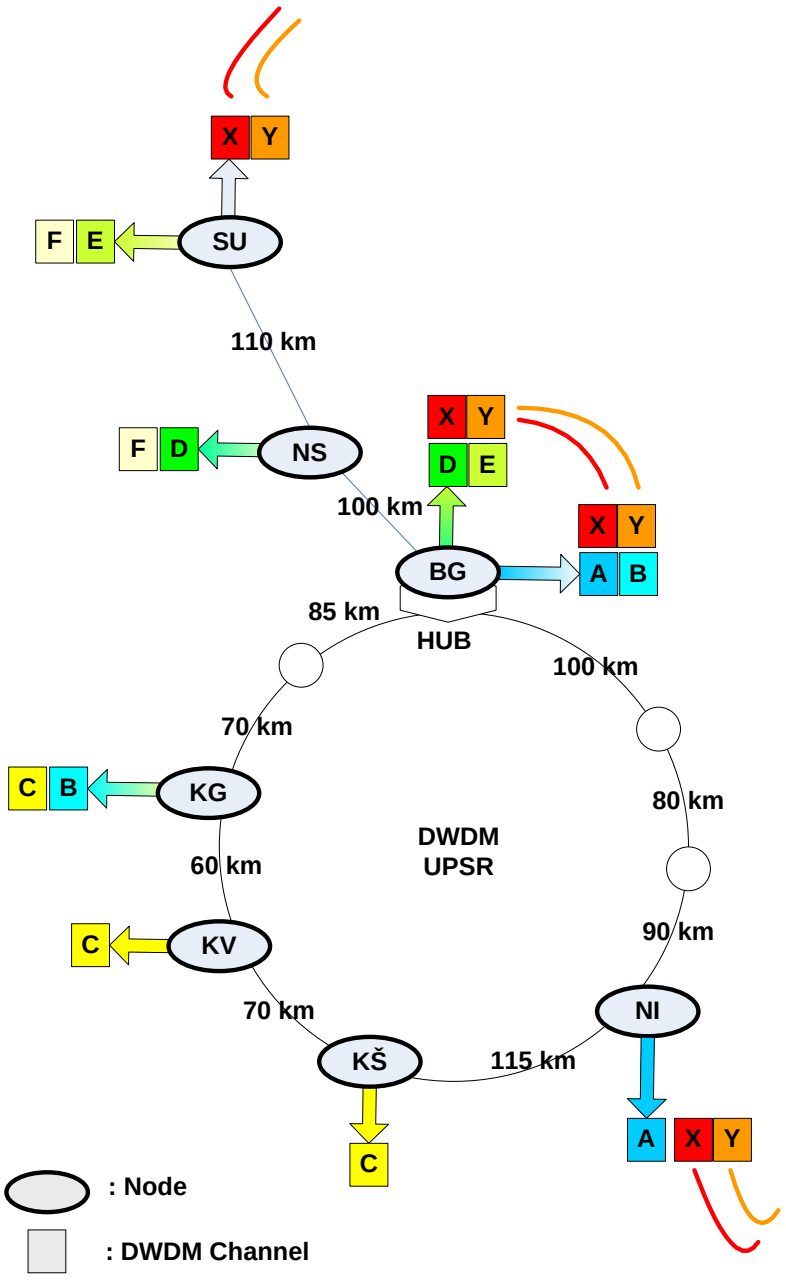

Figure 5-13 Desired topology of the DWDM part of the network in the second phase

5.6.3.2.1 Transmission equipment

Table 5-14 shows the estimation of the price of this solution according to the available price list from one equipment vendor.

PoP	Description of the equipment	Quantity	Price [EUR]	Total
NI Node:	OADM Node Protected	1	254,392	254,392
Line Amplifier Node:	Line Amplifier Node	3	100,377	301,130
BG Node 1:	OADM Node Protected	1	273,637	273,637
BG Node 2:	OADM Terminal Node	1	143,033	143,033
NS Node:	OADM Node	1	134,254	134,254
SU Node:	OADM Terimnal Node	1	148,039	148,039
KG Node:	OADM Node	1	160,434	160,434
KV Node:	OADM Node	1	134,254	134,254
KS Node:	OADM Node	1	121,936	121,936
TOTAL				**1,414,921**

Table 5-14 Cost estimation for the equipment in the second phase

6. Case studies: Procurement documents used for DF and transmission equipment purchase

One significant part of the establishment of a dark fibre infrastructure by NRENs is the procurement of both dark fibre lines and transmission equipment. The legislation for public tenders is similar if not equal in all Southeast European countries, and is very similar to the European legislation. Therefore, examples of the procurement documents used in different countries for dark fibre service and transmission equipment purchasing present very valuable source of information about how to organize public tenders, how to prepare technical documentation and how to ask for different features or services from tenderers.

Appendix 1 has different examples of the procurement documentation used by GRNET, CESNET and DANTE. Procurement documentation from the Czech Republic and Greece was made originally in Czech and Greek languages, and is presented in Appendix 1 in English translation.

All the documentation listed in Appendix 1 is not equal with the original in parts which reveal sensitive information about the institution that published the tender.

7. Acronyms

10 GE	*10 Gigabit Ethernet*
CD	*Chromatic Dispersion*
CEF	*Customer Empowered Fibre*
CWDM	*Coarse Wavelength Division Multiplexing*
DCF	*Dispersion Compensating Fibre*
DSP	*Digital Signal Processing*
DWDM	*Dense Wavelength Division Multiplexing*
EDFA	*Erbium Doped Fibre Amplifier*
EoMPLS	*Ethernet over MultiProtocol Label Switching*
FBG	*Fibre Bragg Grating*
GBIC	*Gigabit Interface Converter*
ISP	*Internet Service Provider*
ITU	*International Telecommunication Union*
NIL	*Nothing in Line*
OA	*Optical Amplifier*
OADM	*Optical Add Drop Multiplexer*
OEO	*Optical-Electrical-Optical*
PoP	*Point of Presence*
PSTN	*Public Switched Telephone Network*
ROADM	*Reconfigurable Optical Add Drop Multiplexer*
RZ	*Return to Zero*
SDH	*Synchronous Digital Hierarchy*
SFP	*Small Form Factor Pluggable Transceiver*
SOA	*Semiconductor Optical Amplifier*
SONET	*Synchronous Optical NETwork*
VLAN	*Virtual LAN*
VPN	*Virtual Private Network*
WAN	*Wide Area Network*
WDM	*Wavelength Division Multiplexing*
XENPACK	*10 Gigabit Ethernet Pluggable Transceiver*
XFP	*10 Gigabit Small Form Factor Pluggable Transceiver*

8. Literature

[1] E6000C MiniOTDR User's guide, Agilent technologies

[2] http://www.ces.net/doc/seminars/20040525/pr/CEF04-SWITCHlambda.pdf

[3] http://www.SURFnet.nl/info/netwerk/nationaal/home.jsp

[4] Lada Altmannova, "Fibre Lease Contracts", SEEFIRE Project Technical Workshop, Sofia, July 2005. http://www.seefire.org/content/modules/downloads/Altmannova.ppt

9. Appendix 1 – Procurement documentation

9.1. Procurement documents used for Dark fibre procurement

9.1.1. Documentation provided by GRNET

The following sections present the key technical requirements for the dark fibre providers in the IRU acquisition.

9.1.1.1 Tender published in February 2005

According to this tender, 15-year IRUs and 15-year maintenance services were procured for three dark fibre links. This tender was successfully concluded in August 2005. Dark fibre links are expected to be delivered by February 2006.

9.1.1.1.1 Mandatory requirements

- Provisioned DF links must support multiple protocols and rates. GRNET intends to deploy multiple technologies over the DF links, such as Gigabit Ethernet and PoS with rates up to 10 Gbps. Desirably, signal amplification/regeneration must be provided along the DF route. In case amplification/regeneration is not provided, the responder must provide collocation to GRNET active equipment at his sites at the appropriate distances.
- Tenderers must monitor DF availability and notify GRNET in case of failures. Tenderers must use a system for remote monitoring of DF availability and record every failure (time and kind). In case of failures, system administrator must inform the GRNET Helpdesk.
- DF availability must be at least 99% for each route. DF availability will be calculated according to the following formula, where TTR (Time To Repair) equals to FFT (Fault Fixed Time) minus FRT (Failure Report Time). FFT and FRT times will be provided by the remote monitoring system.

$$A_\delta\% = 100\% - \frac{\sum_{\delta}^{365x24x60} TTR_\delta}{365 \times 24 \times 60} \times 100\%,$$

- Maximum time for fault rectification must not be greater than 3 working days for terrestrial DF links and 20 working days for submarine DF links. Non compliance to these thresholds will activate penalty clauses.
- Tenderers must maintain the DF links for the whole IRU period (15 years). For every scheduled maintenance activity that may affect DF availability, the provider must inform GRNET at least 15 working days prior the scheduled date.
- Collocation services must be provided to all existing and planned GRNET PoPs.
- Selected tenderers must sign an SLA with GRNET. Contract among GRNET and the Provider will include an SLA as appendix. The SLA will define the technical parameters of the provisioned service in terms of availability, faults, quality of the optical signal (e.g. attenuation, CD, PMD) based on the provider's technical offer. Non compliance to the SLA will activate penalty clauses.

- The type of the provisioned fibre must be single mode. For every DF link, tenderers must fill the following table:

Length
Terminal point A
Terminal point B
Fibre type [G652, G653, G655]
Fibre manufacturer (e.g. Corning LEAF, Lucent TrueWave)
Number of fusion splices
Number of mechanical connections
Expected attenuation [dB]
Expected Optical Return Loss (at both end points) [dB]
Expected Chromatic Dispersion – CD [ps/nm]
Expected Polarization Mode Dispersion (PMD) [ps]
Supported transmission rate [Gbps]
Available wavelength bands

- Tenderers must provide specification of his equipment for measuring optical signal quality and fault detection.
- Tenderers must describe the acceptance tests, based on international standards that will be conducted prior to delivering the DF links.

9.1.1.1.2 Desirable

- Tenderers accept to provide access to the remote monitoring system.
- Tenderers' remote monitoring system sends automatic notifications to GRNET Helpdesk in case of fibre failures or malfunctioning.
- Tenderers provide protected DF links. In case of a link's failure, GRNET will be able to use an alternative DF link among the same endpoints.

9.1.1.2 Tender published for consultation at October 2005

According to this tender, 20-year IRUs and 20-year maintenance services were procured for ten DF links. The tender text was based on the previous one; however, some additions were included based on the experience that was gained from the first tender.

- Provisioned DF links must support multiple wavelengths at the regions 1270-1380nm, 1460-1530nm (S-band), 1530-1565nm (C-band) and 1565-1625 (L-band).
- Selected tenderers must not intervene any active or passive equipment along the DF route, except from optical patch panels. Indicatively this kind of equipment includes WDM transponders, WDM mux/demux, optical filters, amplifiers and dispersion compensation modules.
- Selected tenderers must provide collocation services at the edges of each fibre span. Fibre span is defined as the segment of the fibre link where optical fibre is not interrupted. Span edges are defined by the optical patch panels.
- Tenderers must document responses for every DF link by filling the following table (for a DF link with 5 spans):

	Span 1	Span 2	….	Span 5
Endpoint A				
Endpoint B				
Cable that DF belongs to				
Optical patch panel position at endpoint A				
Optical patch panel position at endpoint B				

- Desirably, provisioned optical fibre will be G.655 or G.655c/d.
- Selected tenderers are obliged to replace provisioned optical fibre pair with a new one that presents improved technical characteristics, if such optical fibre pair is available, among the same endpoints with no extra cost. Provisioned optical fibre pair replacement can occur under the condition that GRNET requests for it.

9.1.2. Documentation provided by CESNET

9.1.2.1 Tender documentation

In the reminder of this section is the tender documentation used by Cesnet in the dark fibre procurement

CONTRACT DOCUMENTATION

for the preparation of the tender for public contract, according to Act no…….. (hereinafter referred to as “Act“)

Connection of locations by a pair of optical fibres and the lease of these dark fibres

Name of the submitter

CONTRACT DOCUMENTATION

for the preparation of the tender for public contract, according to Act no……., (hereinafter referred to as "Act")

The name of the public contract: Connection of locations by a pair of optical fibres and the lease of these dark fibres

Submitter

Name:

Identification number:

Tax identification number:

Address of registered office:

Authorized representative of the submitter:

Contact person:

Telephone:

Fax:

Email:

Classification of the subject of public contract

Classification of the subject matter of public contract corresponds to the item of:

Service – telecommunication services

CPV (Common Procurement Vocabulary) 64220000-4 pcs 1

Public contract over/under threshold

Estimated value ……

If the subject matter of public contract contains references to specific marks of products and services, which are typical for certain entrepreneur, the submitter enables also the use of other solution – qualitatively and technically analogous.

Subject matter of public contract

The subject matter is the connection of the below stated locations by a pair of optical fibres and the lease of these dark fibres to the submitter.

All optical and electronic devices for the use of the circuit shall be ensured by the submitter. The tenderer has to describe precisely the parameters of the circuit between final points, for individual segments and totally (fibre length, attenuation, chromatic dispersion, PMD, number and type of connectors, number of spans etc.). The tenderer shall guarantee that these parameters shall not be exceeded.

Term of performance of public contract

Term of performance of public contract

The submitter requires the handover of the subject matter as a functional unit before ……

Place of performance of public contract

The place of performance is:

A. Place
Address

B. Place
Address

Tender

Tenders must be submitted in written form and in an enclosed envelope appended on the closures with the label of the firm/name/first name and surname and a stamp or signature of the tenderer– if the tenderer is a physical person – or the statutory body of the tenderer – if the tenderer is a juridical person – labelled with "Do not open – public contract on the connection of locations by a pair of optical fibres and the lease of these dark fibres". On the envelope, there has to be the address to which the tender can be returned acc. to par. …… of the Act. If the tender is submitted by a corporation of firms, the name and address to which the envelope is returnable shall be stated.

The tenders have to be submitted by ..... (till ..... a.m./p.m.) to the address and person stated in the contract notice. Other way of delivery is not considered as proper submission of the tender.

On the cover page of the tender, identification particulars of the tenderer have to be given in the extent stated in par. …… of the Act. The offer shall be compiled in …… language and signed by an authorized representative.

The tenderer is bound by their tender till ..... This period shall be prolonged for the time when the submitter was not authorized to conclude the contract and for the time when the submitter was not provided with the cooperation acc. to par. …….. of the Act.

The tenderer shall submit the tender in three printouts, one of them shall be labelled on the cover page as "Original" and the other two as "Copy". All pages of the tender shall be put together tightly or stapled so that they are sufficiently protected against their removal from the tender. All three printouts shall be properly readable, without any cross-outs and overwriting. The cover page has to bear the number of the printout, the "Original" or "Copy" label, and identification particulars in the extent acc. to par. …… of the Act. All pages of the tender, or of the individual printouts, shall be numbered by an ascending continual line.

The tenderer shall state in the tender expressively the contact address for written communication between the tenderer and submitter. If the tender is submitted by more suppliers together (common tender), these suppliers shall state in their tender, besides the contact address acc. to the previous sentence, also the person who will be authorized to represent these suppliers at the contact with the submitter during the tender procedure.

The tenderer shall submit the tender also in electronic form on a CD; this obligation does not apply to the documents proving the tenderer´s qualification fulfilment. Each tenderer is bound to submit the draft contract in electronic form in MS Office format, or other format compatible.

The tender shall be submitted according to the following pattern:

1. INTRODUCTION PAGE

Name of the subject of the tender, of the place of performance, identification particulars of the submitter (acc. to the stated conditions).

2. CONTENTS

The contents shall include all the bellow listed chapters of the tender acc. to the required segmentation. The chapters shall be assigned by the numbers of corresponding sheets, or possibly pages.

3. OVERALL INFORMATION ABOUT THE TENDERER

The name of the tenderer, legal form, registered office, identification number, tax identification number, bank connection, the names of the statutory body members, including the contacts (telephone, fax, e-mail, address), the person authorized for further negotiation, including written authorization for representing, and the profile of the company.

4. COVER PAGE OF THE TENDER

On the cover page, the following particulars shall be mentioned: the name of the public contract, basic identification information of the submitter and tenderer (including the persons authorized for further negotiation) in the extent stated in paragraph …….. of the Act, the highest acceptable tender price segmented according to the contract documentation, date and signature of authorized representative of the tenderer.

5. DOCUMENTS PROVING QUALIFICATION FULFILMENT IN SEGMENTATION

The tenderer is bound to prove the qualification fulfilment, according to paragraph ….. of the Act.

QUALIFICATION DEFINITION

Qualification shall be fulfilled by the tenderer who fulfils the qualifying criteria stated in paragraph …… of the Act, cited bellow.

Basic qualifying criteria

The basic qualifying criteria shall be fulfilled by the tenderer

a) who is not in liquidation

b) against whom there has been no bankruptcy declared in the recent three years, or no bankruptcy was cancelled due to insufficient property

c) who has no recorded tax underpayments in tax register

d) who was not authoritatively sentenced for a delict or whom the sentence for a delict, of which the facts concern the tenderer´s subject of business, was obliterated, as for the physical person; as for the juridical person, this condition has to be fulfilled by the statutory body or each member of the statutory body, the head of organisational part of foreign juridical person or a statutory body-authorized representative,

e) who has no arrear on insurance and on public health insurance penalty or on insurance and on social benefits and state employment policy fee penalty, with the exception of the cases when the payments in instalments are allowed – the tenderer must not be in delay with the instalment payments

f) who has not been disciplinary punished in recent three years according to special regulations modifying the business activity performance, if this activity is related to the subject of this public contract, as for a physical person or responsible representative.

Other qualifying criteria

Other qualifying criteria shall be fulfilled by the tenderer who, according to paragraph ……. of the Act, proves

a) financial and economic standing and

b) technical ability.

Business licence

The tenderer proves the qualification fulfilment acc. to paragraph …… of the Act by corresponding business licence, including the Commercial Register abstract or other evidence not older than 90 days; the business licence may be documented in a printout or officially verified copy. The documents for the business licence must authentically cover all the activities that are the subject matter of public contract and that emerge from the public contract subject specification stated in contract and technical documentation, which is an attachment of contract documentation.

Qualification fulfilment authentication

Basic qualifying criteria

a) The tenderer documents the basic qualifying criteria fulfilment according to paragraph ……of the Act, that is column 5.1, letter a) – c) and e) and f) of this contract documentation, by *the declaration – attachment no. 4.* The tenderer shall prove the basic qualifying criteria fulfilment acc. to column 5.1, letter f), if the tenderer is a physical person, or in relation to responsible representative, if the tenderer is a juridical person.

b) The tenderer shall prove the basic qualifying criteria fulfilment acc. to column 5.1, letter d) of the contract documentation by *the abstract from the evidence of Criminal Record or other corresponding document, not older than 6 months.* The tenderer shall evidence the abstract from the evidence of Criminal Record, as for a juridical person, for the statutory body or all members of the statutory body. If the tender is submitted by a foreign juridical person by means of organisational part, the tenderer shall evidence the abstracts from the evidence of Criminal Register for the head of the organisational part, as well as for the statutory body or all members of the statutory body of the foreign person. If some operations should be carried out by a statutory body-authorized representative, the tenderer shall evidence the abstracts from the evidence of Criminal Record for this authorized representative, as well as for the statutory body or all members of the statutory body of this person.

Other qualifying criteria

a) The tenderer shall prove the qualification fulfilment acc. to paragraph ……of the Act (financial and economic standing), that is column 5.2, letter a) of the contract documentation,

- *by presenting balance sheet in full or simplified extent, including the auditor´s comment, if required under the law, edited to the last day of the preceding accounting period.*

- *by the statement of the tenderer's overall turnover and turnover reached for performed work, goods supplies or provided services in the preceding 3 accounting periods. The tenderer fulfils the financial and economic standing criteria if the minimum business turnover for the years 2002,2003,2004 was ……. for each of these years. The tenderer shall prove this fact by the statement of the authorized representative of the tenderer. For the business turnover documentation, the tenderer shall use attachment no. 3 "The statement on reached business turnovers".*

- *by the document on the insurance of responsibility for the damage caused at the occupation performance at the minimum rate of …… (the "document" means an insurance contract + the document on insurance payment).*

b) The tenderer shall prove the qualification fulfilment according to paragraph ……..of the Act, (technical ability), that is column 5.2, letter b) of the contract documentation,

- *by the list of important services provided in the recent 3 years ("service" means the realisation of one line at least with the installation with the concrete specification of the service type) with the statement of their extent, period of fulfilment, value and joint certificate in proper service provision, drawn up by public or private orderer, or the declaration of the supplier on service provision, if such certificate is not possible to gain from the orderer.*
- *by the statement of the part of public contract, which the tenderer or the candidate intends to submit to another person. The submitter requires the tenderer to be the founder and lessor of the whole line between the final points of the connection. The tenderer is bound to state the possible sub-supplies.*

The abstract from the list of approved suppliers

The tenderers written in the list of approved suppliers can prove the qualification fulfilment according to paragraph …… of the Act, that is paragraph 5.1 and 5.3 of the contract documentation, by the abstract from the list of approved suppliers, not older than 90 days.

The form of qualification fulfilment

The tenderer is bound to prove the qualification fulfilment in all cases by documents submitted in original or officially verified copies of these documents. The original documents or the officially verified copies will be enclosed to the tender in the printout noted as "Original"; the copies of these documents shall be enclosed to the printout of the tender noted as "Copies". The documents, by which the tenderer proves the qualification fulfilment, shall be submitted by the tenderer as separate part of the tender called "the Qualification", in accordance to the structure of the tender.

If more suppliers submit the tender together (as one tenderer), each of them must separately prove qualification fulfilment according to paragraph …… of the Act, that is column 5.1 of the contract documentation; the qualification according to paragraph …….. of the Act , that is according to paragraph 5.2 and 5.3 of the contract documentation, must be fulfilled by at least one of the suppliers.

If more suppliers submit the tender together (as one tenderer), they are bound to enclose to the tender the original or verified copy of the document (contract) on the obligation that all these suppliers shall be bound together and indifferently to the submitter and any third person of all obligations arisen in connection with the fulfilment of the subject of the public contract or arisen as a result of the delay or other contractual or other duties breach in connection with the public contract performance.

The required documents, if not required otherwise by the law or by this contract documentation, may not be older than 90 calendar days preceding the last day of the term for tender submission.

Foreign person shall prove the qualification fulfilment according to paragraph ……..of the Act, that is column 5.1 and 5.3 of the contract documentation. According to paragraph …….. of the Act, the foreign person shall prove the basic qualifying criteria by the documents according to the legislative valid in the country of the registered office of the foreign person, or possibly the abode, or by the abstract from the list of approved suppliers. The documents proving qualification fulfilment shall be submitted by the foreign person in the original language together with their officially verified translation to …… language.

The result of qualification misfulfilment

If the tenderer shall not fulfil the qualification in the whole extent, this tenderer shall be expelled from the open procedure according to paragraph …….. of the Act. The submitter shall immediately inform the tenderer about the exclusion from the open procedure.

THE TENDER PRICE IN SEGMENTATION

Basic requirements of the supplier

The total price shall be stated in the tender as the highest acceptable amount for the public contract performance, including all fees and all other costs connected with the public contract performance.

The price shall be stated by the tenderer in the tender in the following structure:

6.1. total price of the public contract performance [the total of the prices acc. to point 6.2. a) and b)]

6.2. a) nonrecurring setup fee

b) monthly fees including reparation and maintenance for the period of 4 years

The submitter prefers higher setup fee and lower monthly fees if this leads to a more favourable total price of the public contract performance (see point 6.1)

The price shall at all parts (as structured above) be stated in …….. *(currency)* in the following structure: price without VAT, the rate of VAT in %, the price including VAT.

Conditions of price exceeding

The price may only be exceeded in connection with the change in tax regulations concerning VAT.

Payment conditions

The submitter shall oblige to pay the monthly fees in monthly period after the commencement of the use of optical line (an acceptance protocol shall be written down about this commencement). A nonrecurring setup fee may be required by the tenderer even before the commencement of new optical line use by the submitter. All fees are mature on the basis of tax document – the invoice of the tenderer. The maturity of the invoice shall be 14 days since the day of delivery of the invoice to the submitter.

DETAILED DESCRIPTION AND SPECIFICATION OF THE OFFERED PERFORMANCE, INCLUDING THE PARTICULARS PROVING THE TECHNICAL REQUIREMETNS FULFILMENT OF THE SUBMITTER

The tenderer shall state here a detailed description and specification of the offered performance, including the particulars proving the submitter´s technical requirements fulfilment stated in technical documentation which is the attachment of the contract documentation.

RELEVANT PARTICULARS AND INFORMATION FOR THE PURPOSES OF THE EVALUATION ACCORDING TO CONTRACT DOCUMENTATION

The evaluation of the tenders shall be carried out according to paragraph ……. of the Act with respect to their economic preferability by scoring method, pursuant to the following partial criteria in descending order according to their importance:

1. Total price of the public contract performance – importance 60%
2. The type of the offered fibres and technical parameters – importance 40%

Within the frame of the partial criterion sub 1., the submitter shall evaluate the total rate of the tender price without VAT stated in point 6 of the contract documentation at point 6.1.

Within the frame of the partial criterion sub 2., the submitter shall evaluate the type of the offered fibres and technical parameters, especially the fibre length, expected attenuation and dispersion.

9. DRAFT CONTRACT

The tenderer is bound to submit a single draft contract for the whole subject matter of public contract. The draft contract must contain the specification of the offered circuit. If the tenderer has concluded a framework agreement on the conditions of circuit lease with the submitter, he may propose only the circuit specification to this agreement and possibly propose the amendment to the framework agreement with the specification of the setup and lease conditions.

The draft contract must not exclude or restrict in any way the rights and requirements of the submitter stated in this contract documentation.

The draft contract has to be signed, from the tenderer´s side, by the statutory body or statutory body-authorized person; in this case, the original or officially verified copy of the authorization has to be a part of the draft contract of the tenderer; if not, the tender is considered as incomplete.

The draft contract has to contain these provisions:

1. The lease of the circuit is arranged for the time unlimited. For the purposes of provision

no. 2, the arranged time of the circuit duration is 48 months.

2. The lessee has the right to terminate the use of the circuit with one-month notice period, but not earlier than one month before the expiry of the agreed period of circuit duration. The lessor has the right to terminate the circuit use with one year notice period, but not earlier than 12 months before the expiry of the agreed period of circuit duration. The notice period starts running on the day of delivery of the termination to the other contractual party.

The submitter requires the tenderer to be the deployer and lessor of the whole line between the final points of the connection. If a part of the public contract is fulfilled by means of sub-supply, the submitter requires the tenderer to state in the draft contract (in the circuit specification) which part of performance shall be submitted to third persons and which persons these will be (the tenderer is bound to state the identification particulars of the sub-supplier, according to paragraph ……. of the Act).

The tenderer is bound to oblige himself in the draft contract to provide quality guaranty of the performance for the minimum period of 4 years. This period starts running on the day of the signing of the acceptance protocol. In the guaranty period, the tenderer is bound to remove the performance disorders, or possibly to satisfy another submitter´s requirement due to defective performance. If a training for the submitters staff is necessary for the proper use of the subject matter after defect reparation or provision of other form of guaranty fulfilment, the tenderer is bound to provide such training, and this has to be carried out without any unnecessary delay after the guaranty fulfilment provision. If the tenderer is delayed with the satisfaction of the submitter´s claim on defective performance, the submitter has the right to arrange the defect reparation from another person on the tenderer´s costs.

Any restriction of the compensation of damage is not permitted.

In the draft contract, the tenderer has to accept the submitter´s right for contractual fine of 0.1% of the total fulfilment price without VAT for each, even only begun, day of the delay with performance of any contractual duty, and this holds good for every single delay, except for the delay at line setup term. The right for compensation of damage is by this in no way restricted.

In the draft contract, the tenderer has to accept the submitter´s right for contract rescission in the case of tenderer´s delay longer than 30 days or in the case of repeated delay within one month.

In the draft contract, the tenderer is bound to accept sanctions for the breach of the contract stated in percentage of the monthly price without any discount, at least as follows:

monthly availability is lower than	**percentage rate of the regular monthly price**
99,6 %	10 %
99,3 %	15 %
99,0 %	20 %
98,0 %	25 %
97,0 %	30 %
96,0 %	100 %

The tenderer shall state the discounts at the payment in advance, for 6 months and 12 months.

At the delay of line setup, the tenderer is bound to pay the contractual fine of 110% of the daily price of the circuit lease for every whole day of the delay.

10. CONCLUSION

The tenderer shall submit the declaration of veracity of the facts stated in the offer and the signature of authorized representative.

OPENING OF THE TENDERS

Opening of the tenders shall take place on ..... in meeting room at the registered office of the submitter. All tenderers, who submitted the tender within the term for tender submitting, are allowed to participate in the opening (maximally one person for a tenderer).

THE SUBMITTER´S RIGHTS

The submitter stipulates the right to cancel the public contract, according to paragraph ……of the Act, at any time, but until the day of contract conclusion.

The submitter accepts no variants of the tender.

The submitter shall answer written inquiries sent according to paragraph …… of the Act. The supplier has the right to send the inquiry also by e-mail or fax, provided that by three days of the inquiry delivery, also a written form of the inquiry is delivered. Written form of the inquiry has to be delivered always until the term stated by the law. The term for submitter´s answer starts running on the day of delivery of the written form of the inquiry.

The submitter stipulates the right to verify the information provided by the tenderer from third persons and the tenderer is bound to cooperate with the submitter in all ways in this respect.

LIST OF ATTACHMENTS:

– Technical documentation – attachment no. 1

– Contract notice – attachment no. 2

- Statement on reached business turnovers – attachment no. 3

- Declaration – attachment no. 4

Place, (date) .....

.....
.....

name

position

company

Attachment no. 1

Technical documentation

The information and particulars stated in this technical documentation define the obligatory requirements of the submitter on public contract performance. The tenderer is bound to fully respect these requirements at tender (draft contract) preparation.

The tenderer is bound to state the following facts in the tender:

- Fibre length, attenuation, chromatic dispersion, PMD, number and type of connectors, number of spans
- The possibility of the location of the equipment on the line (state the lengths of segments between potential location points, the length of the segments shall be shorter than 80km)
- The possibility of the submitter to use optical amplifiers up to 24dBm for fibres lighting
- Term of delivery

Fibre Line	a' End	b' End	Length of span [km]	Number of fibres [Single, Pair or Other]	Type of fibre used [G.652, G.653, G.655 or Other]	Manufacturer and brand (e.g. Corning LEAF, Lucent TrueWave, etc.)	Number of fusion splices	Number of mechanical connectors	Attenuation [dB] - as measured	Chromatic Dispersion (CD) [ps/nm] - as measured	Polarization Mode Dispersion (PMD) [ps/km$^{1/2}$] - as measured	Other comments
Span 1												
Span 2												
Span 3												
Span 4												
Span 5												
Span 6												
Span 7												
Span 8												
Span 9												
Etc.												
Sum of Values			0	0			0	0	0	0	0	

Attachment no. 2

Contract notice

Attachment no. 3

Statement on reached business turnovers

STATEMENT ON REACHED BUSINESS TURNOVERS

Year	Business turnover in ……
2002	
2003	
2004	

Authorized representative of the tenderer

Attachment no. 4

Declaration

HONORARY STATEMENT

according to the Act no. …….. (hereinafter referred to as ”Act”)

I honestly declare that:

acc. to § …… – the tenderer is not in liquidation

acc. to § ……. – there has been no bankruptcy declared on the tenderer´s property in the recent three years, or no bankruptcy was cancelled due to insufficient property

acc. to § …… – the tenderer has no evidence of tax underpayments in tax register

acc. to § ……. - the tenderer has no arrear on insurance and on public health insurance penalty or on insurance and on social benefits and state employment policy fee penalty, with the exception of the cases when the payments in instalments are allowed – the tenderer is not delayed with the instalment payments

acc. to § ……..– the tenderer has not been disciplinary punished in recent three years according to special regulations modifying the business activity performance, if this activity is related to the subject of this public contract, as for a physical person or responsible representative.

This honorary statement is attached together with the abstract from the evidence of the Criminal Code according to § ……. to the document on the business licence, including the abstract from the Commercial Register or other evidence according to § ……..

I sign this honorary statement as the ……..…….of the …… firm, authorized by the abstract from the Commercial Register to act on behalf of the firm.

……

Signature

of the authorized representative

9.1.2.2 An example of the contract

This is an example of the Contract on the lease of optical fibre circuits.

C O N T R A C T

on the lease of optical fibre circuits

concluded according to the valid regulations of particular country on the bellow stated date, month and year between

number: .....

organisation A
registered office:
identification number:
tax identification number:
bank connection:
bank account number:
represented by:
registered at:
(further only „**lessor**“)

and

organisation B
registered office:
identification number:
tax identification number:
bank connection:
bank account number:
represented by:
registered at:
(further only “**lessee**”)

I.

Subject of the contract

1. On the basis of this contract and in accordance to the conditions stated in it, within the lessor´s telecommunication network, the lessor is obliged to lease optical fibre circuits consisting of a pair of optical fibres or single fibre (further only “leased circuits”), of which the lessor is the proper owner, and the lessee is obliged to pay the contractually agreed price to the lessor.
2. Together with the lease of the circuits, the lessor is obliged to provide the lessee with further service, such as regular maintenance of the circuits and

elimination of the disorders that have occurred on them and on other devices and lessor´s optical fibres, which are connected with the lease of the circuits.

3. Description and technical parametres of the leased circuits are stated in Attachement no.1 to this contract, which is an inseparable component of this contract. Other circuits are appended to this attachement according to the agreement between the lessor and lessee.
4. In connection with the circuit lease, according to the lessor´s possibilities, the lessor shall provide the lessee with the option to locate and operate the lessee´s devices in the lessor´s premises and shall enable the access of the lessee and their commissioned staff. The lessee shall guarantee keeping the rules for the access to the lessor´s premises and the lessor shall inform the lessee about these rules. Being appealed by the lessee, the lessor will ensure local assistance at the lessee´s devices operation in the above mentioned premises (e.g. feeding state supervision, finding out the signalised device state, switching-on, switching-off, etc.), and this duty holds good for the circuits where the lessee´s device located in the lessor´s premises will be stated in the technical specification.

II.

The circuit set-up

1. The lessor will set up the leased circuit up to the date stated in the technical specification of the circuit. This specification shall be a component of the Attachment no.1.
2. The lessor´s hand over of the leased circuit to lessee´s lease shall be confirmed by the acceptance protocol; the example of this protocol is attached as Attachment no.2 to this contract. The acceptance protocol will be signed by both contractual parties and these parties guarantee by their signatures that, at the time of hand over, the particular circuit has the guaranteed parameters.

III.

Quality guaranty

1. The lessor pledges to keep the leased circuit, including its own devices connected to it, for the whole period of lease in such state that the guaranteed and standard parameters are properly kept, and the lessee pledges to provide all necessary cooperation. Standard parameters of optical fibres are stated in Attachment no.3.
2. For the purpose of standard parameters of the circuit guaranty, the lessor pledges to check and evaluate the parameters of the leased circuit and interface continuously.
3. The lessor guarantees and ensures to the lessee continuous operation of the leased circuit and its availability for 24 hours a day, seven days a week for the whole calendar year, with the exception of justified interruption of the operation according to this contract.

4. The lessor guarantees to the lessee minimal monthly availability and exploitability of the leased circuit at 99.7%. For availability assessment, the following formula will be used:

$$availability = \frac{(P - N)}{P} \times 100\%$$

P is the number of hours in the calendar month when the lessee had the right to use the leased circuit properly, including the time of justified interruption of operation provision and availability according to this contract; and ***N*** is the number of hours when the lessee cannot use the leased circuit in the particular month due to lessor´s cause.

5. For justified interruption of the circuit, such interruption of continuous operation or unavailability of the leased circuit is considered that has occurred due to:
   a) reasons of planned maintenance of the lessor´s telecommunication network, which was properly announced to the lessee at least 5 calendar days in advance or ordered by the lessee, and the length has not exceeded 120 minutes within the calendar month; or
   b) damage or disorder of the leased circuit, its part or connected telecommunication device due to lessee´s reasons; or
   c) reasons of disorder reparation, for which the lessee has not provided the lessor with all necessary cooperation; or
   d) legal reason or on the basis of legal regulation or decision of state authority; or
   e) lessor´s side one-sidedly, if the lessee´s handling, negligence or default is capable of influencing proper operation or lessor´s telecommunication network safety, or is in contradiction to the contract, generally valid legal regulations or good morals.
6. The technical specification of the lessor´s circuit is an inseparable component of this contract. The pattern of this specification is stated in Attachment no.4. In the technical specification, some lease conditions of certain circuit may be adapted distinctly from general regulations of this contract.

IV.

Duties of the lessee

1. The lessee is bound to guarantee, and is responsible for, the use of the leased circuit and the devices connected to it according to the legal regulations of NREN, and to guarantee that the circuit and devices will not be used for the purposes that are in contradiction to the law or good manners, or misused in any other way.
2. The lessee will not allow any third party´s lease of the circuit for remuneration without prior approval of the lessor. The lessor shall not groundlessly refuse this approval.
3. The lessee is not allowed to change anything on the leased circuit or lessor´s devices connected to it, or interfere in them, and is not allowed to permit any

third party to interfere without the lessor´s permission, and is responsible for the damages that would arise due to such unjustified interference.

4. On the basis of lessor´s challenge, the lessee is bound to enable and procure the entrance to the premises where the device is located to the lessor and the persons appointed by the lessor, for the purposes of fulfilment of the obligations of this contract.

V.

Disorder announcement and elimination

1. The lessee is obliged to announce a disorder on the leased circuit and the telecommunication devices connected to it without unnecessary delay to the operator of the lessor´s information line on the continuously operated telephone: ..... The lessee shall announce the disorder after checking that the disorder is not on the lessee´s telecommunication devices. The lessor shall confirm the announcement of the disorder by electronic post, address: .....
2. In the disorder announcement, the lessee shall state at least:
   a) identification of the lessee;
   b) who is announcing the disorder;
   c) at what time the disorder has occurred;
   d) description of the disorder, including the information about the device on which the disorder has occurred.
3. The lessee has the right to claim the disorder reparation from the time of the announcement of the disorder. If the disorder occurs on the telecommunication device which is located in lessee´s area premises, the lessor is not delayed with the reparation in the time when the lessee has not enabled the lessor´s access to the device.
4. Disorders caused by the lessor´s party shall be repaired by 8 hours since the announcement, other disorders by the terms corresponding to their location and technical demandingness, by seven calendar days at the latest.
5. During the disorder reparation, the lessee is bound to provide the lessor with all necessary assistance. The lessor is rightful to require this assistance. If the necessary assistance is not provided, the lessor is not responsible for the prompt renewal of the leased circuit and devices parameters or availability that has been affected by the disorder.
6. The lessor shall inform the lessee about the reparation of the disorder without any unnecessary delay. The lessee shall immediately check the availability and functionality of the leased circuit or devices that have been affected by the disorder, and shall confirm this to the lessor. If the lessee announces repeated occurrence of the repaired disorder within 15 minutes after the confirmation of full functionality of the leased circuit and devices, and the lessor finds out objectively that the disorder still exists, the disorder is not considered as repaired. If the disorder occurs later, it is considered as new disorder.
7. The lessor has the right of charging the lessee costs connected with disorder reparation according to this article, if the disorder occurred as a result of the lessee´s breaking this contract, or pertinently if the disorder has not occurred at all.

VI.

Price and payment conditions

1. Since the day of handover of the leased circuit according to paragraph 3, article II above in this contract, the lessee pledges to cover to the lessor for the lease and corresponding services the following prices and fees:
   a) monthly fee for the lease of one metre of the circuit realised by a pair of optical fibres, depending on the agreed period of rent:
      I. 3 years …… ……Euro
      II. 5 years …… Euro
      III. 10 years ……..…….. Euro
      IV.15 years …….. Euro
      V. 20 years …….. Euro
   b) monthly fee for the lease of one metre of the circuit realised on single optical fibre, depending for the period of three years, depending on the length of the leased circuit:
      over 100 km ……..…. Euro
      20 - 100 km ……....…. Euro
      under 20 km ……..….. Euro
   c) monthly fee for the lease of one metre of the circuit realised on single optical fibre, depending on the agreed period of rent (with no respect to the length of the leased circuit):
      5 years ….....……60% of the price acc. to article VI. paragraph 1 letter a) point II.
      10 years ……..……60% of the price acc. to article VI. paragraph 1 letter a) point III.
      15 years ……....…60% of the price acc. to article VI. paragraph 1 letter a) point IV.
      20 years ……60% of the price acc. to article VI. paragraph 1 letter a) point V.
   d) yearly fee for the maintenance of one circuit ……....……..... Euro
2. The above stated prices do not include legitimate VAT, which will be added to them and charged to the lessee within the scope of regular accounting.
3. If the total of regular monthly fees without VAT for all leased circuits for the given monthly account period exceeds ..... Euro, the lessor shall provide the lessee with a discount:
   a) if the total of regular monthly fees without VAT is up to XX Euro ..... 4% out of the total of regular monthly fees without VAT
   b) If the total of regular monthly fees without VAT is over XX Euro ..... 10% out of the total of regular monthly fees without VAT.
4. The lessee pledges to pay a nonrecurring fee for the deployment of the circuit of leased optical fibres. The price of this fee will be stated in the technical specification of the circuit and both parties will make an agreement on this price in advance, which means within 14 days since the day of the circuit order on the basis of tax document written out by the lessor. The day of the

circuit order is the day when the fulfilled and by both parties signed technical specification was handed over to the lessor. This technical specification serves for identification of the circuit and is an inseparable component of this contract.

5. All the prices charged according to this contract, including pertinent advances, contractual fines or delay interests, or accounted recompenses, will be paid together with legitimate VAT by the lessee, based on tax document (invoice) written out by the lessor, by means of transfer within the maturity term stated in corresponding tax document. Accounting is considered to be defrayed when the corresponding amount is credited to the lessor´s bank account stated in the headings of this contract. The maturity of tax documents will be 14 days since the date of their delivery to the lessee, if not stated differently in some of the regulations of this contract.
6. The lessor shall charge the lessee all prices according to this contract by the following way:
   a) a nonrecurring fee charged after the order of the circuit, acc. to article VI., paragraph 4 of this contract
   b) regular monthly fees for a complete accounting period, regressively to the last day of accounting period;
   c) regular monthly fees for an incomplete accounting period, regressively to the last day of supposed accounting period at the rate of 1/30 of the monthly fee multiplied by the length of the incomplete accounting period in calendar days.

   An account period is a calendar month, if not stated distinctly.
7. The date of taxable supplies realization comes up according to the corresponding law on VAT in the valid version, and is always stated on the particular tax document.
8. Monthly price and other payment accounting according to this contract in the form of tax document (invoice) shall be send by the lessor to the lessee, to the address of the lessee stated in the headings of this contract, till the 10th day since the final date of the corresponding accounting period.
9. Within the maturity term of the accounting of prices and fees according to this contract, the lessee has the right to write a complaint against the rate or contents of this accounting to the lessor. Complaints against accounting shall be solved by the lessor without any unnecessary delay.
10. If the complaint is admitted by the lessor as justified, the lessor shall write out new corrected accounting and shall send it to the lessee´s address stated in the headings of this contract. The maturity of such additional accounting will not be shorter than 14 days since its delivery.
11. The lessee is bound to pay an installation fee at the rate of 70% of the installation costs for the setup of the ordered last mile. These costs will be mentioned in the setup budget in the offer and consequentially in the technical specification, in the Attachment no. 1. The lessor is bound to reserve 70% of optical fibres in such last mile for the lessee´s use. The remaining cost at the rate of 30% of installation costs for the last mile setup, is the duty of the lessor. The lessor has thus the right to reserve 30% of optical fibres in such last mile for the lessor´s own use.

VII.

Contractual fines and default interests

1. If the setup of the leased circuit is not finished within seven calendar days since the pointless expiry of the term for its setup stated in the technical

specification, the lessee has the right to charge the lessor contractual fine at the rate of 0.5% out of the nonrecurring fee for the leased circuit deployment, for every – even only commenced – day of the delay, maximally to the total rate of 110% of the setup fee.

2. If the guaranteed availability and usability of the leased circuit in the calendar month is not kept, the lessee has the right to charge the lessor contractual fine calculated according to the bellow stated percentage rates out of the regular monthly fees:

monthly availability is lower than	**percentage rate of the regular monthly price**
99,6 %	10 %
99,3 %	15 %
99,0 %	20 %
98,0 %	25 %
97,0 %	30 %
96,0 %	100 %

3. If a properly announced disorder is not repaired by 12 hours since the moment of its announcement, the lessee is rightful to charge the lessor contractual fine at the rate of 0.1% out of the monthly fee for every – even only commenced – hour of the delay with the disorder removal, which exceeds the above-mentioned 12-hour term, but maximally up to the rate of monthly fee for the corresponding circuit according to Attachment no. 1.
4. If the guaranteed availability and usability of the leased circuit, or its component, is not kept, the lessee has the right for the refund of the proportional part of the unrightfully charged and paid sums of the regular fees. This holds good for every continuous period longer than 15 minutes. The proportional part of the fees will be calculated as 1/720 of the part of the fee multiplied by the total of the length of such periods in the corresponding accounting period, when the leased circuit, or its part, did not reach the contracted parameters, rounded off for whole hours up. In the case of partial co-responsibility with the lessee, the contractual parties shall agree on the adequate cut-down on the sum to return. The lessor is bound to return the sum within 30 days. The lessor may deduct the sum from the price accounted in the next accounting period.
5. The lessee is bound to account to the lessor the contractual fines, according to this article, at the latest, till two calendar months since the day of emergence of the lessee´s claim according to this contract, otherwise this claim expires. The contracted fines are payable till 30 days.
6. In case of delay with accounting payment, the lessor has the right to charge the lessee the default interest at the rate of 0.05% out of the owing sum for every day of the delay. The lessee has the right to charge the lessor the same interest rate in the case of the delay of the refund of the sums stated in paragraphs 4 and 5 of this article.
7. The provisions of paragraphs 1,2,3 and 4 of this article shall not be claimed if the reality stated in these provision was caused provably due to the lessee´s action.

VIII.

Liability for damage

1. The parties are obliged to recompense only the factual damage, in case of damage liability, and this holds good if the parties have broken their duties arising out of the contract, if such breach was caused by wilful conduct or gross negligence of their staff or persons commissioned by them. The claim of the recompense of the lost profit or loss of business opportunity of the contractual party is suspended by this provision.
2. The lessor is not liable for damage that arises as a result of justified operation interruption or leased circuit availability.
3. Contractual parties are not responsible for the breach of the contract if this breach is caused by the circumstances excluding liability in the extent of the definition stated in the corresponding Business Code. The mandatory party is obliged to prove the emergence of these circumstances to the other party, 14 days since the emergence at the latest. If the mandatory party does not prove these circumstances, the party is liable for the damage caused by this way. In the case of emergence of liability excluding circumstances, the parties are obliged to negotiate about a compensatory fulfilment at the most immediate time, pertinently to cope with the mutual contractual rights and obligations, if it is not be possible to eliminate the consequences caused by liability excluding circumstances effectively, or the compensatory fulfilment is not possible.

IX.

The validity and effectiveness of the contract

1. This contract becomes valid and effective at the moment of signing by both contractual parties.
2. The contract is concluded for the time unlimited. The contract may be terminated only after the lease of all circuits has been terminated, the notice period is 3 months and starts on the first day of the calendar month following after the termination delivery to the other contractual party.
3. The lessee is bound to use the leased circuit for the minimum of 36 months, if not stated distinctly in the technical specification.
4. The lessee has the right to terminate the circuit use with one-month notice period, but not earlier than one month before the expiry of agreed period of circuit duration. The lessor has the right to terminate the circuit use with one-year notice period, but not earlier than 12 months before the expiry of agreed period of circuit duration. The notice period begins on the day of the delivery of the termination to the other contractual party.
5. The contract or individual circuit lease may also be terminated by agreement of contractual parties.
6. Either contractual party has the right to terminate the contract by written rescission from the contract with immediate effect if the other party, despite the written warning of the justified party, for a period longer than three months does not fulfil its duties according to this contract, or materially breaches its provisions. For the purpose of contract rescission, the following contract breaches are material:
   a) the lessor repeatedly and against warning does not keep the agreed parameters of the circuits, especially circuit availability, or is delayed with the circuit deployment for longer than 45 calendar days since the pointless expiry of the term for its deployment;

b) the lessee is repeatedly and against warning in delay with the payment of accounted fee or its part, for the time longer than 45 days after the date of maturity;
c) the lessee repeatedly and against warning uses the leased circuit or lessor´s device in contradiction to the contract;
d) it is not possible to dispose of the barriers on the lessee´s side, due to which the lessor has interrupted the operation or leased optical fibres availability, according to the article III., paragraph 5, letter e) above.

7. The termination of the contract or individual circuit, or an announcement of contract rescission, shall be sent to the other party by registered post and are considered as delivered at the moment when the other party takes the consignment over, refuses to take the consignment over, does not take the consignment out within 3 days since the storage at the post office or when such consignment comes back to the sender as undeliverable, although it was sent to the address which was stated in the headings of the contract as delivery address of the addressee.
8. The circuit use may be unilaterally terminated by the lessee before the expiry of 35 months of the use with two-month notice period, which begins on the day of delivery of the termination to the other contractual party. In such case, the lessor has the right to charge the lessee a contractual fine, which equals 50% out of all payments for the leased circuit, which the lessee would be obliged to pay since the date of the lease termination till 3 complete years of use. The maturity of this contractual fine is 6 months.
9. In the case of contract termination, the contractual parties are bound to pay out their mutual obligations and debts arising out of this contract, without any unnecessary delay, according to the law and this contract.

X.

Final provisions

1. If not stated distinctly in this contract, other rights and duties are stated by the valid Business Code and other generally valid regulations.
2. This contract may be changed only by written amendments signed by both contractual parties.
3. Either contractual party is allowed to assign its rights and duties emerged from this contract to another party which is able to fulfil the contractual obligations, but only with prior written approval of the other contractual party.
4. All disagreements between contractual parties emerging from this contract or in connection with it, shall be solved by contractual parties without any delays, mainly by conciliatory mutual agreement. If the disagreement is not solved within 30 days, the matter shall be solved by the Arbitration Court in …….. in accordance with the Rules of this court. There shall be three (3) arbitrators appointed according to the Rules of the court, by which the place of judging shall also be stated. The arbitration shall be led in the language ……., which shall also be the language of arbitration finding. Such arbitration finding shall be final, obligatory for both parties and enforceable by the corresponding court.
5. If one or more provisions of this contract is considered as illegal, invalid or unenforceable, such illegality, invalidity or unenforceability shall not influence other provisions, which shall be interpreted as if the illegal, invalid or unenforceable provisions did not exist. The contractual parties agree that all illegal, invalid or unenforceable provisions shall be replaced by legal, valid and enforceable ones, which are the closest to the sense and purpose of the

stated contracts.

6. This contract is written in two copies, each contractual party will obtain a copy.
7. The contractual parties affirm that, at the time of signing the contract, they are not familiar with any circumstances which might obstruct or exclude the conclusion of this contract, or which could be a serious barrier to the contract fulfilment.
8. The contractual parties affirm that this contract is a demonstration of their true and free will, that they have read the contract, they understand the contents of the contract and agree with it, and to prove this, they subjoin their signatures

(place)_____date _____

(place)_____date _____

.....…..... .....….....

on lessor´s behalf on lessee´s behalf

List of attachments:

1) **Technical specifications of the circuits**
2) **Acceptance protocol example**
3) **Standard parameters of the optical fibres of the lessor**
4) **The pattern of the technical specification**

Attachment number 1 of the contract number .....

Technical specification of the circuits

Number of pages : 2

Specification/Version number : 1	Lessee: organization B
Substitutes specification no.:	Circuit name: city x – city y
Circuit number:	Requirement:

End point A ***First mile setup (yes/no):***

Identification: workplace name	Floor:	
Street:	Room:	
City:	Post code:	Telephone:
Contact person:	Fax:	
Post:	E-mail:	
End equipment (producer, type):		
Connector:		
(E2000, FC/PC, SC)		

End point B ***First mile setup (yes/no):***

Identification: workplace name	Floor:	
Street:	Room:	
City:	Post code:	Telephone:
Contact person:	Fax:	
Post:	E-mail:	
End equipment (producer, type):	Power supply and backup:	
Connector:		
(E2000, FC/PC, SC)		

Circuit type: *(single fibre/pair of fibres)* ***Fibre length:*** *a) first mile to point A: km*

Number of splices on the line max: b) middle part: km

Number of connectors on the line max: c) first mile to point B: km

Service quality level: *Date of service setup/change:*

Monthly price of the circuit:

The price of circuit setup including first mile:

on lessor´s behalf:	**on lessee´s behalf:**
Date:	Date:
Name and title of the lessor´s warranted representative	**Name and title of the lessee´s warranted representative**
Signature	Signature

Page no. 2 for specification no. 1: Special statement

Attachment number 2 of the contract number . …….

Acceptance protocol example

Lessor: **organization A** **residence:**	Lessee: **organization B** **residence:**

Circuit:

Identification

	end A	end B
Address		
Connector		

Circuit number	end A connector number	end B connector number
circuit 1		
circuit 2		
circuit 3		
circuit 4		

Measurement device

	Attenuation measurement	Reflection measurement	PMD measurement	
Device	Attenuation meter	Reflection meter	Analyser	Source
Producer				
Type				

Measurement cable/fibre

Producer	
Cable type	
Fibre type	

Fibre length	
Attenuation on fibres (max)	
Number of splices – total	
Number of splices – inner	
Number of connectors	0

RESULTS

Pattern::

MaxA (dB) = (Nsp x 0,15) + (L x A) + (Nc x 0,5)

Nsp = number of splices

L = fibre length

Nc = number of connectors

Power Measurement

Max. value 1310 nm		Max. value 1550 nm	

Fibre number	1310		dB	1550		dB
	A	B	Med	A	B	Med

Maximum						

Date of measurement:

Notes:

Attachment:

1. – Measurement protocol of the company

date

..... …….....

Attachment number 3 of the contract number …….

Standard parameters of the lessor´s optical fibres

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1. Type and construction

2. Geometrical parameters

3. Optical parameters

4. Mechanical parameters

Attachment number 4 of the contract number .....

Technical specification of the circuit

Specification/Version number :	Lessee:
Substitutes specification no.:	Circuit name:
Circuit number:	Requirement:

End point A	***First mile setup (yes/no):***	
Identification: workplace name	Floor:	
Street:	Room:	
City:	Post code:	Telephone:
Contact person:	Fax:	
Post:	E-mail:	
End equipment (producer, type):		
Connector: (E2000, FC/PC, SC)		

End point B	***First mile setup (yes/no):***	
Identification: workplace name	Floor:	
Street:	Room:	
City:	Post code:	Telephone:
Contact person:	Fax:	
Post:	E-mail:	
End equipment (producer, type):	Power supply and backup:	

Connector:

(E2000, FC/PC, SC)

Circuit type: *(single fibre/pair of fibres)* ***Fibre length:*** *a) first mile to point A: km*

Number of splices on the line max: b) middle part: km

Number of connectors on the line max: c) first mile to point B: km

Service quality level: *Date of service setup/change:*

Monthly price of the circuit:

The price of circuit setup including first mile:

on lessor´s behalf:	**on lessee´s behalf:**
Date:	Date:
Name and title of the lessor´s warranted representative	**Name and title of the lessee´s warranted representative**
Signature	Signature

9.1.3. Documentation provided by DANTE

DANTE has provided two documents they prepared and used for the purchase of different telecommunication services among which is dark fibre leasing. The first document is initial purchase of telecommunication services for GN2 from November 2003. The second one is the additional purchase of telecommunication services from September 2005.

9.1.3.1 Tender for Network elements for the GN2 network, November 2003

The next 20 pages present a tendering documentation for the GN2 network issued during November 2003.

1. INTRODUCTION

This Invitation to Tender is for the procurement of the successor to the GÉANT Pan-European Research and Education Network, which has the working title of the GN2 network. This will replace the existing GÉANT network with a combination of network infrastructure, services and equipment that will dramatically expand the capacity, functionality and cost effectiveness of the world's largest research network as a production and research networking environment. In this tender we are specifically seeking offers for

- network infrastructure plus associated equipment and/or network services to provide the connectivity for GN2.

Network management will be subject to a separate tender exercise in due course

There may also be a separate tender conducted for standalone network routing equipment depending on the nature of the connectivity procured.

It is proposed to hold an open day on 5 February 2004, at which you will be invited to present any questions you may have regarding this document. This will be held in Paris. Please advise gn2-coordinator@dante.org.uk if you wish to attend this event and to receive further details.

2. BACKGROUND INFORMATION

2.1 Profile of current GÉANT network

DANTE and the European National Research and Education Networks (NRENs) first implemented the initial GÉANT network in late 2001. It forms the world's largest research and education network with over 3,500 academic and research centres in 32 Countries being connected with an overall capacity across the network in excess of 130 Gbit/s. The complete set of countries that GÉANT serves is listed in Annex 1. GÉANT has allowed NRENs access speeds of up to 10 Gbit/s between their national networks and GÉANT and has been upgraded during its lifespan. An illustration of the current GÉANT network can be found at:

http://www.dante.net/upload/pdf/GÉANT_topology_Nov_2003_high_res.pdf

Currently the GÉANT network has a backbone infrastructure consisting of eight core nodes handling data traffic at up to 10Gbit/s and connected by rings of high speed leased circuits of 2.5 and 10Gbit/s capacities. High levels of resilience have been achieved primarily through the diverse network routing provided by this topology. There are further networked nodes are operating at speeds of up to 2.5Gbit/s and some peripheral nodes connected via high speed SDH circuits.

Utilisation levels on the present network are growing rapidly. In addition to the traditional use of communications for email and file transfer applications, increasing use of the capacity is now occurring for bandwidth-intensive uses such as video-conferencing and for major scientific projects such as the European VLBI radio astronomy project and for grid computing applications, enabled by the near ubiquitous coverage of research networking throughout Europe.

Further expansion of the access and core capacities is foreseen during the GN2 project. The network will face considerable demands to meet the needs of 'production' and network research uses, and particularly needs to accommodate very high capacity point to point requirements principally from large scientific projects.

The tender for the current GÉANT network examined a number of technical options for sourcing and managing the connectivity required, and concluded at the time that the most cost effective and technically sound solution throughout Europe was to base GÉANT on a mesh of leased circuits, either provided as wavelengths or, where necessary, as SDH circuits linked by routers. In this tender alternatives to leased circuits will be re-examined in the light of technical and regulatory developments since the last tender and to the changing relative economics of alternative solutions. It is considered unlikely that the GN2 network will be based on exactly the same technologies.

2.2 Technology Guidance

The basic requirement in this ITT is for high-speed connectivity between as many of the countries covered by GÉANT as possible. Tenderers are welcome to propose any, or a range of, appropriate technologies for providing this connectivity; the choice will, of course, have implications for equipment requirements and management responsibility between tenderers and DANTE. Management boundaries between the services tenderers supply and other components managed by other contractors will have to be agreed by DANTE during contract negotiations. In particular, the extent to which a connectivity supplier includes the equipment provision and management hardware in his tender is also open to some extent.

In order to give guidance on the kind of proposals that are being sought, some possible technology scenarios are outlined below. The solution will consider the cost, technical performance and operational manageability of tenderers' proposals and the GN2 network could comprise a combination of these and/or other technologies.

2.2.1 Short Haul Dark Fibre (SHDF)

Short Haul Dark Fibre is dedicated point-to-point optical fibre or fibre provided by the tenderer between agreed A and B termination points and implemented as a single unbroken fibre span with no in-line equipment. Tenderers will also be expected to arrange for the maintenance of the fibre infrastructure.

Tenderers are also welcome to suggest appropriate technologies that DANTE may use to transmit data over the SHDF services on offer (especially where the fibre length is greater than 60km).

2.2.2 Long Haul Dark Fibre (LHDF)

Long Haul Dark Fibre is dedicated optical fibre infrastructure taking the form of multiple dark fibre spans, provided by the tenderer, between agreed A and B termination points which includes housing facilities (space, power, air conditioning and security) along the fibre route. These facilities would be used to house suitable amplification/regeneration equipment thereby allowing much greater distances between termination points than would be possible for SHDF services. The housing facilities at intermediate points (in huts) are mandatory. DANTE would arrange amplification/regeneration at the intermediate points and run its services over the infrastructure. The management and maintenance of this equipment is open to negotiation but DANTE would be interested to receive details of offers of management and maintenance services from LHDF tenderers.

Possibility of remote monitoring and management by DANTE is requested. Remote access independent on fibre or cable integrity is preferred.

2.2.3 Lit Fibre

Lit fibre is an extension to 2.2.2 (LHDF) in which tenderers are expected to provide, manage and maintain all the necessary dark fibre and associated transmission equipment (i.e. all in-line and end-terminal equipment for some number of wavelengths) and all of this infrastructure is dedicated for use by GN2.

2.2.4 Fixed Wavelength Services

'Fixed wavelengths' are unprotected point to point circuits using DWDM transmission technology provided by the tenderer between agreed A and B termination points with SONET/SDH, Gigabit Ethernet or 10 Gigabit Ethernet (LAN PHY) interfaces.

2.2.5 Re-configurable Wavelength Services

'Re-configurable wavelengths' are circuits offering the same characteristics as fixed wavelengths between a defined set of termination points allowing, on request, fast reconfiguration of the circuits. The meaning of the term "fast" is open to negotiation but as an indication we expect the lead time for reconfigurations to be no more than one week for manual reconfiguration and no more than one minute for remote managed reconfiguration.

2.2.6 SDH Based Services

These are protected or unprotected point-to-point circuits using SONET/SDH transmission equipment provided by the tenderer between agreed A and B termination points. The SONET/SDH transmission equipment may or may not make use of an underlying DWDM transmission infrastructure. Client interfaces are expected to be ANSI/ITU compliant SONET/SDH interfaces at speeds ranging from OC-3/STM-1 (155 Mbps) to OC-48/STM-16 and normally the payload can be expected to be concatenated. There is no expectation that any of the SONET/SDH (or DWDM) transmission equipment (other than the A- and B-end ADM client interfaces) is dedicated for use by GN2. SDH based services are currently used in parts of the GÉANT network.

2.3 Procurement Strategy

Tender responses will be evaluated and negotiations concluded via Negotiated Procedures in accordance with the Council Directive 92/50/eec of 18 June 1992 published in the OJ L209 in 1992.

It is very unlikely that a single provider will be able to provide the most cost effective connectivity solution across the whole required network footprint. Based on the experience in GÉANT it is possible that contracts be awarded to providers for connectivity between multiple pairs of countries, though this will be judged on the merits of the offers received. In any case the GN2 connectivity will require close cooperation between providers and those that are eventually selected will be required to accept this.

DANTE will prefer geographically different physical path to network nodes for reasons of reliability in both local loop and international line parts.

In the evaluation of tenders, DANTE will select from amongst all the offers it receives in order to achieve the most cost effective operational service. This means there may be a lengthy period of clarification, discussion and iteration to assess the relative merits of the different technical solutions in the range of geographies and markets across Europe, as well as the relative merits of the offers for similar technical solutions from the different providers. Where DANTE needs to source equipment to deliver part of the connectivity solution, an associated network equipment tender may be held during the period of this tender if this is necessary to enable DANTE to understand the availability and cost of suitable equipment. This would contribute to the evaluation for the assessment of the different technical solutions by helping assess the full end to end connectivity service costs.

This tender is seeking to provide a solution from the start of the new network for all the countries listed in Annex 1. If necessary interim solutions and/or further ITTs may be considered in due course.

2.4 Relationship with EC Programmes

GÉANT has been funded in part by the EC's Fifth Framework Programme since November 2000, with 26 European NREN participants and DANTE as the Co-ordinating Partner. A proposal has been submitted for continuing to support a Pan-European research network as part of the GN2 project within the 6th Framework Programme.

93 M Euro has been earmarked by the EC towards financing GN2 over the four years of FP6, and representing up to 50% of its total cost, with the remainder to be sourced from national funds by the NRENs, as with the current GÉANT network and previous generations of Pan-European research networks.

2.5 Implementation Timescales

The transition from the current GÉANT network service to that of GN2 will be implemented as an orderly programme of migration with a high priority given to maintaining the continuity of service to end users. It is planned that this should take place within a three month period starting from January 2005.

3. SERVICES TO BE PROCURED

This Invitation to Tender is for the network elements necessary to maintain or upgrade the existing connectivity to the countries listed in Table 1 of Annex 1. Tenderers may make proposals for either or both of the services 3.1 and 3.2 below. The procurement of network equipment is not within the scope of this tender.

3.1 Connectivity

Connectivity is sought between one or more nodes in the GN2 network to connect the NRENs in Table 1. Tenderers may offer single or multiple connections. The connectivity speeds may not be the same for each location. While this depends largely on price, it will also depend on the NRENs capacity requirements. If wavelength services or fibre infrastructure, together with the equipment necessary to provide end to end connectivity services, are not available or are not cost effective in relation to NREN budgets, SDH circuits with capacities in the range 155 Mbit/s (STM-1) to 622 Mbit/s (STM-4c) may be required and exceptionally only at 34/45 Mbit/s (E3/T3). It is intended that following the tender each NREN in Table 1 will be connected to other points on the GN2 network by at least 2 diverse routes.

The main requirement is for international connectivity as described above. Normally the connectivity will terminate at the equipment interface at each GN2 PoP. Where necessary a new GN2 PoP will be deployed for this purpose. Exceptionally if an NREN has only one

connection to GN2, then the connectivity would need to terminate at the NREN Equipment interface at the NREN PoP. In either case the management boundary is one or more physical interfaces in a patch panel within a GN2 or NREN PoP. The nature of the physical interface(s) will reflect the nature of the physical interface(s) used by the vendors of popular IP routers, layer 2 switches, optical cross connects (OXCs) or DWDM transmission equipment and will, in part, depend on the nature and capacity of the circuits offered by the tenderer.

In the event that the proposed termination point of the international connectivity is not the same as the NREN location as listed in Table 1, then suppliers are requested to include offers for any local tail circuits that may be required to complete these connections or alternatively provide a response for housing GÉANT and NREN equipment at the proposed termination point per 3.2 below.

Tenderers providing dark fibre based services will be required to make available accommodation suitable for the housing of DWDM transmission system components (notably in-line amplifiers and/or regenerators) in intermediate repeater sites (huts).

4 COMMERCIAL ISSUES

4.1 General

4.1.1 The contract for the requirements set out in this ITT may be awarded wholly, in part or not at all to any specific tenderer.

4.1.2 Tenderers will be required to co-operate with other suppliers in the provision of service to DANTE.

4.1.3 Tenderers must confirm that any services they offer conform to any relevant national or EC regulatory requirements.

4.1.4 All expenses relating to the submission of tenders and any subsequent contract negotiations are the responsibility of the tenderer.

4.1.5 Existing suppliers who respond to this tender and who are unsuccessful will be required to agree to co-operate with the implementation of successful responses from other potential suppliers.

4.1.6 All tenders must remain valid for a period of six months following the deadline for submission.

4.2 Contractual

4.2.1 EU funding support is expected for the activity as part of the Integrated Infrastructure Initiative Programme under FP6. Selected suppliers will be expected to agree contractual terms and conditions appropriate to the funding arrangements for this activity.

4.2.2 Contract duration will be discussed during contract negotiations. For simple leased circuits, contracts are likely to be for 12 months and then extendable for further periods at DANTE's option, subject to satisfactory performance and price reviews. Longer contracts of up to 3 – 4 years duration will be agreed where warranted, for example where the technical solution requires significant capital investment by the tenderer and/or DANTE, or where a major part of the GN2 network is being provided by the tenderer. IRU's are also negotiable provided the financial commitments can be accommodated within the GN2 project period.

4.2.3 Contracts shall include specific clauses relating to quality of service including availability guarantees and delivery dates. As a guide an overall availability in excess of 99.0 % on a monthly basis is expected for un-protected services

4.2.4 Precise delivery dates for connectivity and services will be subject to negotiation. However, suppliers will be required to make firm commitments to such delivery dates as are agreed, with compensation for late delivery. Agreed dates are expected to be available within the fourth calendar quarter of 2004.

4.3 Pricing

4.3.1 Tenderers must quote prices for each link at each capacity that they offer. They are also encouraged to offer discount arrangements for the supply of multiple links.

4.3.2 Prices for different service elements shall be quoted separately in Euro and, in the case of recurrent charges, in units of Euro/year. VAT and other taxes, if applicable, must also be quoted separately.

4.3.3 Prices for connectivity shall be structured such that they relate to the capacity offered and shall include terms and conditions for increasing capacity.

4.3.4 Prices for connectivity must cover all components which lie within the supplier's boundary of responsibility (as defined in the response to Annex 2).

4.3.5 Tenderers are asked to propose pricing arrangements for one year contracts extendable on a monthly basis and, subject to meeting the requirements in 4.2.2, for longer term contracts.

4.3.6 Tenderers will be expected to provide assurances about the competitiveness of their prices both in respect of the contractual arrangements to be entered into and also in respect of future developments in the market place. Subject to an extension contracts shall provide for an annual price review (which may result in capacity upgrades for the same price). Price reviews shall take account of comparisons with similar services within the network as well as competitiveness with alternative suppliers.

It is expected that all prices will be exempt from VAT and other taxes. In the event that any VAT or other taxes have to be applied, these must also be quoted separately and fully detailed. Price information must be summarised in the Pricing table in Annex 5 and this must be supplied electronically. Tenderers should confirm their preparedness to allow DANTE to assign part of the contracted connectivity to other national research networks.

4.3.7 Tenderers should clearly state if there are any restrictions of use that apply to their Offers.

5. INSTRUCTION TO TENDERERS

Tenders must be in English and must conform to the following structure:

5.1 Overview of the Response

5.2 Summary of Pricing Information, formatted using the template guide in Annex 5, with accompanying electronic spreadsheet in Microsoft Excel.

5.3 Proposed Solution/Offer, including

- a list of the services for which the tenderer is making a proposal,
- for each service offered, a point by point response to the elements of the technical specification given in italics in Annexes 2 and 3, as applicable

5.4 Statement of Conformance

- confirmation on a point by point basis that the tenderer acknowledges the requirements specified in sections 4.1 to 4.3 above and is prepared to negotiate detailed contract terms on the basis of these requirements

- reservations, i.e. a list of points on which the tender explicitly does not meet the specifications set out in this Invitation to Tender

5.5 Background Information about the tenderers organisation including

- one set of latest audited financial results (e.g. most recently published annual report).
- Brief description of funding structure including main stakeholders (less than 100 words).
- Publicly available details of any planned restructuring/refinancing which might affect the tenderer's ability to perform its duties as detailed in the proposal submitted (less than 200 words).

5.6 Brief CV's of key personnel who will be responsible for contract negotiation and service implementation

5.7 Reference Sales

- a list of three reference sales which the tenderer puts forward as evidence of technical and operational capability and of timely implementation
- for each reference listed, the name and contact information of a person with whom DANTE can communicate to discuss the tenderers performance.

5.8 Deadline for Submissions

- **Five copies of your tender must be sent to DANTE, Francis House, 112 Hills Road, Cambridge, CB2 1PQ, UK to be received no later than 17.00 hours local time on 6 March 2004. An electronic copy should also be sent to**

  gn2-coordinator@dante.org.uk

  to arrive in the same timescales.

5.9 Complete the checklist in Annex 6

6. EVALUATION CRITERIA

The following criteria will be used in evaluating responses. The order of listing has no significance:

- Compliance to the requested commercial and technical requirements and questions in this ITT (Sections 2, 3, and 4, and Annexes 2, 3, and 5)
- Cost of ownership, reflecting the non commercial use of GN2 connectivity and the competitive pricing attracted by GÉANT
- Service availability and technical performance levels, and demonstrability of achieving them
- Capability to install and deliver to services according to the agreed timetable
- Upgrade path, especially costs of wavelength service upgrade to higher transmission rate or higher number of wavelengths
- Financial standing including an audited copy of the latest set of accounts and relevant experience of the Tenderer

ANNEX 1: SERVICE LOCATIONS

TABLE 1

Tenderers are invited to make offers for connectivity between GÉANT PoP addresses in any pairs of countries from the table below.
The addresses listed in columns four and five are ones suggested by the NREN where the GÉANT PoP could be located and as convenient locations for providing the end to end service to the NREN.
Tenderers are also free to propose other addresses including arranging the local connections to reach the NREN. All proposals will be assessed for overall technical merit, cost effectiveness and carrier neutrality.

1. Country	**2. Access Node Location**	**3. Current GÉANT PoP Address**	**4. NREN PoP Address 1st recommendation**	**5. NREN PoP Address 2nd recommendation**
Austria	VIENNA	Columbusgasse 55 1100 Vienna	ACOnet Vienna University Computer Centre, Modemrau 1. Keller Universitaetstrasse 7 A-1010 Wien	InterXion Austria, A-1210 Wien, Shuttleworthstr. 4-8
Belgium	BRUSSELS	CH De Haecht 1430, 1130 Brussels	tba	
Bulgaria	SOFIA	N/a	tba	
Croatia	ZAGREB	Hrvatska akademska i istrazivacka mreza - CARNet J. Marohnica bb HR-10000 Zagreb	University computing centre - SRCE, J.Marohnica bb, 10000 Zagreb	
Cyprus	NICOSIA	N/a (currently directly connected to the NREN)	Kallipoleos 75 1678 Nicosia (tbc)	
Czech Republic	PRAGUE or BRNO	CESNET 3rd Floor, Room 95 Zikova 4, 160 00 Prague 6	CESNET 3rd Floor, Room 95 z.s.p.o Zikova 4, 16000 Prague 6	CESNET Masaryk University Brno, Botanická 68a, 602 00 Brno
Eire	DUBLIN	City West Business Park HeaNET City West PoP Dublin	City West Business Park HeaNET City West PoP Dublin (tbc)	
Estonia	TALLINN or TARTU	N/a (currently directly connected to the NREN)	Sõle 14, Tallinn	Lai 29 Tartu,

France	PARIS	23-27 Rue Pierre Valette-Malakoff 92240 Paris	CIPB 21 rue de la Banque 75002 Paris	Telehouse2 Address tbc
Germany	FRANKFURT (or possibly HAMBURG, BERLIN or KARLSRUHE)	ITENOS 25-31 Rebstockerstrasse D-60326 Frankfurt	InterXion, Hanauer Landstrasse 302, GIP Park, House D, D-60314 Frankfurt	tba
Greece	ATHENS	Hellaspac Division, 1st Floor OTE Building, 45-47 Em. Benaki Str & Koletti Str 10681 Athens	OTE premises Koletti 23 & Em. Mpenaki 47, Athens	MEDNAUTILUS, Ermou 37, Metamorphosis, Athens
Hungary	BUDAPEST	NIIFI/HUNGARNET Victor Hugo 18-22 1134 Budapest	NIIFI/HUNGARNET Victor Hugo 18-22 1134 Budapest	
Israel	PETACH TIKVA or TEL AVIV	Tel-Aviv University Ramat-Aviv Tel-Aviv 69978 Israel	Med-1 colo site, 94 Jabotinsky, Petach Tikve	Computer Centre, Tel Aviv University, Ramat Aviv
Italy	BOLOGNA or MILAN	A Building Via Lancetti 23 20158 Milan	c/o INFN-CNAF, Viale Berti Pichat 6/2, 40127 Bologna	c/o MIX (building C) or Netscalibur (building E), Via Caldera 21, 20153 Milano
Latvia	RIGA	N/a (currently directly connected to the NREN)	LATNET 304 Brivibas St Riga LV1006 Latvia	LATNET 29 Raina bulv. Riga, Latvia
Lithuania	KAUNAS	N/a (currently directly connected to the NREN)	LITNET AB Lietuvos telekomas,Taikos 54	LITNET NOC, Studentu 48a
Luxembourg	LUXEMBOURG	ITC 45 Boulevard Pierre Frieden L-1543 Luxembourg Luxembourg	RESTENA ITC BROADCASTING CENTRE EUROPE, 45 Bvd Pierre FRIEDEN L-1543	EBRC , Godbell centre Tour A 5, rue Ruppert, L-2453
Malta	MSIDA	N/a (currently directly connected to the NREN)	(University of Malta Computing Services Centre University of Malta Msida, Malta) tba	

Netherlands	AMSTER-DAM	Van der Madeweg 12-14a 1090 GA Amsterdam	SURFnet SARA Kruislaan 415 1098 SJ Amsterdam	TeleCity Amsterdam Science Park Kruislaan 411 1098 SJ Amsterdam
Nordic countries	STOCKHOLM	Trekantsvagen 7 11743 Stockholm	Trevantsvagen 7, 11743 Stockholm	Other addresses possible
Poland	POZNAN	10 Taczuka Str 60-687 Poznan	PSNC Rack 1 and 2 Supercomputing Room Ground Floor Ul. Wieniawskiego 17/19 Poznan	
Portugal	LISBON	FCCN Av.do Brasil 101 1700-066 Lisbon	FCCN Av.do Brasil 101 1700-066 Lisbon	
Romania	BUCHAREST	N/a (currently directly connected to the NREN)	(RoEduNet Room R506-507 Floor R Splaiul Independentei 313 Bucharest) ? tba	
Slovakia	BRATISLAVA	University Computing Centre of the Slovak University of Technology, 812 43, Bratislava,	SANET Ground Floor Nam Slobody 17 812 43 Bratislava	
Slovenia	LJUBLJANA or MARIBOR	ARNES Room C91 Floor 1 Jamova 39 1000 Ljubljana	ARNES Room C91 Floor 1 Jamova 39 1000 Ljubljana	IZUM, Presernova 17, 2000 Maribor
Spain	MADRID or BARCELONA	COLT Telemaco 5 28027 Madrid	Carrier House 2, Edificio Telvent, Avda Valgrande 6, Alcobendas, Madrid	Centre de Supercomputació de Catalunya (CESCA) Gran Capità, 2 - 4 (Edificio Nexus)
Switzerland	GENEVA or ZURICH	Hallfret 4 Airport 1216 Cointrin Geneva	CERN, IT Division, CH-1211 Geneva 23, Switzerland	IXEurope Telehouse Facilities AG, Hardstarsse 235, CH-8005 Zürich
Turkey	ANKARA	N/a (currently directly connected to the NREN)	ULAKBIM YOK Binasi B5 Blok Bilkent 06539 Ankara	

United Kingdom	LONDON	Telecity 8-9 Harbour Exchange London E14 9GB	Telecity, 8-9 Harbour Exchange Square, Lime Harbour, London, E14 9GE	
United States of America	NEW YORK	GÉANT US PoP NYSERNET, 24th Floor 32 Avenue of the Americas New York NY10013	n/a	

ANNEX 2: CONNECTIVITY

A2.1 Introduction

This Annex specifies the GN2 requirements for connectivity and the information that must be supplied in tenders for connectivity of different types.
Section A2.2 covers technical requirements, A2.3 to A2.6 cover operational and management requirements.

A2.2 Technical Requirements for Connectivity Solutions

The choice of the most appropriate technology is left to tenderers (but see section 2.2 of the main document for some guidance). DANTE will however require tenderers to demonstrate that the connectivity they supply will, in conjunction with such other equipment as may be agreed, support the reliable and error-free transport of data between equipment which DANTE will own and operate. This data will take a number of possible forms including IP packets, Ethernet frames, concatenated SONET/SDH channels and wavelengths.

Information to be provided by tenderers for ALL types of connectivity:

R2.0 Statement of conformance to the all the relevant requirements specified in this section, A2.2.

R2.1 A list of all the locations (as specified in Annex 1) to and from which connectivity can be supplied and, if appropriate, a list of alternative locations (cities) in the GN2 countries.

R2.2 A map or plan showing the layout of the tenderer's underlying fibre network and the pairs of locations that can be most easily interconnected. Different versions of the map or plan should show the connectivity that is available now, that which the tenderer will commit to making available by July 2004 and by January 2005. Tenderers must distinguish between fibre that is owned by them and fibre they have acquired by means of leasing or swapping arrangements with other organisations.

R2.3 A description of the technology platform the tenderer proposes to use. The description should be sufficiently full to allow DANTE and NREN engineers to confirm as part of the evaluation of the tender that the proposal offers a complete and effective means of meeting the requirement.

R2.4 A specification of the management boundary between the equipment which the tenderer proposes to supply and DANTE equipment and the interface standards which the tenderer is able to support across this management boundary.

R2.5 A description of the way in which the initial capacity could be progressively upgraded over a contract period potentially up to November 2008, including details of any changes which would be required to DANTE's equipment and of any dependencies which might disrupt a planned upgrade timetable.

Where tenderers offer connectivity based on "fixed" or "re-configurable" wavelength services then:

R2.6 The framing of 10 Gbit/s wavelengths can be either SDH or SONET or 10G Ethernet (LAN PHY). The SDH/SONET wavelengths must, however, be fully transparent, i.e. provide complete and unmodified end-to-end transport of payload and overhead bytes of the SDH/SONET frames. However, transparency is not required for the following overhead bytes: A1, A2, J0, B1, H1, H2, H3, K1, K2 and S1.

Where tenderers offer connectivity based on re-configurable wavelength services then:

R2.7 Tenderers must specify the lead time for a re-configuration request to become effective along with any associated conditions (such as frequency of allowed re-configurations) and any service level guarantees the tenderer is willing to offer.

R2.8 Description of procedures to request changes in configurations.

Where tenderers offer connectivity based on SONET/SDH services then:

R2.9 A full list of the circuits offered and, for each circuit, the possible capacities in the range 155 – 622 Mbit/s.

R2.10 For each circuit offered, an indication of whether the underlying fibre is owned by them or is based on capacity which they have acquired by means of leasing or swapping arrangements with a third party organisation.

Where tenderers offer connectivity based on dark fibre (SHDF or LHDF as defined in section 2.2 of the main document) then the tenderer is expected to provide information addressing the areas outlined below in R2.11 to R2.18b.

R2.11 No active or passive optical transmission equipment or components are to be placed in a single dark fibre span. This includes: WDM transponders, WDM multiplexers, passive optical filters, optical amplifiers and dispersion compensation fibre (DCF). The only exception to this is that DCF may be included in a service section at DANTE's request (following examination of the physical characteristics of that section and a clearer view of the equipment that will be used over it).

R2.12 If a dark fibre span is not made from one single strand (unbroken fibre straight from the reel) then the tenderer must specify the number of fusion splices and/or mechanical connections in the optical path.

R2.13 The dark fibre services must be capable of supporting the transmission of optical carriers (light) with wavelengths in the S-, C- and L-bands (1485 to 1610 nm). In addition, single mode dark fibre services over intermediate distances (section lengths up to 15 km) must be capable of supporting the transmission of light with wavelengths in the range 1270-1380 nm.

R2.14 The dark fibre service demarcation point should be an interface on DANTE equipment (be it an IP router, layer-2 switch, OXC or DWDM transmission equipment). If tenderers wish to install an in-line optical distribution frame (ODF) or patch panel in DANTE rack space then this must occupy no more than 1U of standard 19 or 23 inch rack space. The mechanical connectors at the service demarcation point should be of the standard types (e.g. FC/PC, SC/PC, etc.) DANTE's preference cannot be stated at this time since this depends on the transmission equipment that will make use of the dark fibre services. Tenderers are required to state if they are only able to support mechanical connectors of a certain type.

R2.15 Tenderers must provide information about the cleaning procedures used when splicing and connecting multiple strands of fibre to form a single dark fibre section.

R2.16 Tenderers must provide an overview of the optical test equipment they or their provider of fibre maintenance services have in their possession (for faultfinding and troubleshooting) such as OTDR, LTS and CD/PDM measurement equipment.

R2.17 For each dark fibre span the tenderer must complete the table provided in Annex 3 and provide the following details:

- *The length of each fibre span*
- *The number of fibres (single, pair or other)*
- *the type of fibre used (G.652/G.653/G.655)**
- *the manufacturer and brand (Corning LEAF, Lucent TrueWave, etc)**
- *the full specification sheets of the fibre**
- *the number of fusion splices*
- *the number of mechanical connectors*
- *the expected attenuation (between service demarcation points) in both directions [dB]*
- *the expected optical return loss (at both ends of the section) [dB]*
- *the expected Chromatic Dispersion (CD) [ps/nm]*
- *the expected Polarization Mode Dispersion (PMD) [ps]*

** where a dark fibre span consists of heterogeneous fibre types (either fusion spliced or mechanically connected together) then full details are to be provided*

R2.18 For each deliverable dark fibre span, the above parameters need to be tested by the tenderer (and documented), if such section is existing in the time of offer. In addition, the tenderer must provide an indication of the deterioration values of these parameters.

R2.18a Tenderers should describe the equipment housing facilities for Long Haul dark fibre along the fibre route detailing the space, power, air conditioning, access and security where applicable.

R2.18b Tenderers agree that testing will be part of acceptation procedure and fibres with worse values than expected could be rejected by DANTE.

A2.3 Installation and Acceptance

Suppliers must take responsibility for all aspects of installation, including the provision of racks and support services for their equipment. Contracts will, in addition, contain clauses which cover a precise definition of the management boundary between the supplier's and DANTE's equipment, preliminary testing by the supplier using international standard tests and acceptance testing by DANTE. Suppliers will be required to hand over connectivity, after successful completion of their own tests, for acceptance testing by DANTE at least five days before the planned start of service date in the case of single links and ten days before in the case of sets of connectivity links.

Information to be provided by tenderers for ALL types of connectivity:

R2.19 Statement of conformance to the requirements specified in this section, A2.3.

R2.20 A description of the standard tests which the tenderer proposes to carry out before the hand over of the connectivity.

A2.4 Operations

The supplier must manage and monitor each link end-to-end (i.e. between the agreed boundaries of management responsibility at each end) 24 hours per day, seven days per week.

The supplier must put in place (and contracts will specify in detail) procedures to deal with fault reporting, diagnosis and correction, scheduled maintenance (within defined time constraints) and reporting of status to DANTE and the NRENs.

Information to be provided by tenderers for ALL types of connectivity:

R2.21 Statement of conformance to the requirements specified in this section, A2.4.

R2.22 Description of monitoring systems and procedures.

R2.23 Description of fault reporting and fault management.

R2.24 Description of trouble ticket facilities and of on-line availability to provider tickets or provider maintenance schedules affecting DANTE circuits.

R2.25 Escalation procedures.

R2.26 Description of proposed scheduled maintenance procedures.

A2.5 Performance and Availability

Contracts will include clauses covering (for each individual link) bit error rate, restoration time after failure and availability (as measured according to an agreed definition) and will provide for compensation in case of failure to meet agreed levels of performance.

Information to be provided by tenderers for connectivity of ALL types:

R2.27 Statement of conformance to the relevant requirements specified in this section, A2.5.

R2.28 Proposed definitions of availability and outage; definition of problem start and problem end. Confirmation that the tenderer is able to measure and report availability based on this definition.

R2.30 Description of the means used to provide backup/restoration in the event of a long lasting outage, confirmation that backup/restoration is provided via physically diverse routes, and procedures (with timings) for switching back to normal routes after faults have been cleared.

R2.31 Proposed guaranteed values of availability, MTBF, MTTR and (where appropriate[1]) bit error rate and method of penalising worse than guaranteed values.

Where tenderers offer connectivity based on re-configurable wavelength services then:

R2.32 Tenderers are required to indicate whether and by how much the proposed guaranteed values (of availability, MTBF, MTTR and bit error rate) requested in R2.31 may change following a circuit re-configuration operation.

[1] Values of BER will be required for all connectivity service offerings except SHDF and LHDF.

A2.6 Reports

Tenderers will be expected to provide monthly reports as outlined below.

Information to be provided by tenderers for connectivity of ALL types:

R2.33 Statement of conformance to the requirements specified in this section, A2.6, descriptions of reports and report samples.

R2.34 Suppliers must provide monthly reports in PDF, Word or Excel format, to be delivered electronically within five working days of the end of each calendar month, covering:

- *availability per circuit or dark fibre span*
- *record and description of faults and steps taken to remedy them including at least the following items: provider ticket number and where available DANTE ticket number, description of outage, and problem start and end times.*

R2.35 Suppliers should also provide access to on-line monitoring and reporting tools via a web-based interface, together with any user documentation.

ANNEX 3: Dark fibre span technical specifications table

THIS ANNEX IS AN EXCEL SPREADSHEET GN2-04-00X WHICH ACCOMPANIES THIS DOCUMENT AND MUST BE COMPLETED BY ALL TENDERERS OFFERING DARK FIBRE SOLUTIONS.

ANNEX 4: TERMINOLOGY

In this document, the following terms are used with the specific meaning shown:

Access Port Manager (APM)	A person/function within a National Research and Education Network responsible for the national access to the GN2 network.
Circuit	A facility for transmitting full duplex bit streams between two defined end points. This term does not define the technology used and can cover a number of technologies, including dark fibre, SDH, DWDM, etc.
Common European public holidays	1 January, Easter Monday, 25 and 26 December
Connectivity	A set of one or more circuits.
Core network	The sub-network formed by the set of core nodes and the circuits which interconnect them.
Core node	A node in the network which is linked to other core nodes by at least two separate circuits operating at speeds of 2.5 Gbit/s or higher.
Dark fibre	A circuit for which the supplier provides only the physical fibre or fibre pair connection between two end points; the supplier takes no responsibility for any equipment, including optical repeaters, necessary to transmit data via the fibre.
Dark fibre span	A single unbroken length of optical fibre or fibre pair that comprises the entire service (i.e. between the A and B termination points) in the case of a SHDF circuit or a part of a LHDF circuit.
Extension of International Circuit	Circuit provided by an international circuit supplier to interconnect his PoP with a GN2 PoP at a different location in the same city (sometimes known as a local tail).
Full Service	Qualified and trained staff at work, actively carrying out required activities and available to deal with fault reports and enquiries from DANTE and APMs
High Speed	2.5 Gbit/s or higher.
LHDF	Long Haul Dark Fibre - a dark fibre circuit comprised of one or more dark fibre spans and equipment housing facilities at intermediate amplification/regeneration sites (huts).
Lit Fibre	A dedicated fibre or fibre pair for which the supplier also provides the equipment and other facilities required for the transmission of optical signals between user equipment (consisting of a selection or combination of IP routers, layer 2 switches or OXCs).
Local Access Circuit	A circuit, normally within a single city, which interconnects a GN2 PoP with an NREN PoP (sometimes known as a local loop).
National Research & Education Network (NREN)	A network connected to GN2 that provides national connectivity to universities, colleges, schools and research centres.
Network Operations	An organisational unit which has responsibility for

Centre (NOC)	providing one of the required network management services. There could, in principle, be four NOCs combining and interacting to manage the complete GN2 service.
Non-core Connectivity	The set of circuits within the network that link nodes other than core nodes to the core network or to other non-core nodes.
On-call Service	Fault reports and enquiries handled initially by unqualified staff who follow pre-defined filtering procedures to establish the urgency of any necessary action; qualified and trained staff available to handle faults that are deemed urgent as a result of the filtering procedure.
Point of Presence (PoP)	A location at which equipment needed to support the service is installed.
Response Time	The elapsed time between the receipt of a fault report or other communication which requires action according to agreed operational procedures and the initiation of the action, including an acknowledgement or report to the originator.
SHDF	Short Haul Dark Fibre - a dark fibre circuit comprised of a single dark fibre span.
Working Hours	08:00 - 1800 CET, Monday to Friday, excluding common European public holidays.

ANNEX 5: FINANCIAL SUMMARY OF OFFERS

This annex is an Excel spreadsheet GN2-04-006X which accompanies this document and must be completed by all tenderers.

ANNEX 6 CHECKLIST FOR TENDERERS

	Check
Overview of the Response	
Summary of Pricing Information (Annex5)	
Proposed Solution (Annex2)	
Statement of Conformance to commercial terms (4.1-4.3+reservations)	
Background Information about the tenderers organisation (latest audited financial results, funding structure, planned restructuring/refinancing)	
Brief CV's of key personnel who will be responsible for contract negotiation and service implementation	
Reference Sales + name and contact information	
An electronic copy (CD or diskette) including (mandatory) the Pricing Table in Excel format and the other documents (preferably) of your offer should also be included in your parcel.	

9.1.3.2 *Tender for Network elements for the GÉANT2 network, September 2005.*

INTRODUCTION

This Invitation to Tender is for the procurement of additional connectivity for European Research and Education Network, GÉANT2. GÉANT2 is progressively replacing the GÉANT network from July 2005 onwards. In this tender we are seeking offers for network infrastructure and for connectivity to complement and enhance what has already been procured for GÉANT2.

It is proposed to hold an information day on 28 September at 1430 hours, at which you will be invited to present any questions you may have regarding this document. This will be held in London. Please advise Gn2coordinator@dante.org.uk if you wish to attend this event and to receive further details.

BACKGROUND INFORMATION

Profile of current GÉANT2 network

The initial tender for the GÉANT2 network has now been completed. This network consists of a mixture of dark fibre links DWDM and SDH connections. The purpose of this current tender is twofold:

(i) to procure transatlantic connectivity to connect the GÉANT2 network to research and education networks in North America.

(ii) to acquire additional connectivity within Europe to improve connectivity to Cyprus, Ireland, Malta, Poland and Spain.

2.2 Technology Guidance

Tenderers are welcome to propose a range of, appropriate technologies for providing this connectivity. The choice will, of course, have implications for equipment requirements and management responsibility between tenderers and DANTE. Management boundaries between the services tenderers supply and other components managed by other contractors will have to be agreed by DANTE during contract negotiations.

In order to give guidance on the kind of proposals that are being sought, some possible technology options are outlined below. The evaluation will consider the cost, technical performance and operational manageability of tenderers' proposals.

2.2.1 Dark Fibre

Dark Fibre is dedicated optical fibre infrastructure taking the form of multiple dark fibre spans, provided by the tenderer, between agreed A and B termination points which includes housing facilities (space, power, air conditioning and security) along the fibre route. These facilities would be used to house suitable amplification/regeneration equipment. The housing facilities at intermediate points are mandatory. DANTE would arrange amplification/regeneration at the intermediate points and run its services over the infrastructure.

2.2.2 Fixed Wavelength Services

'Fixed wavelengths' are unprotected point to point circuits using DWDM transmission technology provided by the tenderer between agreed A and B termination points with SONET/SDH, Gigabit Ethernet or 10 Gigabit Ethernet (LAN PHY) interfaces.

2.2.3 SDH Based Services

These are protected, or unprotected, point-to-point circuits using SONET/SDH transmission equipment provided by the tenderer between agreed A and B termination points. The SONET/SDH transmission equipment may, or may not, make use of an underlying DWDM

transmission infrastructure. Client interfaces are expected to be ANSI/ITU compliant SONET/SDH interfaces at speeds ranging from OC-3/STM-1 (155 Mbps) to OC-48/STM-16 and normally the payload can be expected to be concatenated. There is no expectation that any of the SONET/SDH (or DWDM) transmission equipment (other than the A- and B-end ADM client interfaces) is dedicated for use by GN2. SDH based services are currently used in parts of the GÉANT network.

2.3 Procurement Strategy

Tender responses will be evaluated and negotiations concluded via Negotiated Procedures in accordance with the Council Directive 92/50/eec of 18 June 1992 published in the OJ L209 in 1992.

DANTE will prefer geographically different physical path to network nodes for reasons of reliability in both local loop and international line parts.

2.4 Relationship with EC Programmes

GÉANT2 is funded in part by the European Commission's Sixth Framework Programme with thirty European NREN participants and DANTE as the coordinating partner. € 93 million has been committed by the European Commission towards the funding of GÉANT2, representing up to 50% of its total costs, with the remainder being seconded from funds from the NRENs.

2.5 Implementation Timescales

The GÉANT2 network is currently being implemented. It is expected that the implementation of the bulk of the European network will be completed by January 2006. Capacity offered in response to this tender should be capable of being delivered in similar timescales and in any event not later than 31 March 2006.

TENDER INFORMATION

The tender is divided into two lots:

- Lot 1 Transatlantic-Connectivity: Fixed Wavelength Services operating at 10 Gbps between locations in North America convenient for connection to North American Research and Education Networks and appropriate locations in Europe on the GÉANT2 network. The specific requirements relating to Lot 1 are specified in Para 4.
- Lot 2 Intra-European Connectivity: Dark Fibre, fixed wavelengths or SDH based services as appropriate connecting the National Research and Education Networks in Cyprus, Ireland, Malta, Poland and Spain to appropriate locations on the GÉANT2 network in Europe. The specific requirements relating to Lot 2 are specified in Para 5.

Tenderers may respond to either or both lots. The Commercial issues, Instructions to tenderers and evaluation criteria apply to either lot. They are defined in paras 6 - 8 respectively.

4 LOT 1, TRANSATLANTIC ACTIVITY

4.1 Connectivity

The transatlantic connectivity will interconnect GÉANT2 with North America. The initial total transatlantic capacity required will be at least two 10 Gbps connections and needs to provide high levels of availability and be highly cost effective.

The transatlantic capacity is intended primarily for interconnection with North American research networks, such as Abilene and Esnet, NASANet and Canarie.

Further upgrades during the contract period are expected. Tenderers are free to propose any cost effective location for termination of connectivity in North America, bearing in mind the primary purpose of the connectivity is to interconnect with North American research network organisations. The requirements are further defined in Annex 3.

4.2 PoP-housing

DANTE already operates a PoP in New York. This is located at Nysernet, 24th floor, 32 Avenue of the Americas, New York NY 10013. USA. It is highly likely that one of the connections will be terminated in the existing PoP. It is envisaged that at least one and maybe more additional connections will be procured. The precise location in North America where these are terminated will depend on the outcome of the tender. It is possible that PoP housing may be required dependent on the location chosen for additional links. A list of potential termination points in North America is at Annex 1. Tenderers are free to propose any cost-effective location convenient for connection to North American research networks.

4.3 European Distributed Access

The GÉANT2 network has a backbone infrastructure consisting of multiple nodes. The majority of the circuits interconnecting these nodes operates at 10 Gbps and will be implemented either as leased wavelengths or as wavelengths provided using DWDM equipment which is part of GÉANT2. High levels of resilience are achieved primarily by the different routing permitted by this topology. Interconnections of trans-Atlantic connectivity with GÉANT2 may be permitted at any of the PoPs which have multiple intra-European 10 Gbps connections.

This feature of GÉANT is known as European Distributed Access (EDA) and offers a choice of interconnection points, high levels of capacity and resilience, and reduced transit costs within Europe. It therefore allows Tenderers responding to this ITT considerable flexibility in solutions they could propose for connectivity with North America. The potential European locations for terminating transatlantic connectivity are the points of presence listed in Annex 2, where there is an asterisk in column 4. In addition, it is expected that, as a result of this tender Ireland will also be connected at multiple 10 Gbps, so it can also be considered potential termination point.

5 LOT2, INTRA-EUROPEAN CONNECTIVITY

5.1 European Connectivity

Connectivity is sought between GÉANT2 nodes in Cyprus, Ireland, Malta, Spain and Poland and existing PoP locations on the GÉANT2 network. The preferred locations for the termination of connectivity in these countries are as listed in Annex 1. Connectivity may be offered in the form of Dark Fibre, DWDM or SDH connectivity. Tenderers may offer single or multiple connections. In principle, connectivity can be offered from the locations listed in Annex 1, to any of the other current GÉANT2 PoP locations listed in Annex 2 or other locations where it can be demonstrated that they would bring additional benefits to the GÉANT2 network. In practice, it is only relevant for tenderers to offer connections that are sensible and cost-effective.

The expectations for connectivity offers are summarised in Table 1 below

Country	Primary Offer expected	Secondary Offer considered
Cyprus	SDH at 155 Mbps	SDH at 155 Mbps
Ireland	Dark fibre	DWDM at 10 Gbps
Malta	SDH at 45 Mbps	SDH at 34 Mbps
Poland	Dark Fibre	DWDM at 10 Gbps
Spain **(Note 1)**	Dark Fibre	DWDM at 10 Gbps

TABLE 1

Note 1. In the case of Spain a dark fibre route already exists between Madrid and Geneva via Barcelona. Offers should therefore be for alternative routes

Where SDH services are offered, the connectivity speeds indicated above are advisory. The final choice will depend on price. It will also depend on the NRENs capacity requirements.

SDH circuits with capacities in the range 155 Mbps (STM-1) to 622 Mbps (STM-4c) may be required and possibly only at 34/45 Mbps (E3/T3). Tenderers are encouraged to make pricing proposals for a range of speeds. It is intended that, following the tender, each NREN in Table 1 will be connected to other points on the GÉANT2 network by at least 2 diverse routes.

The main requirement is for international connectivity as described above. Normally the connectivity will terminate at the equipment interface at each GÉANT 2 PoP. Where necessary a new GÉANT 2 PoP will be deployed for this purpose. Exceptionally if an NREN has only one connection to GÉANT 2, the connectivity will terminate at the NREN Equipment interface at the NREN PoP. In either case the management boundary is one or more physical interfaces in a patch panel within a GÉANT 2 or NREN PoP. The nature of the physical interface(s) will reflect the nature of the physical interface(s) used by the vendors of popular IP routers, layer 2 switches, optical cross connects (OXCs) or DWDM transmission equipment and will, in part, depend on the nature and capacity of the circuits offered by the tenderer.

In the event that the proposed termination point of the international connectivity is not the same as the NREN location as listed in Table 1, then suppliers are requested to include offers for any local tail circuits that may be required to complete these connections.

Tenderers providing dark fibre based services will be required to make available accommodation suitable for the housing of DWDM transmission system components (notably in-line amplifiers and/or regenerators) in intermediate repeater sites.

6 COMMERCIAL ISSUES

6.1 General

6.1.1 The contracts for the requirements set out in this ITT may be awarded wholly, in part or not at all to any specific tenderer.

6.1.2 Tenderers will be required to co-operate with other suppliers in the provision of service to DANTE.

6.1.3 Existing suppliers who respond to this tender and who are unsuccessful will be required to agree to co-operate with the implementation of successful responses from other potential suppliers.

6.1.4 Tenderers must confirm that any services they offer conform to all relevant national or EC, US or Canadian regulatory requirements as appropriate.

6.1.5 All expenses relating to the submission of tenders and any subsequent contract negotiations are the responsibility of the Tenderer.

6.1.6 All tenders must remain valid for a period for six months following the deadline for submission.

6.2 Contractual

6.2.1 EU funding support is available for the activity as part of the IST Programme under FP6. Selected suppliers will be expected to agree contractual terms and conditions appropriate to the funding arrangements for this activity as well as conditions which apply to sub-contractors under this Programme.

6.2.2 It is intended that contracts shall have a minimum duration of 12 months. Longer contracts are not ruled out if the Tenderer is prepared to offer guarantees that would effectively ensure future price competitiveness and overall performance competitiveness throughout the contract period. In the case of contracts for dark fibre a longer term leasing arrangement is envisaged. Dark fibre contracts awarded in the first tender round for GÉANT2 were typically a three year lease arrangement with an optional seven year extension at a significantly lower annual rate of payment.

6.2.3 Contracts shall include specific clauses relating to quality of service including availability guarantees and delivery dates.

6.2.4 Precise delivery dates for circuits and services will be subject to negotiation but should ensure that installation and testing can be complete no later than 30 December 2005. Suppliers will be required to make firm commitments to such delivery dates as are agreed, with compensation for late delivery.

6.3 Pricing

6.3.1 Tenderers must quote prices for each link at each capacity that they offer. They are also encouraged to offer discount arrangements for the supply of multiple links.

6.3.2 Prices for different service elements shall be quoted separately in Euro and, in the case of recurrent charges, in units of Euro/year. VAT and other taxes, if applicable, must also be quoted separately.

6.3.3 Prices for circuits shall be structured such that they relate to the capacity offered and shall include terms and conditions for increasing capacity.

6.3.4 Prices for circuits must cover all components which lie within the supplier's boundary of responsibility (as defined in the response to Annex 3).

6.3.5 Tenderers are asked to propose pricing arrangements for one year's contracts extendable on a monthly basis and, subject to meeting the requirements in 6.2.2, for longer term contracts.

6.3.6 Tenderers will be expected to provide assurances about the competitiveness of their prices both in respect of the contractual arrangements to be entered into and also in respect of future developments in the market place. Contracts for fixed wavelengths or services shall provide for an annual price review (which may result in capacity upgrades for the same price). Price reviews shall take account of comparisons with similar services within the network as well as competitiveness with alternative suppliers.

6.3.7 Tenderers should say whether VAT or other taxes will be applied to invoices for services supplied under contracts resulting from this tender and, if so, specify details.

6.3.8 Tenderers should clearly state if there are any restrictions of use that apply to their offers.

7 INSTRUCTION TO TENDERERS

Tenders must be in English and must conform to the following structure:

7.1 Overview of the Response

7.2 Summary of Pricing Information, formatted using the template guide in Annex 5.

7.3 Proposed Solution/Offer, including

- a list of the services (described in sections 4 and/or 5) for which the tenderer is making a proposal,
- proposed solution or range of options for topologies/routings
- for each service offered, a point by point response to the elements of the technical specification given in italics in Annex 3
- a clear commercial Offer including a point by point response to the commercial requirements in section 6

7.4 Statement of Conformance

- confirmation that the Tenderer acknowledges the requirements specified in sections 6.1 and 6.2 above and is prepared to negotiate detailed contract terms on the basis of these requirements

- reservations, ie a list of points on which the tender explicitly does not meet the specifications set out in this Invitation to Tender

7.5 Background Information about the Tenderer's organisation including

- one set of the latest audited financial results (e.g most recently published annual report).
- Brief description of funding structure including main stakeholders (less than 100 words).
- Publicly available details of any current or planned restructuring/refinancing which might affect the proposer's ability to perform its duties as detailed in the proposal submitted (less than 200 words) and any other information which the Tenderer wishes to make available

7.6 Brief CVs of key personnel who will be responsible for contract negotiation and service implementation

7.7 Reference Sales

- a list of up to three reference sales which the Tenderer puts forward as evidence of technical and operational capability and of timely implementation
- for each reference listed, the name and contact information of a person with whom DANTE can communicate to discuss the Tenderer's performance.

8 EVALUATION CRITERIA

The following criteria will be used in evaluating responses. The order of listing has no significance:

- Compliance to the requested commercial and technical requirements and questions in this ITT (Sections 3, 4, 5and 6 and Annexes 2, 3, and 5)
- Cost of ownership
- US/Europe service availability and technical performance levels, and demonstrability of achieving them
- capability to install and deliver to services according to the agreed timetable
- upgrade path
- financial standing and relevant experience of the Tenderer
- Ability to provide physically divergent solutions from existing connectivity thereby maximizing resilience of the overall trans-Atlantic and trans-European connectivity.

9 DEADLINE FOR SUBMISSIONS

Five copies of your tender must be sent to DANTE, City House, 126-130 Hills Road, Cambridge, CB2 1PQ, UK to be received no later than 17.00 hours local time on 26th October 2005. An electronic copy, including separate excel format pricing tables described in section 6 should also be sent to gn2coordinator@dante.org.uk **to arrive within the same timescales**.

ANNEX 1: SERVICE LOCATIONS

This annex lists the preferred locations in Cyprus, Ireland, Malta, Poland and Spain respectively, to which service should be provided, as well as possible North American locations.
For Europe, the addresses listed in columns four and five are ones suggested by the NREN where the GÉANT2 PoP could also be located and as convenient locations for providing the end to end service to the NREN.
Tenderers are also free to propose other addresses including arranging the local connections to reach the NREN. All proposals will be assessed for overall technical merit, cost effectiveness and carrier neutrality.

EUROPE

1. Country	**2. Access Node Location**	**3. Current GÉANT PoP Addresses**	**4. NREN PoP Address 1st recommendation**	**5. NREN PoP Address 2nd recommendation**
Ireland	DUBLIN	HeaNET Unit 4029, National Digital Park, City West, County Dublin	HEAnet. Unit 7, Kilcarbery Business Park, Nangor Road, Clondalkin, Dublin 22	
Malta	MSIDA	N/a (currently directly connected to the NREN)	(University of Malta Computing Services Centre University of Malta Msida, Malta) tba	
Poland	POZNAN	PSNC Rack 1 and 2 Supercomputing Room, ground floor, Ul. Wieniawskiego 17/19 Poznan		
Spain	MADRID	Carrier House 2, Edificio Telvant, Avda Valgrande 6, Alcobendas, Madrid		

NORTH AMERICA

1. Country	2. Access Node Location	3. Current/ potential GÉANT PoP Addresses	4. Other Potential Addresses	5. Other Potential Addresses
United States	New York	NYSERNET, 24th floor 32 Avenue of the Americas New York NY10013		
United States	Washington	Building 224, Computer and Space Sciences Room 0312A (old building), University of Maryland College Park, MD 20742-2411 NPA-NXX 301405	Colo/Juca space, rack 9706 1500 Eckington Place NE Washington, DC 20002 NPA-NXX 202548	Suite 109 1755 Old Meadow Rd. Mclean, VA 22102-4301 NPA-NXX 703762
Canada	Montreal	2nd floor 625, Ré ne Lévesque West Blvd Montreal		
Canada	Halifax	Room B509 6225 University Avenue Halifax NS B3H 4H8		

ANNEX 2: CURRENT GÉANT2 PoP LOCATIONS

COUNTRY	CITY	PoP ADDRESS	MULTIPLE 10 Gbps CONNECTED
Austria	Vienna	InterXion Austria A-1210 Wien, Shuttleworthstrasse 4-8 Building VIE, room 200	*
Belgium	Brussels	Level 3 Building Avenue Leon Grosjean No.2, 1140 Evre, Brussels	*
Croatia	Zagreb	University Computing Centre, SRCE, J Marohnica bb, HR-10000 Zagreb	*
Czech Republic	Prague	CESNET, 3rd floor, room 95, Zikova 4, 160 00 Prague 6	*
Denmark	Copenhagen	Örestaden, Floor L, room 106.C Örestadens Boulevard 95, DK-2300 Copenhagen	*
Estonia	Tallinn	Sole 14, Tallinn	
France	Paris	InterXion-1, Batiment 260, rez-de-chaussée, 45 avenue Victor Hugo, 93534 Aubervilliers Cedex	*
Germany	Frankfurt	InterXion, FRA3, Weismullerstrasse 21-23, D 60314 Frankfurt, 1st floor/cage 2-1C	*
Greece	Athens	Hellaspac Division, 1st floor, OTE Building, 45-47 Em. Mpenaki Str & Koletti Str, 10681 Athens	*
Hungary	Budapest	Victor Hugo 18-22, 1132 Budapest	*
Israel	Tikva	Med-1, Petach Tikva	
Italy	Milan	A Building, Via Lancetti 23, 20158 Milan	*
Latvia	Riga	Raina Boulvd 29, Riga	
Lithuania	Kaunus	Taikos 54, Kaunus	
Luxembourg	Luxembourg	ITC, 45 Boulevard Pierre Frieden, L-1543 Luxembourg	
Netherlands	Amsterdam	SARA Kruislaan, 415 1098 SJ Amsterdam	*
Portugal	Lisbon	FCCN Av. Do Brasil, 101 1700-066 Lisbon	
Russia	Moscow	JSCC, Russian Academy of Science, Leninsky pr. 32a, 119991 Moscow	
Slovakia	Bratislava	Sitel Telehouse, Kopcianska 20/C, Bratislava	*

Slovenia	Ljubljana	ARNES Room C91, Floor 1, Jamova 39 1000 Ljubljana	*
Switzerland	Geneva	CERN, IT Division, 385 route de Meyrin, CH-1211 Geneva 23, Room 513	*
United Kingdom	London	Telecity 2, 8-9 Harbour Exchange Square, London E14 9GB	*

Denotes multiple connections at 10 Gbps

ANNEX 3: CONNECTIVITY

A3.1 Introduction

This Annex specifies the GN2 requirements for connectivity and the information that must be supplied in tenders for connectivity of different types.

Section A3.2 covers technical requirements, A3.3 to A3.6 cover operational and management requirements.

A3.2 Technical Requirements for Connectivity Solutions

The choice of the most appropriate technology is left to tenderers (but see section 2.2 of the main document for some guidance). DANTE will, however, require tenderers to demonstrate that the connectivity they supply will, in conjunction with such other equipment as may be agreed, support the reliable and error-free transport of data between equipment which DANTE will own and operate. This data will take a number of possible forms including IP packets, Ethernet frames, concatenated SONET/SDH channels and wavelengths.

Information to be provided by tenderers for ALL types of connectivity:

R3.0 Statement of conformance to the all the relevant requirements specified in this section, A3.2.

R3.1 A list of all the locations (as specified in Annexes 1 and 2) to and from which connectivity can be supplied and, if appropriate, a list of alternative locations (cities) in the GN2 countries.

R3.2 A map or plan showing the layout of the tenderer's underlying fibre network and the pairs of locations that can be most easily interconnected. Different versions of the map or plan should show the connectivity that is available now, that which the tenderer will commit to making available by March 2006 and by January 2007. Tenderers must distinguish between fibre and/or duct that is fully owned by them and fibre they have acquired by means of leasing or swapping arrangements with other organisations.

R3.3 A description of the technology platform the tenderer proposes to use. The description should be sufficiently full to allow DANTE and the NREN engineers to confirm, as part of the evaluation of the tender, that the proposal offers a complete and effective means of meeting the requirement.

R3.4 A specification of the management boundary between the equipment which the tenderer proposes to supply and DANTE equipment and the interface standards which the tenderer is able to support across this management boundary.

R3.5 A description of the way in which the initial capacity could be progressively upgraded over a contract period potentially up to November 2008, including details of any changes which would be required to DANTE's equipment and details of any dependencies which might disrupt a planned upgrade timetable.

Where tenderers offer connectivity based on wavelength services then:

R3.6 The framing of 10 Gbit/s wavelengths can be either SDH or SONET or 10G Ethernet (LAN PHY). The SDH/SONET wavelengths must, however, be fully transparent, i.e. provide complete and unmodified end-to-end transport of payload and overhead bytes of the SDH/SONET frames. However, transparency is not required for the following overhead bytes: A1, A2, J0, B1, H1, H2, H3, K1, K2 and S1.

Where tenderers offer connectivity based on SONET/SDH services then:

R3.7 A full list of the circuits offered and, for each circuit, the possible capacities in the range34Mbps– 622 Mbps.

R3.8 For each circuit offered, an indication of whether the underlying fibre is owned by them or is based on capacity which they have acquired by means of leasing or swapping arrangements with a third party organisation.

Where tenderers offer connectivity based on dark fibre then the tenderer is expected to provide information addressing the areas outlined below in R3.9 to R3.18.

R3.9 No active or passive optical transmission equipment or components are to be placed in a single dark fibre span. This includes: WDM transponders, WDM multiplexers, passive optical filters, optical amplifiers and dispersion compensation fibre (DCF). The only exception to this is that DCF may be included in a service section at DANTE's request (following examination of the physical characteristics of that section and a clearer view of the equipment that will be used over it).

R3.10 If a dark fibre span is not made from one single strand (unbroken fibre straight from the reel) then the tenderer must specify the number of fusion splices and/or mechanical connections in the optical path.

R3.11 The dark fibre services must be capable of supporting the transmission of optical carriers (light) with wavelengths in the S-, C- and L-bands (1485 to 1610 nm). In addition, single mode dark fibre services over intermediate distances (section lengths up to 15 km) must be capable of supporting the transmission of light with wavelengths in the range 1270-1380 nm.

R3.12 The dark fibre service demarcation point should be an interface on DANTE equipment (be it an IP router, layer-2 switch, OXC or DWDM transmission equipment). If tenderers wish to install an in-line optical distribution frame (ODF) or patch panel in DANTE rack space then this must occupy no more than 1U of standard 19 or 23 inch rack space. The mechanical connectors at the service demarcation point should be of the standard types (e.g. FC/PC, SC/PC, etc.) DANTE's preference cannot be stated at this time since this depends on the transmission equipment that will make use of the dark fibre services. Tenderers are required to state if they are only able to support mechanical connectors of a certain type.

R3.13 Tenderers must provide information about the cleaning procedures used when splicing and connecting multiple strands of fibre to form a single dark fibre section.

R3.14 Tenderers must provide an overview of the optical test equipment they or their provider of fibre maintenance services have in their possession (for faultfinding and troubleshooting) such as OTDR, LTS and CD/PDM measurement equipment.

R3.15 For each dark fibre span the tenderer must complete the table provided in Annex 3 and provide the following details:

- *The length of each fibre span*
- *The number of fibres (single, pair or other)*
- *the type of fibre used (G.652/G.653/G.655)**
- *the manufacturer and brand (Corning LEAF, Lucent TrueWave, etc)**
- *the full specification sheets of the fibre**
- *the number of fusion splices*
- *the number of mechanical connectors*
- *the expected attenuation (between service demarcation points) in both directions [dB]*
- *the expected optical return loss (at both ends of the section) [dB]*
- *the expected Chromatic Dispersion (CD) [ps/nm]*
- *the expected Polarization Mode Dispersion (PMD) [ps]*

** where a dark fibre span consists of heterogeneous fibre types (either fusion spliced or mechanically connected together) then full details are to be provided*

R3.16 For each deliverable dark fibre span, the above parameters need to be tested by the tenderer (and documented), if such section is existing in the time of offer. In addition,

the tenderer must provide an indication of the deterioration values of these parameters.

R3.17 Tenderers should describe the equipment housing facilities for Long Haul dark fibre along the fibre route detailing the space, power, air conditioning, access and security where applicable.

R3.18 Tenderers agree that testing will be part of acceptation procedure and fibres with worse values than expected could be rejected by DANTE.

A3.3 Installation and Acceptance

Suppliers must take responsibility for all aspects of installation, including the provision of racks and support services for their equipment. Contracts will, in addition, contain clauses which cover a precise definition of the management boundary between the supplier's and DANTE's equipment, preliminary testing by the supplier using international standard tests and acceptance testing by DANTE. Suppliers will be required to hand over connectivity, after successful completion of their own tests, for acceptance testing by DANTE at least five days before the planned start of service date in the case of single links and ten days before in the case of sets of connectivity links.

Information to be provided by tenderers for ALL types of connectivity:

R3.19 Statement of conformance to the requirements specified in this section, A3.3.

R3.20 A description of the standard tests which the tenderer proposes to carry out before the hand over of the connectivity.

A3.4 Operations

The supplier must manage and monitor each link end-to-end (i.e. between the agreed boundaries of management responsibility at each end) 24 hours per day, seven days per week.

The supplier must put in place (and contracts will specify in detail) procedures to deal with fault reporting, diagnosis and correction, scheduled maintenance (within defined time constraints) and reporting of status to DANTE and the NRENs.

Information to be provided by tenderers for ALL types of connectivity:

R3.21 Statement of conformance to the requirements specified in this section, A3.4.

R3.22 Description of monitoring systems and procedures.

R3.23 Description of fault reporting and fault management.

R3.24 Description of trouble ticket facilities and of on-line availability to provider tickets or provider maintenance schedules affecting DANTE circuits.

R3.25 Escalation procedures.

R3.26 Description of proposed scheduled maintenance procedures.

A3.5 Performance and Availability

Contracts will include clauses covering (for each individual link) bit error rate, restoration time after failure and availability (as measured according to an agreed definition) and will provide for compensation in case of failure to meet agreed levels of performance.

Information to be provided by tenderers for connectivity of ALL types:

R3.27 Statement of conformance to the relevant requirements specified in this section, A3.5.

R3.28 Proposed definitions of availability and outage; definition of problem start and problem end. Confirmation that the tenderer is able to measure and report availability based on this definition.

R3.30 Description of the means used to provide backup/restoration in the event of a long lasting outage, confirmation that backup/restoration is provided via physically diverse routes, and procedures (with timings) for switching back to normal routes after faults have been cleared.

R3.31 Proposed guaranteed values of availability, MTBF, MTTR and (where appropriate[2]) bit error rate and method of penalising worse than guaranteed values.

A3.6 Reports

Tenderers will be expected to provide monthly reports as outlined below.

Information to be provided by tenderers for connectivity of ALL types:

R3.32 Statement of conformance to the requirements specified in this section, A3.6, descriptions of reports and report samples.

R3.33 Suppliers must provide monthly reports in PDF, Word or Excel format, to be delivered electronically within five working days of the end of each calendar month, covering:

- *availability per circuit or dark fibre span*
- *record and description of faults and steps taken to remedy them including at least the following items: provider ticket number and where available DANTE ticket number, description of outage, and problem start and end times.*

R3.34 Suppliers should also provide access to on-line monitoring and reporting tools via a web-based interface, together with any user documentation.

[2] Values of BER will be required for all connectivity service offerings except Dark Fibre

ANNEX 4: DARK FIBRE SPANS TECHNICAL SPECIFICATIONS

SPANS for DARK FIBRE

Name of Tenderer:

L1	**a' End**	**b' End**	**Length of span [km]**	**Number of fibres [Single, Pair or Other]**	**Type of fibre used [G.652, G.653, G.655 or Other]**	**Manufacturer and brand (e.g. Corning LEAF, Lucent TrueWave, etc.)**	**Number of fusion splices**	**Number of mechanical connectors**	**Attenuation [dB] - as measured**	**Optical Return Loss (at both ends of the span) [dB] - as measured**	**Chromatic Dispersion (CD) [ps/nm] - as measured**	**Polarization Mode Dispersion (PMD) [ps/km$^{1/2}$] - as measured**	**Other comments**
Span 1													
Span 2													
Span 3													
Span 4													
Span 5													
Span 6													
Span 7													
Span 8													
Span 9													
Etc.													

IF YOU NEED TO USE THE 'OTHER' CATEGORY PLEASE EXPLAIN USING THE COMMENT COLUMN

L2	a' End	b' End	Length of span [km]	Number of fibres [Single, Pair or Other]	Type of fibre used [G.652, G.653, G.655 or Other]	Manufacturer and brand (e.g. Corning LEAF, Lucent TrueWave, etc.)	Number of fusion splices	Number of mechanical connectors	Attenuation [dB] - as measured	Optical Return Loss (at both ends of the span) [dB] - as measured	Chromatic Dispersion (CD) [ps/nm] - as measured	Polarization Mode Dispersion (PMD) [ps/km$^{1/2}$] - as measured	Other comments
Span 1													
Span 2													
Span 3													
Span 4													
Span 5													
Span 6													
Span 7													
Span 8													
Span 9													
Etc.													

IF YOU NEED TO USE THE 'OTHER' CATEGORY PLEASE EXPLAIN USING THE COMMENT COLUMN

IF NEEDED, PLEASE COPY AND PASTE ADDITIONAL TABLES BELOW MAKING SURE ITEM NOs. TALLY WITH ANNEX 5

ANNEX 5 FINANCIAL SUMMARY OF OFFERS

Attached separately as excel file GN2-05-183 Annex 5

ANNEX 6 CHECKLIST FOR TENDERERS

	Check
Overview of the Response	
Summary of Pricing Information (Annex5)	
Proposed Solution (Annex2)	
Statement of Conformance to commercial terms (4.1-4.3+reservations)	
Background Information about the tendering organisation (latest audited financial results, funding structure, planned restructuring/refinancing)	
Brief CV's of key personnel who will be responsible for contract negotiation and service implementation	
Reference Sales + name and contact information	
An electronic copy (CD or similar) including (mandatory) the Pricing Table in Excel format and the other documents (preferably) of your offer should also be included in your parcel.	

9.2. Procurement documents used for Transmission equipment

9.2.1. Documentation provided by GRnet

At September 2005, GRNET published a tender for optical transmission equipment in order to light the three DF links acquired by the previous DF tender. At the time of writing this document, GRNET evaluates proposals submitted in response to this tender.

Tender document provides detailed information regarding:

- The technical characteristics of the each DF link, in terms of expected attenuation, expected Chromatic Dispersion (CD) and expected Polarisation Mode Dispersion (PMD).
- The distances among the involved sites.
- The intermediate sites that GRNET can use for installing equipment, according to the contract with the DF provider.
- The intermediate sites at which lambdas must be added/dropped.
- Existing GRNET equipment at terminal and intermediate sites that will be directly connected to the provisioned equipment.

At the following, selected key requirements for the optical transmission equipment are presented.

9.2.1.1 Minimum requirements

Minimum requirements for 2 of the 3 DF links are defined as:

- One end to end CWDM or DWDM coloured lambda, without counting the add/drop lambdas.
- C/DWDM lambda carries a single Gigabit Ethernet signal.

For the third DF link, since this is expected to be more heavily loaded, minimum requirements are defined as:

- Two end to end CWDM or DWDM coloured lambdas, without counting the add/drop lambdas.
- Each C/DWDM lambda carries a single Gigabit Ethernet signal.

9.2.1.2 General requirements

At this section some general requirements for the overall solution is presented:

- Desirably, proposed solution for each DF link can scale up to 8 lambdas.
- Desirably, a “homogeneous” approach should be followed for each link; equipment along the link corresponds to a specific manufacturer and uses the same multiplexing scheme avoiding CWDM-DWDM hybrids.
- At each DF link, BER 10^{-12} or less must be guaranteed.
- Desirably, a complete Network Management System (NMS) along with Element Management Systems (EMSs) is provided.
- Equipment implements SNMP.
- Equipment is reachable for administration purposes through serial console, modem, “telnet” or “ssh”.
- Desirably, equipment implements TL1 protocol.

- Desirably, a responder will offer extra equipment to be used by GRNET personnel for testing purposes. Extra equipment includes two terminal CWDM devices along with interfaces for implementing at least 3 lambdas framed as 1 Gigabit Ethernet each.
- Selected tenderer will have the obligation to perform on-site measurements of the technical characteristics of the 3 DF links.
- Selected tenderer will have the obligation to offer training services to GRNET personnel, regarding equipment's every day operation and troubleshooting.
- Selected tenderer will have the obligation to support provisioned equipment for 3 years. Selected tenderer must have established a failure reporting centre in Greece. In addition, it is his obligation to repair a failure within 1 day after GRNET personnel announces it. A failure is defined as the situation where a DF link operates end to end with BER more than 10^{-12}. By "end to end" is defined the path among the interfaces of GRNET L2/3 equipment that are directly connected to the provisioned equipment.

9.2.1.3 Terminal equipment requirements

At this section, a summary of requirements for the terminal equipment is provided:

- Equipment must regenerate (3R) all lambdas.
- Equipment must include WDM multiplexers/demultiplexers even when a single lambda is deployed.
- Desirably, equipment should provide the ability to add new lambdas without interfering to working lambdas.
- Desirably, equipment should support the ability for carrying 10 Gigabit Ethernet client signals (IEEE 802.3ae LAN PHY).
- Desirably, equipment includes high availability features such as redundant power supply.

9.2.1.3.1 Client interfaces

- Client interfaces must implement (fully or partially) the 1 Gigabit Ethernet stack. Client 1 Gigabit Ethernet interfaces can be provisioned through one of the following ways:
    - Through equipment that multiplexes 2 Gigabit Ethernet signals to the same lambda.
    - Through equipment that implements (fully or partially) multiple framing technologies (e.g. 1 Gigabit Ethernet, Fast Ethernet, STM-1, STM-4, STM-16, 1G FibreChannel and 2G FibreChannel) and a specific technology is selected by the network manager.
- Desirably, client interfaces should be fully transparent without any restrictions to the incoming frame's MTU size. In any case, client interfaces must support jumbo frames.
- Desirably, client interfaces are pluggable and support SFP MSA and SFF-8472 standards.

9.2.1.3.2 Line interfaces

- Line interfaces must transmit at ranges compatible with CWDM/DWDM ITU-T standards.
- Desirably, line interfaces comply with the G.709 standard.
- Desirably, client interfaces are pluggable and support SFP MSA and SFF-8472 standards.
- Desirably, bidirectional use of the fibre cable is supported.

9.2.2. Documentation provided by Cesnet

In the reminder of this section is the tender documentation used in a purchase of transmission equipment for Cesnet. This purchase was according to Czech Act for public contracts. Since this purchase is for the amount of less then EUR 200.000 which is the threshold for different tendering procedures, the procedure is in some aspects easier (e.g. no mandatory publication in the Official Journal of the EU is necessary)

CONTRACT DOCUMENTATION

for the preparation of the tender for public contract, according to Act no……..
(hereinafter referred to as "Act")

Purchase of …….. (equipment)

Name of the submitter

CONTRACT DOCUMENTATION

for the preparation of the tender for public contract, according to Act no……., (hereinafter referred to as "Act")

The name of the public contract: Purchase of …… (equipment)

Submitter

Name:

Identification number:

Tax identification number:

Address of registered office:

Authorized representative of the submitter:

Contact person:

Telephone:

Fax:

Email:

Classification of the subject of public contract

Classification of the subject matter of public contract corresponds to the item of:

Telecommunications equipment

CPV (Common Procurement Vocabulary) 32522000-8 pcs 1

Computer software *(if it is a part of the purchase)*

CPV (Common Procurement Vocabulary) 30241000-0 pcs 1

Public contract over/under threshold

Estimated value ……

If the subject matter of public contract contains references to specific marks of products and services, which are typical for certain entrepreneur, the submitter enables also the use of other solution – qualitatively and technically analogous.

Subject matter of public contract

The subject matter of public contract is the purchase of …… (equipment) including corresponding software according to the technical documentation which is an attachment of contract documentation.

Term of performance of public contract

Term of performance of public contract

The submitter requires the handover of the subject matter as a functional unit before ..... *(date)*.

Place of performance of public contract

The place of performance is:

Name of the place (e.g. name of the NREN where the equipment shall be used)

Address

Tender

Tenders must be submitted in written form and in an enclosed envelope appended on the closures with the label of the firm/name/first name and surname and a stamp or signature of the tenderer– if the tenderer is a physical person – or the statutory body of the tenderer – if the tenderer is a juridical person – labelled with "Do not open – public contract on the purchase of ……. (equipment)". On the envelope, there has to be the address to which the tender can be returned acc. to par. …… of the Act.

The tenders have to be submitted by ..... (till ..... a.m./p.m.) to the address and person stated in the contract notice. Other way of delivery is not considered as proper submission of the tender.

On the cover page of the tender, identification particulars of the tenderer have to be given in the extent stated in par. ……. of the Act. The offer shall be compiled in …… language and signed by an authorized representative.

The tenderer is bound by their tender till ..... This period shall be prolonged for the time when the submitter was not authorized to conclude the contract and for the time when the submitter was not provided with the cooperation acc. to par. …….. of the Act.

The tenderer shall submit the tender in three printouts, one of them shall be labelled on the cover page as "Original" and the other two as "Copy". All pages of the tender shall be put together tightly or stapled so that they are sufficiently protected against their removal from the tender. All three printouts shall be properly readable, without any cross-outs and overwriting. The cover page has to bear the number of the printout, the "Original" or "Copy" label, and identification particulars in the extent acc. to par. …… of the Act. All pages of the tender, or of the individual printouts, shall be numbered by an ascending continual line.

The tenderer shall state in the tender expressively the contact address for written communication between the tenderer and submitter. If the tender is submitted by more suppliers together (common tender), these suppliers shall state in their tender, besides the contact address acc. to the previous sentence, also the person who will be authorized to represent these suppliers at the contact with the submitter during the tender procedure.

The tenderer shall submit the tender also in electronic form on a CD; this obligation does not apply to the documents proving the tenderer´s qualification fulfilment. Each tenderer is bound to submit the draft contract in electronic form in MS Office format, or other format compatible.

The tender shall be submitted according to the following pattern:

1. INTRODUCTION PAGE

Name of the subject of the tender, of the place of performance, identification particulars of the submitter (acc. to the stated conditions).

2. CONTENTS

The contents shall include all the bellow listed chapters of the tender acc. to the required segmentation. The chapters shall be assigned by the numbers of corresponding sheets, or possibly pages.

3. OVERALL INFORMATION ABOUT THE TENDERER

The name of the tenderer, legal form, registered office, identification number, tax identification number, bank connection, the names of the statutory body members, including the contacts (telephone, fax, e-mail and address), the person authorized for further negotiation, including written authorization for representing, and the profile of the company.

4. COVER PAGE OF THE TENDER

On the cover page, the following particulars shall be mentioned: the name of the public contract, basic identification information of the submitter and tenderer (including the persons authorized for further negotiation) in the extent stated in paragraph …….. of the Act, the highest acceptable tender price segmented according to the contract documentation, date and signature of authorized representative of the tenderer.

5. DOCUMENTS PROVING QUALIFICATION FULFILMENT IN SEGMENTATION

The tenderer is bound to prove the qualification fulfilment, according to paragraph ….. of the Act.

Qualification definition

Qualification shall be fulfilled by the tenderer who fulfils the qualifying criteria stated in paragraph …… of the Act, cited bellow.

Basic qualifying criteria

The basic qualifying criteria shall be fulfilled by the tenderer

g) who is not in liquidation

h) against whom there has been no bankruptcy declared in the recent three years, or no bankruptcy was cancelled due to insufficient property

i) who has no recorded tax underpayments in tax register

j) who was not authoritatively sentenced for a delict or whom the sentence for a delict, of which the facts concern the tenderer´s subject of business, was obliterated, as for the physical person; as for the juridical person, this condition has to be fulfilled by the statutory body or each member of the statutory body, the head of organisational part of foreign juridical person or a statutory body-authorized representative,

k) who has no arrear on insurance and on public health insurance penalty or on insurance and on social benefits and state employment policy fee penalty, with the exception of the cases when the payments in instalments are allowed – the tenderer must not be in delay with the instalment payments.

Other qualifying criteria

Other qualifying criteria shall be fulfilled by the tenderer who, according to paragraph ……. of the Act, proves

a) financial and economic standing and

b) technical ability.

Business licence

The tenderer is obliged to prove the business licence, including the abstract from Commercial Register or other evidence not older than 90 days if the tenderer has to be registered in such evidence according to special legislation.

Qualification fulfilment authentication

Basic qualifying criteria

c) The tenderer documents the basic qualifying criteria fulfilment according to paragraph ……of the Act, that is column 5.1, letter a) – c) and e) of this contract documentation, by *the declaration – attachment no. 3.*

d) The tenderer shall prove the basic qualifying criteria fulfilment acc. to column 5.1, letter d) of the contract documentation by *the abstract from the evidence of Criminal Record or other corresponding document, not older than 6 months.* The tenderer shall evidence the abstract from the evidence of Criminal Record, as for a juridical person, for the statutory body or all members of the statutory body. If the tender is submitted by a foreign juridical person by means of organisational part, the tenderer shall evidence the abstracts from the evidence of Criminal Register for the head of the organisational part, as well as for the statutory body or all members of the statutory body of the foreign person. If some operations should be carried out by a statutory body-authorized representative, the tenderer shall evidence the abstracts from the evidence of Criminal Record for this authorized representative, as well as for the statutory body or all members of the statutory body of this person.

Other qualifying criteria

c) The tenderer shall prove the qualification fulfilment acc. to paragraph ……of the Act (financial and economic standing), that is column 5.2, letter a) of the contract documentation,

- *by presenting balance sheet in full or simplified extent, including the auditor´s comment, if required under the law, edited to the last day of the preceding accounting period.*

d) The tenderer shall prove the qualification fulfilment according to paragraph ……..of the Act, (technical ability), that is column 5.2, letter b) of the contract documentation,

- *by the list of important supplies provided in the recent 3 years with the statement of their extent, period of fulfilment, value and joint certificate in proper service provision, drawn up by public or private orderer, or the declaration of the supplier on supply delivery, if such certificate is not possible to gain from the orderer. The tenderer shall use attachment no. 4.*

Business licence

The tenderer proves the qualification fulfilment acc. to paragraph …… of the Act, that is column 5.3 of the contract documentation by corresponding business licence, including the Commercial Register abstract or other evidence not older than 90 days; the business licence may be documented in a printout or officially verified copy. The documents for the business licence must authentically cover all the activities that are the subject matter of public contract and that emerge from the public contract subject specification stated in contract and technical documentation, which is an attachment of contract documentation.

The abstract from the list of approved suppliers

The tenderers written in the list of approved suppliers can prove the qualification fulfilment according to paragraph …… of the Act, that is paragraph 5.1 and 5.3 of the contract documentation, by the abstract from the list of approved suppliers, not older than 90 days.

The form of qualification fulfilment

The tenderer is bound to prove the qualification fulfilment in all cases by documents submitted in original or officially verified copies of these documents. The original documents or the officially verified copies will be enclosed to the tender in the printout noted as ”Original”; the copies of these documents shall be enclosed to the printout of the tender noted as ”Copies”. The documents, by which the tenderer proves the qualification fulfilment, shall be submitted by the tenderer as separate part of the tender called ”the Qualification”, in accordance to the structure of the tender.

If more suppliers submit the tender together (as one tenderer), each of them must separately prove qualification fulfilment according to paragraph …… of the Act, that is column 5.1 of the contract documentation; the qualification according to paragraph …….. of the Act , that is according to paragraph 5.2 and 5.3 of the contract documentation, must be fulfilled by at least one of the suppliers.

If more suppliers submit the tender together (as one tenderer), they are bound to enclose to the tender the original or verified copy of the document (contract) on the obligation that all these suppliers shall be bound together and indifferently to the submitter and any third person of all obligations arisen in connection with the fulfilment of the subject of the public contract or arisen as a result of the delay or other contractual or other duties breach in connection with the public contract performance.

The required documents, if not required otherwise by the law or by this contract documentation, may not be older than 90 calendar days preceding the last day of the term for tender submission.

Foreign person shall prove the qualification fulfilment according to paragraph ……..of the Act, that is column 5.1 and 5.3 of the contract documentation by the documents according to the legislative valid in the country of the registered office of the foreign person, or possibly the abode, or by the abstract from the list of approved suppliers. The documents proving qualification fulfilment shall be submitted by the foreign person in the original language together with their officially verified translation to …… language.

The result of qualification misfulfilment

If the tenderer shall not fulfil the qualification in the whole extent, this tenderer shall be expelled from the open procedure according to paragraph …….. of the Act. The submitter shall immediately inform the tenderer about the exclusion from the open procedure.

6. THE TENDER PRICE IN SEGMENTATION

Basic requirements of the supplier

The total price shall be stated in the tender as the highest acceptable amount for the public contract performance, including all fees and all other costs connected with the public contract performance.

The price shall be stated by the tenderer in the tender in the following structure:

a) total price of the public contract performance [the total of the prices acc. to letters b) and c)];

b) price for the equipment in requested basic configuration including software and corresponding licences;

c) price for additional functions supported by the equipment (see technical documentation).

If the tenderer shall offer additional functions, the submitter requires the tenderer to state in the tender the price for every offered additional function separately; this price has to include the price of software and corresponding licences.

The price shall at all parts (as structured above) be stated in …….. *(currency)* in the following structure: price without VAT, the rate of VAT in %, the price including VAT.

Conditions of price exceeding

The price may only be exceeded in connection with the change in tax regulations concerning VAT.

Payment conditions

The submitter shall pay the price of the public contract performance on the basis of tax document – a tenderer's invoice. The tenderer is authorized to make out the invoice after the handover and takeover of the performance. The maturity of the invoice shall be 14 days since the day of delivery of the invoice to the submitter. The submitter does not provide advance deposit.

7. DETAILED DESCRIPTION AND SPECIFICATION OF THE OFFERED PERFORMANCE, INCLUDING THE PARTICULARS PROVING THE TECHNICAL REQUIREMETNS FULFILMENT OF THE SUBMITTER

The tenderer shall state here a detailed description and specification of the offered performance, including the particulars proving the submitter´s technical requirements fulfilment stated in technical documentation which is the attachment of the contract documentation.

8. RELEVANT PARTICULARS AND INFORMATION FOR THE PURPOSES OF THE EVALUATION ACCORDING TO CONTRACT DOCUMENTATION

The evaluation of the tenders shall be carried out according to paragraph ……. of the Act with respect to their economic preferability by scoring method, pursuant to the following partial criteria in descending order according to their importance:

3. Total price of the public contract performance without VAT – importance 40%
4. Support of additional functions of the equipment and its features – importance 30%
5. General warranty – importance 10%
6. Time period for removal of defective performance since its notification by the submitter, all this during the warranty period – importance 10%
7. Delivery term – importance 10%

Within the frame of the partial criterion sub 1., the submitter shall evaluate the total rate of the tender price without VAT stated in point 6 of the contract documentation, letter a), i.e. the tender price including the total of tender prices for individual equipment functions offered by the tenderer above the required minimum configuration (additional functions) – see the submitter's requirement acc. to art. 2 of technical documentation.

Within the frame of the partial criterion sub 2., the submitter shall evaluate the features of the offered equipment and the extent of other (additional) functions of the equipment offered by the tenderer (see art. 2 of technical documentation). The tenderer is obliged to describe these functions in as much detail as possible.

Within the frame of the partial criterion sub 3., the submitter shall evaluate the general warranty. The submitter requires a warranty period for the offered hardware to be at least 3 years from the date of signature of acceptance protocol (protocol on handover and takeover of the performance).

Within the frame of the partial criterion sub 4., the submitter shall evaluate the time period, which the tenderer needs for removal of defective performance since its notification by the submitter, all this during the warranty period. The place of removal of the defective performance shall be the same as the place of performance.

Within the frame of the partial criterion sub 5., the submitter shall evaluate the delivery term. The tenderer shall state the delivery term of the subject matter of public contract in *weeks/days/months*.

9. DRAFT CONTRACT

The tenderer is bound to submit a single draft contract for the whole subject matter of public contract.

The draft contract may not exclude or restrict in any way the rights and requirements of the submitter stated in this contract documentation.

The draft contract has to be signed, from the tenderer´s side, by the statutory body or statutory body-authorized person; in this case, the original or officially verified copy of the authorization has to be a part of the draft contract of the tenderer; if not, the tender is considered as incomplete.

The tenderer is bound to oblige himself in the draft contract to provide quality guaranty of the performance for the minimum period of 3 years. This period starts running on the day of the signing of the acceptance protocol. In the guaranty period, the tenderer is bound to remove the performance disorders, or possibly to satisfy another submitter´s requirement due to defective performance. If the tenderer is delayed with the satisfaction of the submitter´s claim on defective performance, the submitter has the right to arrange the defect reparation from another person on the tenderer´s costs.

The tenderer is obliged to specify detailed warranty conditions in the draft contract including a proposal of penalty clauses for a case he does not succeed to put the equipment into operation within required term after a defect in any individual case.

In case of provided software on the day of signing the acceptance protocol a licence to use the software to the extent needed for proper use of the subject matter of performance by the submitter passes from the tenderer to the submitter. Such licence is provided for an indefinite period of time and the submitter is not obliged to use it. The price of the licence is included in the total price of the performance. In case the licence shall be in contrary to the above mentioned invalid or provided in insufficient extent the submitter shall then be authorized to call upon the tenderer to ensure the licence provision within necessary extent. If such a duty shall not be fulfilled by the tenderer within 30 days from the receipt of the call the submitter shall have the right to withdraw from the contract. The submitter's right to claim compensation of damage shall not be affected.

In the draft contract, the tenderer has to accept the submitter´s right for contract rescission in the case of tenderer´s delay longer than 30 days or in the case of repeated delay within one month.

Any restriction of the compensation of damage is not permitted.

10. CONCLUSION

The tenderer shall submit the declaration of veracity of the facts stated in the offer and the signature of authorized representative.

OPENING OF THE TENDERS

Opening of the tenders shall take place on ..... in meeting room at the registered office of the submitter. All tenderers, who submitted the tender within the term for tender submitting, are allowed to participate in the opening (maximally one person for a tenderer).

THE SUBMITTER´S RIGHTS

The submitter stipulates the right to cancel the public contract, according to paragraph ……of the Act, at any time, but until the day of contract conclusion.

The submitter accepts no variants of the tender.

The submitter stipulates the right to conclude a contract for only a part of the offered performance of public contract. However this part of public contract shall always include the provision of equipment in required basic configuration including corresponding software and licences. The submitter is not obliged to conclude a contract for the part of public contract corresponding to the offered additional functions of the equipment.

If any change in information stated in the tender occurs until the conclusion of a contract with selected tenderer, this tenderer is obliged to inform the submitter about the change immediately in written form.

The submitter shall answer written inquiries sent according to paragraph …… of the Act. The supplier has the right to send the inquiry also by e-mail or fax, provided that by three days of the inquiry delivery, also a written form of the inquiry is delivered. Written form of the inquiry has to

be delivered always until the term stated by the law. The term for submitter´s answer starts running on the day of delivery of the written form of the inquiry.

The submitter stipulates the right to verify the information provided by the tenderer from third persons and the tenderer is bound to cooperate with the submitter in all ways in this respect.

LIST OF ATTACHMENTS:

– Technical documentation – attachment no. 1

– Contract notice – attachment no. 2

- Declaration – attachment no. 3

- List of important supplies provided in the recent three years – attachment no. 4

Place, (date) ……

……

name

position

company

Attachment no. 1

Technical documentation

The information and particulars stated in each part of this technical documentation define the obligatory requirements of the submitter on public contract performance. The tenderer is bound to fully respect these requirements at tender (draft contract) preparation.

1. Description of the required equipment

The subject matter of public contract is a modular generator and traffic analysator of computer network traffic including software corresponding to the functionality required in this documentation (basic required configuration). The device must be equipped with two optical ports, either with replaceable transceivers or with fixed transceivers single-mode 1550 nm (preferred) or 1310 nm. The device must support the following technologies directly in offered configuration:

1 10 Gigabit Ethernet, according to specification LAN-PHY and WAN-PHY

2 OC- 192c / STM-64c PoS (Packet over SONET)

The device must enable to perform configuration and measuring in distant way with internet access from a distant PC (IBM compatible). Work with the measuring device must not require a computer of any other type than PC.

The device must enable future extension for ports 1 Gigabit Ethernet and OC - 48c.

The device must enable to assign precise time stamps to received and sent packets from outer source of time (GPS or atomic clock).

2. Supported tests (Additional functions)

The device must enable generation and lossless receipt of packets with specified content heading in all the speeds up to 10 Gb/s at all the lengths of packets.

The device must enable measuring of efficiency characteristics (especially packet loss and delay) and analysis of protocols from L2 to L4 levels for IPv4 and IPv6.

The submitter requires presentation of tester characteristics, features and all the other functions, which are supported by the tester and which enable performance of other monitoring tests (e.g. function Next - Generation SONET/ SDH (GFP, LCAS, VCAT), support of measuring BER (Bit Error Rate) for SONET/SDH etc.); this information must be offered by a

tenderer also for the purpose of evaluation of a tenderer´s tender according to the point 8 of contract documentation.

Attachment no. 2

Contract notice

Attachment no. 3

Declaration

HONORARY STATEMENT

according to the Act no. …….. (hereinafter referred to as ”Act”)

I honestly declare that:

acc. to § …… –	the tenderer is not in liquidation
acc. to § ……. –	there has been no bankruptcy declared on the tenderer´s property in the recent three years, or no bankruptcy was cancelled due to insufficient property
acc. to § …… –	the tenderer has no evidence of tax underpayments in tax register
acc. to § ……. -	the tenderer has no arrear on insurance and on public health insurance penalty or on insurance and on social benefits and state employment policy fee penalty, with the exception of the cases when the payments in instalments are allowed – the tenderer is not delayed with the instalment payments

This honorary statement is attached together with the abstract from the evidence of the Criminal Code according to § ……. to the document on the business licence, including the abstract from the Commercial Register or other evidence according to § ……..

I sign this honorary statement as the ……..…….of the …… firm, authorized by the abstract from the Commercial Register to act on behalf of the firm.

……

Signature
of the authorized representative

Attachment no. 4

List of important supplies provided in the recent three years

Description of a supply	Place of performance	Period of fulfilment	Name of the orderer	Represen-tative of the investor	Telephone contact	Extent of supplies carried out with own capacity (%)	Value of the supply

9.2.3. Documentation provided by Dante

Dante issued a tender during July 2004 for the purchase of the transmission equipment…

Introduction

This Invitation to Tender is for the procurement of the successor to the GÉANT Pan-European Research and Education Network, which has the working title of the GN2 network. This will replace the existing GÉANT (detailed in Annex 3) network with a combination of network infrastructure, services and equipment that will dramatically expand the capacity, functionality and cost effectiveness of the world's largest research network as a production and research networking environment. In this tender we are specifically seeking offers for

- network equipment and network management services for GN2.

It is proposed to hold an information day in London on 16 July 2004, at which you will be invited to present any questions you may have regarding this document. Please advise Gn2coordinator@dante.org.uk if you wish to attend this event and to receive further details.

Relationship with EC Programmes

GÉANT has been funded in part by the EC's Fifth Framework Programme since November 2000, with 26 European NREN participants and DANTE as the Co-ordinating Partner. A proposal has been submitted for continuing to support a Pan-European research network as part of the GN2 project within the 6th Framework Programme.

93 M Euro has been earmarked by the EC towards financing GN2 over the four years of FP6, representing up to 50% of its total cost, with the remainder to be sourced from national funds by the NRENs, as with the current GÉANT network and previous generations of Pan-European research networks.

Overview of GN2 network architecture and network services

The current pan-European network for research, GÉANT, offers a high capacity IP service to the NRENs that connect to it. It is based on Juniper M-160 and Juniper M-40 routers interconnected by circuits of capacity up to 10Gbps. The list of services offered on the GÉANT network is:

- Basic dual stack IP (IPv4 and IPv6)
- Premium IP
- Less Than Best Effort (aka *scavenger*)
- Multicast (IPv4 and IPv6)
- Circuit emulation services (using Juniper proprietary MPLS/CCC technology as well as standard L2VPN technology)

The Circuit emulation services are of particular relevance to GN2 in that these services set the foundations for the architecture of the successor to GÉANT. Currently, these resources are used to offer services to users, with capacities up to 1 Gigabit. These services are presented as STM-1, STM-4 or Ethernet.

In GN2 the number of circuit-emulation services required by users is set to increase, and will require Gigabit Ethernet , 10Gigabit Ethernet, STM-16 or STM-64 framing.

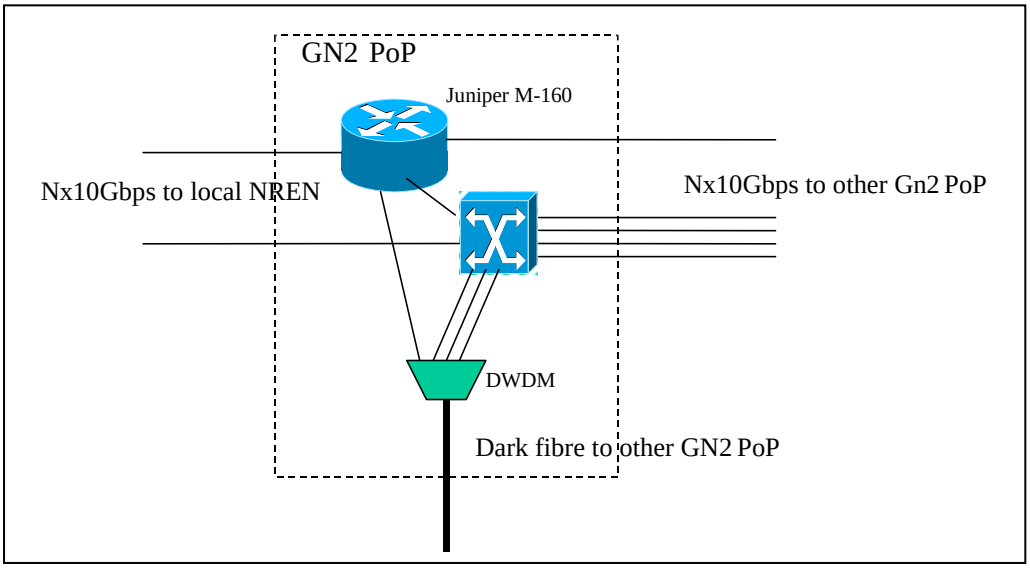


Figure 8-1 Possible layout of a GN2 PoP

Figure 8-1 outlines a possible layout of a GN2 PoP. The Juniper M-160 router will handle all the IP traffic. It will have a connection to the local NREN (with access capacity up to 10Gbps) and a connection to switching equipment. It will also have direct connections to neighbouring GN2 PoPs. New routers, of different type, may be introduced during the lifetime of GN2.

The switching equipment will terminate multiple wavelengths to/from neighbouring GN2 PoPs. It will also terminate 10Gbps circuits to the locally connected NREN. Some PoPs will be equipped with transmission equipment (DWDM or other) to light dark fibre which DANTE may procure as part of the GN2 connectivity tender. The switching and transmission equipment are the objects of this tender.

End to end circuit switched services will be between users in NREN networks. NRENs all have their own choice of switching equipment. In some specific cases users may be connected directly to the switching equipment in the GN2 PoPs. Therefore, interoperability with other vendor's switching equipment is a fundamental feature we require.

It is expected that the GN2 core network will be fully operational by the end of Q1 2005, with initial installations from January 2005.

Network Operations

The Network Operations services for GN2 will perform the following functions:

- Transmission fault management
- Transmission configuration management
- Switching configuration and fault management
- Trouble ticketing
- Reporting

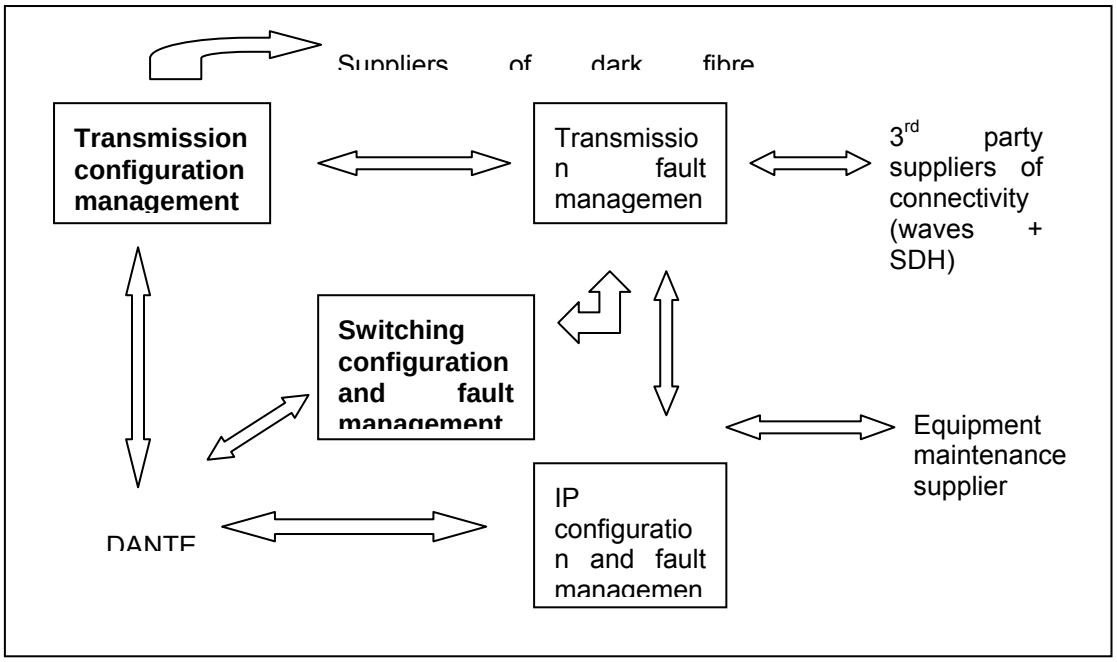


Figure 8-2: Functional diagram of Network Operations services

Figure 8-2 outlines a possible functional diagram of the NOC services for GN2. Transmission Fault Management (TFM) liaises with suppliers of connectivity to signal connectivity faults and follow up on their resolution. TFM will also liaise with Transmission Configuration Management (TCM) in those cases where connectivity for GN2 is provisioned via dark fibre lit with equipment procured via this tender. TCM will configure the transmission equipment and will correct all corresponding faults. TCM will also liaise with suppliers of dark fibre maintenance to fix any identified fibre cuts etc.

The Switching Configuration and Fault Management function (SCFM) will deal with the configuration of the switching equipment procured via this tender and will handle any faults with this equipment by interfacing with the supplier of the maintenance of the equipment. Similarly the IP configuration and fault management function (IPCFM) deals with the IP equipment and service.

In this tender, the TCM function will be procured, either together with the transmission equipment and corresponding delivery, installation and maintenance services or separately. Similarly, the SCFM function is procured (as an option) together with the switching equipment or separately.

Tender Information

Lots

The tender is divided into two lots:

- Lot 1: transmission equipment provision, delivery, installation, maintenance and support (**TES**) and corresponding network operations/management service (**TCM**);
- Lot 2: switching equipment provision, delivery, installation, maintenance and support (**SES**) and corresponding network operations/management service (**SCFM**).

Tenderers may respond to either or both lots. Tenderers may also respond to variants of the lots. For Lot 1 they may respond to either **TES** or **TCM** or both. For Lot 2 they may respond to either **SES** or **SCFM** or both.

Scale

The exact details of the number and configuration of the equipment for which we are tendering are not entirely known at this stage. This is particularly true for the switching equipment and corresponding management services.

Annex 1 contains all the known information in respect of dark fibre routes that will potentially need to be equipped. The exact number of wavelengths to be provided will vary and will be known during the negotiation phase of this tender. However, it can be assumed that up to 8x10Gbps wavelengths may be provisioned on some of the fibre routes.

The exact configuration of each switching node will also be known during the negotiation phase of this tender, but the following initial assumptions can be made:

- There will be approximately 20 GN2 nodes with switching equipment;
- Approximately 6 nodes will need to support capacities up to 250Gbps;
- The remaining nodes will need to support up to 100Gbps

Implementation Timescales

The transition from the current GÉANT network service to that of GN2 will be implemented as an orderly programme of migration with a high priority given to maintaining the continuity of service to end users. It is planned that this should take place within a three-month period starting from January 2005.

Lot 1, Transmission Equipment and Services

DANTE has issued a tender for connectivity between the locations of GN2. The options for connectivity include the provision of wavelengths and the provision of dark fibre. In the case of dark fibre, DANTE will need all the necessary terminal (wave division multiplexing) and in-line (optical amplification) equipment to light the dark fibre and provide the capacity. This equipment is the object of this part of the tender. The transmission equipment must be able to provide up to 8x10Gbps capacity on each fibre route.

There are 25 potential dark fibre routes to be equipped, the technical details of which are in Annex 1.

Technical Details for Transmission Equipment

Tenderers are required to provide the following details on Transmission Technology (**TT**). Please provide concise answers not exceeding two A4 pages for each point **TT1** to **TT4**:

TT 1 Indication of transmission equipment make and model, type (DWDM, CWDM)

TT 2 A high level specification of the operational aspects of the equipment proposed, including DC/AC power, cooling requirements, redundancy, in and out band management, hot-swappable modules, MTBF, support for pluggable optics;

TT 3 A high level specification of the technical aspects of the equipment proposed, including max. link capacity, max. number of wavelengths, capability of multiplexing GE channels, single fibre use, max. span loss, max. distance without regeneration, BER, upgrade potential, capability to support 40Gbps and more;

TT 4 Details on the management system, including its architecture, operating systems supported, licensing terms and conditions;

Delivery and Installation

Please provide details on the project management structure for timely delivery and installation of equipment in the remote field sites across Europe.

Maintenance and Support

Tenderers are required to provide the following details on Transmission Equipment Maintenance and Support (**TM**). Please provide concise answers not exceeding one A4 page for each point **TM1** to **TM3:**

TM 1 A description of second and third line maintenance for undiagnosed problems including interaction with other vendors' equipment (such as switching and routing equipment), the timing that can be guaranteed for resolution of such undiagnosed problems and a description of the structure of the proposed maintenance organisation;
TM 2 Details on spares management and how a 4-hour replacement of parts can be guaranteed in all locations. If 4 hours is not possible in all locations, please give details and clarify what can be achieved;
TM 3 Information on appropriate training for DANTE staff on the technology proposed, including any associated costs;

Pricing of Transmission Equipment and Maintenance Services

Please fill in the following table for each fibre route. This table must be made available also as a separate Excel spreadsheet. There is the option of purchase or lease of equipment and the tenderer must fill in the appropriate cells.

Route identifier (see annex 1)	Num. ampl on route	Num. regen on route	Base eqpt cost (inc 1x 10G wave) KEUR (purchase)	Incremental cost for 1x10 Gbps KEUR (purchase)	Base eqpt cost (inc 1x 10G wave) KEUR/year (lease)	Incremental cost for 1x10 Gbps KEUR/year (lease)	Delivery + Installation KEUR	Base maint.+ support cost KEUR/year	Incremental maint.+ support cost KEUR/ year

Table 8-0-1: Transmission equipment and services pricing

Tenderers must also specify the unit cost of each component needed to build a working system lit with one 10Gbps wavelength and each component needed to add a 10Gbps wavelength to the working system.

NOC Services for Transmission

The contractor will be expected to:

- Use English as the working language;
- Put in place the appropriate configuration in the transmission equipment in order to provision capacity (light wavelengths) between the end terminals and present it to the GN2 switches or routers;
- Maintain an information system which records historical, current and planned configuration data in such a way that the evolution of the network can be re-constructed;
- Proactively monitor all network elements related to transmission on a 24h x 7d basis;
- Liaise with the GN2 TFM function;
- Take responsibility for all fault corrective actions required on the transmission equipment. This includes organising access to in-line sites for correcting faults on in-line equipment;
- Liaise with the providers of dark fibre maintenance for GN2 for the co-ordination of intervention on the dark fibre resulting form fibre cuts, planned work etc.
- Raise trouble tickets and produce monthly performance reports in respect of faults and their resolution, both hard copy and on-line.

Tenderers must provide the following information on Transmission Configuration Management (**TCM**). Please provide concise answers not exceeding 2 pages for each point **TCM1** to **TCM8**:

TCM 1 Explicit confirmation that each of the points listed above will be performed;
TCM 2 Location(s) of the NOC; In the case of more than one location, which location acts as primary and which as backup;
TCM 3 A description of the configuration process proposed, including tools and information systems used;
TCM 4 A description of the proactive fault monitoring procedures, including tools and information systems used;
TCM 5 Description of trouble ticketing procedures;
TCM 6 Description of reporting functionality;

TCM 7 Description of staffing levels and expertise (from help desk to senior management) dedicated to the service, the percentage of their time dedicated to GN2 and how 24x7 operation will be guaranteed

TCM 8 A description of the pricing structure for the service and the total cost, broken down into the components identified by the pricing structure.

Lot 2, Switching Equipment and Services

Switching equipment as outlined in **Error! Reference source not found.** is required for GN2 PoPs. The basic requirements of this equipment are to:

- Support up to 250 Gbps switching capacity;
- Offer Gigabit Ethernet, 10Gigabit Ethernet, STM-16 or STM-64 services to users.

Technical Details for Switching Equipment

Tenderers are required to provide the following details on Switching Technology (**ST**). Please provide concise answers not exceeding two A4 pages for each point **ST1** to **ST3**:

ST 1 An overview of operational parameters including DC/AC power, cooling requirements, redundancy, in and out band management, hot-swappable modules, MTBF, support for pluggable optics;

ST 2 An overview of the technical features including granularity of user services offered, multiplexing of GE into STM-16 and STM-64, support for LAN-PHY and WAN-PHY, support for control protocols (GMPLS, UNI), switching fabric characteristics, upgrade possibilities, capability to support 40Gbps and more;

ST 3 Details on the management system, including its architecture, operating systems supported, licensing terms and conditions.

Delivery and Installation

Please provide details on the project management structure for timely delivery and installation of equipment in the locations listed in Annex 2.

At Maintenance and Support for Switching Equipment

Tenderers must provide the following details on Switching Maintenance and Support (**SM**). Each answer must not exceed one A4 page for each point **SM1** to **SM3**:

SM 1 A description of second and third line maintenance for undiagnosed problems including interaction with other vendors' equipment (such as switching and routing equipment), the timing that can be guaranteed for resolution of such undiagnosed problems and a description of the structure of the proposed maintenance organisation .

SM 2 Details on spares management and how a 4 hour replacement of parts can be guaranteed in all locations. If 4 hours is not possible in all locations, please give details and clarify what can be achieved.

SM 3 Information on appropriate training for DANTE staff on the technology proposed, including any associated costs;

Pricing of Switching Equipment

Please fill in the following pricing table. There is the option of purchase or lease of equipment and the tenderer must fill in the appropriate table:

Base system with dual power (KEUR) (purchase)	Delivery + installation (KEUR)	SW license (KEUR)	10Gbps line card cost (KEUR)	GE Line card Cost (KEUR)	10GE line card cost (KEUR)	Support + Maint (KEUR/year)

Table 8-0-2 Switching equipment and services pricing – purchase option

Base system with dual power (KEUR)/year (lease)	Delivery + installation(KEUR)	SW license (KEUR)	10Gbps line card cost (KEUR)/year	GE Line card Cost (KEUR)/year	10GE line card cost (KEUR)/year	Support + Maint (KEUR/year)

Table 8-0-3 Switching equipment and services pricing – lease option

Please provide details of volume discounts and any other costs needed to have a fully working system. Please provide pricing of all the single components necessary to build a working system capable of being equipped with 10x10Gbps interface cards. Tenderers must outline any configuration/performance limitations, such as those related to the combinations of GE and 10Gbps line cards, throughput limitations and so on.

Development of New Services

DANTE and the NRENs will be involved in the development of new services. There will be substantial effort in the development of a “bandwidth allocation and reservation” service that will need to operate in an end-to-end, multi-domain and multi-vendor environment. We forsee the development of bandwidth brokers operating across multiple domains, the use of GMPLS and/or UNI. The development will happen in stages, with the aim by 2007 to achieve automated end-to-end setup of connectivity. Tenderers are invited to explain if and how they would contribute to this development program

NOC Services for Switching

The SCFM function must:

- Use English as the working language;
- Take responsibility for network provisioning, i.e. the set of activities that supports the effective management of bandwidth resources and the allocation of those resources to specific purposes;
- Measure and report on usage of the individual resources;
- Perform configuration management, i.e. maintenance of an information system which records historical, current and planned configuration data in such a way that the evolution of the network can be re-constructed;
- Maintain an up to date system inventory which accurately reflects the current configuration at any time and which covers an inventory of all hardware in the network, an inventory of software releases in use, all the parameters required to configure all network equipment and changes to any of the above mentioned elements;
- Provide on-line access to this set of information to DANTE and staff from other NOCs;

- Proactively monitor all switching equipment on a 24h x 7d basis;
- Liaise with the GN2 TFM function;
- Take responsibility for all fault corrective actions required on the switching equipment. This includes organising access to GN2 PoPs.
- Raise trouble tickets and produce monthly performance reports in respect of faults and their resolution, both hard copy and on-line.

The following information must be provided:

SCFM 1 Explicit confirmation that each of the points listed above will be performed;

SCFM 2 Location(s) of the NOC. In the case of more than one location, which location acts as primary and which as backup;

SCFM 3 A description of the configuration process proposed, including tools and information systems used;

SCFM 4 Description of access to performance information;

SCFM 5 A description of the proactive fault monitoring procedures, including tools and information systems used;

SCFM 6 Description of staffing levels and expertise, from help desk to senior positions;

SCFM 7 A description of the pricing structure for the service and the total cost, broken down into the components identified by the pricing structure.

Alternative Solutions

Tenderers are free to propose alternative solutions capable of fulfilling the basic requirements of:

- Lighting dark fibre with up to 8x10 Gbps wavelengths on the fibre routes detailed in Annex 1;
- Handling Nx10Gbps wavelengths on a single route;
- Supporting the provision of end-to-end gigabit services to end-users in a multi-domain environment. The equipment proposed will operate in the GN2 domain, whilst end-users are located in NREN domains connected to GN2.

When doing so, tenderers must provide supporting material in order to demonstrate that the alternative solution provides attractive value for money in comparison to the combination of switching and transmission equipment as outlined previously. There must be clear technical, operational and economic advantages. The alternative solution must be forward looking and proven in an operational environment. The solution must include all elements of delivery, maintenance, support and operations.

Commercial Issues

7.1 General

7.1.1 The contract for the requirements set out in this ITT may be awarded wholly, in part or not at all to any specific tenderer.

7.1.2 Tenderers will be required to co-operate with other suppliers in the provision of service to DANTE.

7.1.3 Tenderers must confirm that any services they offer conform to any relevant national or EC regulatory requirements.

7.1.4 All expenses relating to the submission of tenders and any subsequent contract negotiations are the responsibility of the tenderer.

7.1.5 Existing suppliers who respond to this tender and who are unsuccessful will be required to agree to co-operate with the implementation of successful responses from other potential suppliers.

7.1.6 All tenders must remain valid for a period of nine months following the deadline for submission.

7.2 Contractual

7.2.1 EU funding support is expected for the activity as part of the Integrated Infrastructure Initiative Programme under FP6. Selected suppliers will be expected to agree contractual terms and conditions appropriate to the funding arrangements for this activity.

7.2.2 Contract duration will be discussed during contract negotiations. Contracts of up to three/four years duration will be agreed where warranted.

7.2.3 Contracts shall include specific clauses relating to quality of service including performance guarantees and delivery dates

7.2.4 Precise delivery dates will be subject to negotiation. However, suppliers will be required to make firm commitments to such delivery dates as are agreed, with compensation for late delivery. Agreed dates are expected to be available within the fourth calendar quarter of 2004.

7.3 Pricing

7.3.1 Prices for different service elements shall be quoted separately in Euro and, in the case of recurrent charges, in units of Euro/year. VAT and other taxes, if applicable, must also be quoted separately.

7.3.2 Tenderers are asked to propose pricing arrangements for one year contracts extendable on a monthly basis and for longer term contracts of up to four years.

7.3.3 Tenderers will be expected to provide assurances about the competitiveness of their prices both in respect of the contractual arrangements to be entered into and also in respect of future developments in the market place. Contracts of greater than one year in duration shall provide for an annual price review which shall take account of comparisons with similar services as well as competitiveness with alternative suppliers.

It is expected that all prices will be exempt from VAT and other taxes. In the event that any VAT or other taxes have to be applied, these must also be quoted separately and fully detailed. Price information must be summarised in the Pricing table in Annex 5 and this must be supplied electronically. Tenderers should confirm their preparedness to allow DANTE to assign part of the contracted connectivity to other national research networks.

7.3.4 Tenderers should clearly state if there are any restrictions of use that apply to their offers.

Format of Response

The response to the tender must be structured in the following way:

1. Cover letter;
2. List of services offered (i.e. one or more of data transmission equipment + services, data transmission operations, data switching equipment + services, data switching operations, alternative solution);
3. A description, not exceeding 3 pages, of the solution offered;
4. If applicable, completed pricing table (table 1) described in section 4.4 of this tender;
5. If applicable, location(s) and cost of NOC services for data transmission operations;
6. If applicable, the appropriate completed pricing table described in section 5.4 (table 2a or table 2b) of this tender;
7. If applicable, location and cost of NOC services for data switching operations;
8. Point by point responses to sections 4 and 5 of this tender where applicable. A response to section 6 where applicable;
9. Statement of conformance to the commercial terms detailed in section 7 with specific details of where the tenderer does not conform to any individual terms listed;
10. Background Information about the tendering organisation including:
    - one set of latest audited financial results (e.g. most recently published annual report).
    - Brief description of funding structure including main stakeholders (less than 100 words).
    - Publicly available details of any planned restructuring/refinancing which might affect the tenderer's ability to perform its duties as detailed in the proposal submitted (less than 200 words).

11. CVs of key personnel involved in this tender;
12. References to contracts of similar scale and functionality;
13. Any other information the tenderer feels useful.

Evaluation Criteria

The following criteria will be applied for the evaluation of proposals. The order of listing has no significance:

- Capability to deliver, install and maintain the proposed equipment in all relevant locations;
- Capability to operate the equipment in all relevant locations;
- Technical capabilities of the equipment proposed;
- Compliance to all requirements set out in the tender, including the format of the response as set out in section 8 of this document;
- Cost;
- Contribution to development programme;
- Financial standing including an audited copy of the latest set of accounts and relevant experience of the Tenderer.

Deadline for Submissions

Five copies of your tender must be sent to DANTE, City House, 126-130 Hills Road, Cambridge, CB2 1PQ, UK to be received no later than 17.00 hours local time on Friday 13 August 2004. An electronic copy, including separate excel format pricing tables described in sections 4.4 and 5.4 should also be sent to gn2coordinator@dante.org.uk **to arrive within the same timescales.**

Annex 1 – Specification of potential fibre routes

L1 City E- City A	Length [km]	Type of fibre	Manufacturer and brand	Number of fusion splices	Number of mechanical connectors	Attenuation [dB]
Span 1	85	G.655	Corning LEAF	14	2	17.6
Span 2	109	G.655	Corning LEAF	20	2	23.4
Span 3	96	G.655	Corning LEAF	17	2	21.2
Span 4	72	G.655	Corning LEAF	66	2	18.3
Span 5	18	G.655	Corning LEAF	84	2	17.2
Span 6	76	G.655	Corning LEAF	88	2	15.4
Span 7	104	G.655	Corning LEAF	84	2	21.2

L2 City B - City A	Length [km]	Type of fibre	Manufacturer and brand	Number of fusion splices	Number of mechanical connectors	Attenuation [dB]
Span 1	70	G.655	Corning LEAF	18	2	19.6
Span 2	70	G.655	Corning LEAF	18	2	19.6
Span 3	40	G.655	Corning LEAF	10	2	11.6
Span 4	84	G.655	Corning LEAF	21	2	23.3
Span 5	76	G.655	Corning LEAF	19	2	21.1
Span 6	86	G.655	Corning LEAF	22	2	23.8
Span 7	86	G.655	Corning LEAF	22	2	23.8
Span 8	73	G.655	Corning LEAF	18	2	20.3
Span 9	56	G.655	Corning LEAF	14	2	15.8
Span 10	52	G.655	Corning LEAF	13	2	14.8
Span 11	71	G.655	Corning LEAF	18	2	19.8
Span 12	67	G.655	Corning LEAF	17	2	18.8

L3 City C - City B	Length [km]	Type of fibre	Manufacturer and brand	Number of fusion splices	Number of mechanical connectors	Attenuation [dB]
Span 1	52	G.655	Corning LEAF	18	2	12.5
Span 2	71	G.655	Corning LEAF	14	2	15.4
Span 3	87	G.655	Corning LEAF	17	2	18.4
Span 4	74	G.655	Corning LEAF	16	2	16.1
Span 5	81	G.655	Corning LEAF	16	2	18.3
Span 6	74	G.655	Corning LEAF	14	2	16.0
Span 7	78	G.655	Corning LEAF	17	2	16.7

Span 8	66	G.655	Corning LEAF	13	2	14.1
Span 9	73	G.655	Corning LEAF	14	2	15.9
Span 10	68	G.655	Corning LEAF	10	2	15.3
Span 11	83	G.655	Corning LEAF	15	2	18.7

L4 City A - City C	**Length [km]**	**Type of fibre**	**Manufacturer and brand**	**Number of fusion splices**	**Number of mechanical connectors**	**Attenuation [dB]**
Span 1	76	G.655	Corning LEAF	14	2	16.4
Span 2	89	G.655	Corning LEAF	16	2	18.4
Span 3	61	G.655	Corning LEAF	12	2	12.9
Span 4	74	G.655	Corning LEAF	14	2	16.0
Span 5	80	G.655	Corning LEAF	15	2	16.8
Span 6	90	G.655	Corning LEAF	17	2	16.0
Span 7	94	G.655	Corning LEAF	18	2	19.9
Span 8	93	G.655	Corning LEAF	18	2	19.2
Span 9	98	G.655	Corning LEAF	18	2	20.9
Span 10	98	G.655	Corning LEAF	18	2	21.6

L5 City C - City D	**Length [km]**	**Type of fibre**	**Manufacturer and brand**	**Number of fusion splices**	**Number of mechanical connectors**	**Attenuation [dB]**
Span 1	87	G.655	Corning LEAF	16	2	18.9
Span 2	96	G.655	Corning LEAF	18	2	20.6
Span 3	54	G.655	Corning LEAF	10	2	11.3
Span 4	69	G.655	Corning LEAF	13	2	13.5
Span 5	83	G.655	Corning LEAF	16	2	17.6
Span 6	91	G.655	Corning LEAF	22	2	21.6
Span 7	75	G.655	Corning LEAF	14	2	16.3
Span 8	88	G.655	Corning LEAF	16	2	19.6

L6 City D - City M	**Length [km]**	**Type of fibre**	**Manufacturer and brand**	**Number of fusion splices**	**Number of mechanical connectors**	**Attenuation [dB]**

Span 1	85	G.655	Corning LEAF	16	2	16.4
Span 2	57	G.655	Corning LEAF	11	2	11.7
Span 3	120	G.652	Corning SMF-28	22	2	22.7
Span 4	85	G.655	Corning LEAF	14	2	17.9
Span 5	85	G.655	Corning LEAF	14	2	19.0

L7 City M - City E	**Length [km]**	**Type of fibre**	**Manufacturer and brand**	**Number of fusion splices**	**Number of mechanical connectors**	**Attenuation [dB]**
Span 1	82	G.655	Corning LEAF	15	2	17.7
Span 2	85	G.655	Corning LEAF	15	2	17.5
Span 3	103	G.655	Corning LEAF	19	2	22.6

L8 City H - City I	**Length [km]**	**Type of fibre**	**Manufacturer and brand**	**Number of fusion splices**	**Number of mechanical connectors**	**Attenuation [dB]**
Span 1	90	G.652	Siemens	16	2	18.95
Span 2	3	G.652	Samsung	5	2	1.6

L9 City L - City J	**Length [km]**	**Type of fibre**	**Manufacturer and brand**	**Number of fusion splices**	**Number of mechanical connectors**	**Attenuation [dB]**
Span 1	60	G.652	Corning	30	2	18
Span 2	35	G.652	Corning	17	0	11
Span 3	81	G.652	Corning	40	2	25
Span 4	35	G.652	Corning	17	0	11
Span 5	80	G.652	Corning	40	1	24
Span 6	45	G.652	Corning	22	1	14
Span 7	75	G.652	Corning	37	1	23

L10 City H - City J	**Length [km]**	**Type of fibre**	**Manufacturer and brand**	**Number of fusion splices**	**Number of mechanical connectors**	**Attenuation [dB]**
Span 1	20	G.652	Alcatel & Ericsson	5	4	5
Span 2	96	G.652	Alcatel & Ericsson			24

Span 3	66	G.652	Alcatel & Ericsson			16.5

L11 City K - City L	**Length [km]**	**Type of fibre**	**Manufacturer and brand**	**Number of fusion splices**	**Number of mechanical connectors**	**Attenuation [dB]**
Span 1	50	G.652	Corning	25	1	15
Span 2	60	G.652	Corning	30	1	18
Span 3	40	G.652	Corning	20	1	12

L12 City I - City K	**Length [km]**	**Type of fibre**	**Manufacturer and brand**	**Number of fusion splices**	**Number of mechanical connectors**	**Attenuation [dB]**
Span 1	55	G.652	Corning	27	1	17
Span 2	45	G.652	Corning	22	0	14
Span 3	55	G.652	Corning	27	0	16
Span 4	50	G.652	Corning	25	0	15
Span 5	85	G.652	Corning	42	1	26
Span 6	70	G.652	Corning	35	1	21
Span 7	80	G.652	Corning	40	3	24

L13 City A - City G	**Length [km]**	**Type of fibre**	**Manufacturer and brand**	**Number of fusion splices**	**Number of mechanical connectors**	**Attenuation [dB]**
Span 1	65	G.652	Ericsson, Corning	13	2	13.1
Span 2	58	G.652	Ericsson, Corning	13	2	11.8
Span 3	84	G.652	Ericsson, Corning	20	2	17.3
Span 4	80	G.652	Ericsson, Corning	16	2	16.3
Span 5	56	G.652	Ericsson, Corning	15	2	11.6
Span 6	99	G.652	Ericsson, Corning	19	2	20.4
Span 7	60	G.652	Ericsson, Corning	11	2	11.8

Span 8	79	G.652	Ericsson, Corning	14	2	15.7
Span 9	44	G.652	Ericsson, Corning	11	2	12.4
Span 10	26	G.652	Ericsson, Corning	5	2	5.3

L14 City F - City A	**Length [km]**	**Type of fibre**	**Manufacturer and brand**	**Number of fusion splices**	**Number of mechanical connectors**	**Attenuation [dB]**
Span 1	57	G.652	Corning SMF-28	22	0	11.60
Span 2	26	G.652	Corning SMF-28	9	0	5.34
Span 3	42	G.652	Corning SMF-28	13	0	7.80
Span 4	24	G.652	Corning SMF-28	8	0	5.30
Span 5	39	G.652	Corning SMF-28	11	0	7.60
Span 6	40	G.652	Corning SMF-28	10	0	7.80
Span 7	3	G.652	ALCATEL SMF	2	0	< 1,00
Span 8	33	G.652	ALCATEL SMF	14	0	8.17
Span 9	14	G.652	ALCATEL SMF	10	0	3.48
Span 10	18	G.652	ALCATEL SMF	8	0	4.54
Span 11	8	G.652	ALCATEL SMF	9	0	2.05
Span 12	23	G.652	SIEMENS SMF	17	0	5.56
Span 13	14	G.652	SIEMENS SMF	11	0	3.06
Span 14	16	G.652	SIEMENS SMF	9	0	6.61
Span 15	18	G.652	ALCATEL SMF	10	0	4.32
Span 16	26	G.652	ALCATEL SMF	15	0	6.14
Span 17	20	G.652	ALCATEL SMF	13	0	4.86
Span 18	25	G.652	ALCATEL SMF	9	0	6.03
Span 19	19	G.652	ALCATEL SMF	9	0	4.35
Span 20	31	G.652	ALCATEL SMF	12	0	7.14
Span 21	34	G.652	ALCATEL SMF	10	1	8.40
Span 22	20	G.652	ALCATEL SMF	7	0	4.30
Span 23	3	G.652	ALCATEL SMF	3	0	< 1,00
Span 24	73	G.652	Corning/Siemens	n.a.	2	17
Span 25	57	G.652	Corning/Siemens	n.a.	2	12
Span 26	34	G.652	Corning/Siemen	n.a.	2	8

			s			
Span 27	75	G.652	Alcatel			
Span 28	83	G.652	Alcatel	54	4	17,70 dB*
Span 29	89	G.652	Alcatel	48	2	20,30 dB*
Span 30	29	G.652	n.a.	15	4	9,39 dB*

L15 City G - City H	**Length [km]**	**Type of fibre**	**Manufacturer and brand**	**Number of fusion splices**	**Number of mechanical connectors**	**Attenuation [dB]**
Span 1	27	G.652	Ericsson, Corning	5	2	5.3
Span 2	100	G.652	Ericsson, Corning	19	2	21.6
Span 3	86	G.652	Ericsson, Corning	17	2	17
Span 4	85	G.652	Ericsson, Corning	17	2	17.3
Span 5	94	G.652	Ericsson, Corning	17	2	17.6

L16 City F - City G	**Length [km]**	**Type of fibre**	**Manufacturer and brand**	**Number of fusion splices**	**Number of mechanical connectors**	**Attenuation [dB]**
Span 1	57	G.652	Corning SMF-28	22	0	11.60
Span 2	26	G.652	Corning SMF-28	9	0	5.34
Span 3	42	G.652	Corning SMF-28	13	0	7.80
Span 4	24	G.652	Corning SMF-28	8	0	5.30
Span 5	29	G.652	Corning SMF-28	12	0	6.20
Span 6	40	G.652	Corning SMF-28	11	0	7.70
Span 7	41	G.652	Corning SMF-28	13	0	8.40
Span 8	29	G.652	Corning SMF-28	11	0	7.20
Span 9	38	G.652	Corning SMF-28	13	0	6.60
Span 10	48	G.652	Corning SMF-28	12	0	10.60
Span 11	53	G.652	Corning SMF-28	13	0	11.20
Span 12	56	G.652	Corning SMF-28	15	0	12.50
Span 13	58	G.652	Corning SMF-28	13	0	12.90
Span 14	52	G.652	Corning SMF-28	13	0	10.97

Span 15	39	G.652	Corning SMF-28	13	0	11.20
Span 16	40	G.652	Corning SMF-28	8	3	14.60
Span 17	34	G.652	Corning SMF-28	7	1	6.87
Span 18	14	G.652	Corning SMF-28	5	0	2.93
Span 19	46	G.652	Corning SMF-28	12	0	9.55
Span 20	6	G.652	Draka	3	1	1.9
Span 21	57	G.652	Draka	12	2	11.4
Span 22	85	G.652	Draka	16	2	18
Span 23	86	G.652	Draka	20	2	18.5
Span 24	50	G.652	Draka	11	2	11.2
Span 25	25	G.652	Ericsson	6	2	6.05
Span 26	85	G.652	Ericsson	21	2	19.9
Span 27	99	G.652	Siemens	24	2	19.82
Span 28	26	G.652	Ericsson	6	2	4.22
Span 29	20	G.652	Ericsson	12	8	6.7

L17 City O City A	**Length [km]**	**Type of fibre**	**Manufacturer and brand**	**Number of fusion splices**	**Number of mechanical connectors**	**Attenuation [dB]**
Span 1	75	G.652	Ericsson	14	0	15.7
Span 2	108	G.652	Ericsson	15	0	21.6
Span 3	104	G.652	Ericsson	15	0	20.8
Span 4	105	G.652	Ericsson	15	0	20.9
Span 5	101	G.652	Ericsson	14	0	20.3
Span 6	107	G.652	Ericsson	17	0	21.5
Span 7	86	G.652	Ericsson	15	0	17.3
Span 8	92	G.652	Ericsson	18	0	18.5
Span 9	85	G.652	Ericsson	15	0	17.0
Span 10	93	G.652	Ericsson	16	0	18.7
Span 11	64	G.652	Ericsson	5	0	12.9
Span 12	58	G.652	Ericsson	9	0	11.8
Span 13	60	G.652	Sumitomo	13	0	13.2
Span 14	72	G.652	Sumitomo	16	0	14.2
Span 15	71	G.652	Sumitomo	16	0	14.5
Span 16	67	G.652	Sumitomo	16	0	14.3
Span 17	72	G.652	Sumitomo	16	0	14.4

Span 18	72	G.652	Sumitomo	16	0	13.1
Span 19	72	G.652	Sumitomo	16	0	14.3
Span 20	57	G.652	Sumitomo	13	0	9.2
Span 21	67	G.652	Sumitomo	15	0	12.5
Span 22	76	G.652	Sumitomo	16	0	15.1
Span 23	67	G.652	Sumitomo	18	0	13.0
Span 24	73	G.652	Sumitomo	20	0	14.5

L18 City O City E	**Length [km]**	**Type of fibre**	**Manufacturer and brand**	**Number of fusion splices**	**Number of mechanical connectors**	**Attenuation [dB]**
Span 1	90	G.652	Ericsson	13	0	16.9
Span 2	99	G.652	Ericsson	14	0	19.9
Span 3	104	G.652	Ericsson	15	0	20.9
Span 4	111	G.652	Ericsson	15	0	22.4
Span 5	81	G.652	Ericsson	12	0	16.4
Span 6	102	G.652	Ericsson	15	0	22.5
Span 7	58	G.652	Ericsson	9	0	11.8
Span 8	87	G.652	Ericsson	12	0	18.4
Span 9	91	G.652	Ericsson	13	0	17.8
Span 10	97	G.652	Ericsson	14	0	20.0
Span 11	67	G.652	Ericsson	10	0	13.8
Span 12	103	G.652	Ericsson	13	0	21.4
Span 13	77	G.652	Ericsson	11	0	15.3
Span 14	77	G.652	Ericsson	11	0	15.0
Span 15	74	G.652	Ericsson	12	0	15.1
Span 16	97	G.652	Ericsson	16	0	19.5
Span 17	84	G.652	Ericsson	15	0	18.8
Span 18	73	G.652	Ericsson	13	0	16.1
Span 19	90	G.652	Ericsson	16	0	21.7
Span 20	90	G.652	Ericsson	16	0	19.3
Span 21	63	G.652	Ericsson	13	0	13.6
Span 22	81	G.652	Ericsson	15	0	13.4
Span 23	99	G.652	Corning	18	0	17.3
Span 24	51	G.652	Corning	12	0	9.6
Span 25	99	G.652	Corning	18	0	18.9

Span 26	84	G.652	Corning	16	0	18.2
Span 27	95	G.652	Corning	18	0	19.0
Span 28	86	G.652	Corning	16	0	17.8

L19 City B - City N	**Length [km]**	**Type of fibre**	**Manufacturer and brand**	**Number of fusion splices**	**Number of mechanical connectors**	**Attenuation [dB]**
Span 1	63	G.655	Corning LEAF	11	2	14.6
Span 2	65	G.655	Corning LEAF	10	2	15.2
Span 3	65	G.655	Corning LEAF	10	2	14.3
Span 4	57	G.655	Corning LEAF	11	2	13.0
Span 5	76	G.655	Corning LEAF	21	2	16.7
Span 6	80	G.655	Corning LEAF	29	2	18.2
Span 7	93	G.655	Corning LEAF	28	2	20.4
Span 8	76	G.655	Corning LEAF	40	2	16.7
Span 9	93	G.655	Corning LEAF	28	2	19.9

L20 City A - City N	**Length [km]**	**Type of fibre**	**Manufacturer and brand**	**Number of fusion splices**	**Number of mechanical connectors**	**Attenuation [dB]**
Span 1	18	G.652	Pirelli (Rapier)	16	2	4.2
Span 2	81	G.655	Corning LEAF	17	2	17.0
Span 3	94	G.655	Corning LEAF	20	2	19.0
Span 4	60	G.655	Corning LEAF	17	2	13.9
Span 5	60	G.655	Corning LEAF	21	2	17.5
Span 6	101	G.655	Corning LEAF	22	2	22.1
Span 7	73	G.655	Corning LEAF	17	2	16.4
Span 8	76	G.655	Corning LEAF	21	2	16.7
Span 9	80	G.655	Corning LEAF	29	2	18.2
Span 10	93	G.655	Corning LEAF	28	2	20.4
Span 11	76	G.655	Corning LEAF	40	2	16.7
Span 12	93	G.655	Corning LEAF	28	2	19.9

L21 City I - City N	Length [km]	Type of fibre	Manufacturer and brand	Number of fusion splices	Number of mechanical connectors	Attenuation [dB]
Span 1	47	G.655	Corning LEAF	12	2	13.5
Span 2	87	G.655	Corning LEAF	22	2	24.1
Span 3	66	G.655	Corning LEAF	17	2	18.5
Span 4	78	G.655	Corning LEAF	20	2	21.7
Span 5	83	G.655	Corning LEAF	21	2	23.0
Span 6	71	G.655	Corning LEAF	18	2	19.8
Span 7	50	G.655	Corning LEAF	13	2	14.3
Span 8	80	G.655	Corning LEAF	20	2	22.2
Span 9	78	G.655	Corning LEAF	20	2	21.7
Span 10	78	G.655	Corning LEAF	20	2	21.7
Span 11	69	G.655	Corning LEAF	17	2	19.3
Span 12	72	G.655	Corning LEAF	18	2	20.1
Span 13	61	G.655	Corning LEAF	15	2	17.2
Span 14	60	G.655	Corning LEAF	15	2	16.9
Span 15	56	G.655	Corning LEAF	14	2	15.8

L22 City I - City B	Length [km]	Type of fibre	Manufacturer and brand	Number of fusion splices	Number of mechanical connectors	Attenuation [dB]
Span 1	59	G.655	Corning LEAF	15	2	16.7
Span 2	85	G.655	Corning LEAF	21	2	23.5
Span 3	87	G.655	Corning LEAF	22	2	24.1
Span 4	85	G.655	Corning LEAF	21	2	23.5
Span 5	51	G.655	Corning LEAF	13	2	14.5
Span 6	80	G.655	Corning LEAF	20	2	22.2
Span 7	78	G.655	Corning LEAF	20	2	21.7
Span 8	46	G.655	Corning LEAF	12	2	13.2
Span 9	70	G.655	Corning LEAF	18	2	19.6
Span 10	73	G.655	Corning LEAF	18	2	20.3
Span 11	73	G.655	Corning LEAF	18	2	20.3
Span 12	86	G.655	Corning LEAF	22	2	23.8
Span 13	86	G.655	Corning LEAF	22	2	23.8
Span 14	76	G.655	Corning LEAF	19	2	21.1
Span 15	84	G.655	Corning LEAF	21	2	23.3

Span 16	40	G.655	Corning LEAF	10	2	11.6
Span 17	70	G.655	Corning LEAF	18	2	19.6
Span 18	70	G.655	Corning LEAF	18	2	19.6

L23 City I - City A	**Length [km]**	**Type of fibre**	**Manufacturer and brand**	**Number of fusion splices**	**Number of mechanical connectors**	**Attenuation [dB]**
Span 1	88	G.652	Alcatel	19	0	17.9
Span 2	57	G.652	Alcatel	13	0	13.4
Span 3	66	G.652	Alcatel	20	0	17.6
Span 4	60	G.652	Alcatel	15	0	15.2
Span 5	71	G.652	Alcatel	18	0	17.4
Span 6	56	G.652	Alcatel	15	0	12.8
Span 7	81	G.652	Alcatel	12	0	18.0
Span 8	63	G.652	Sumitomo	13	0	11.4
Span 9	76	G.652	Sumitomo	18	0	14.9
Span 10	66	G.652	Sumitomo	15	0	12.6
Span 11	92	G.652	Sumitomo	46	0	19.6
Span 12	105	G.652	Sumitomo	48	0	22.8
Span 13	75	G.652	Sumitomo	15	0	14.1
Span 14	59	G.652	Sumitomo	14	0	11.7
Span 15	79	G.652	Sumitomo	20	0	14.2

L24 City I - City J	**Length [km]**	**Type of fibre**	**Manufacturer and brand**	**Number of fusion splices**	**Number of mechanical connectors**	**Attenuation [dB]**
Span 1	35	G.652	Corning	17	0	10
Span 2	40	G.652	Corning	20	0	12
Span 3	50	G.652	Corning	25	2	15
Span 4	40	G.652	Corning	20	0	12
Span 5	51	G.652	Corning	25	0	15
Span 6	67	G.652	Corning	33	1	20
Span 7	62	G.652	Corning	31	0	19

L25 City H - City I	Length [km]	Type of fibre	Manufacturer and brand	Number of fusion splices	Number of mechanical connectors	Attenuation [dB]
Span 1	60	G.652	Corning	30	1	18

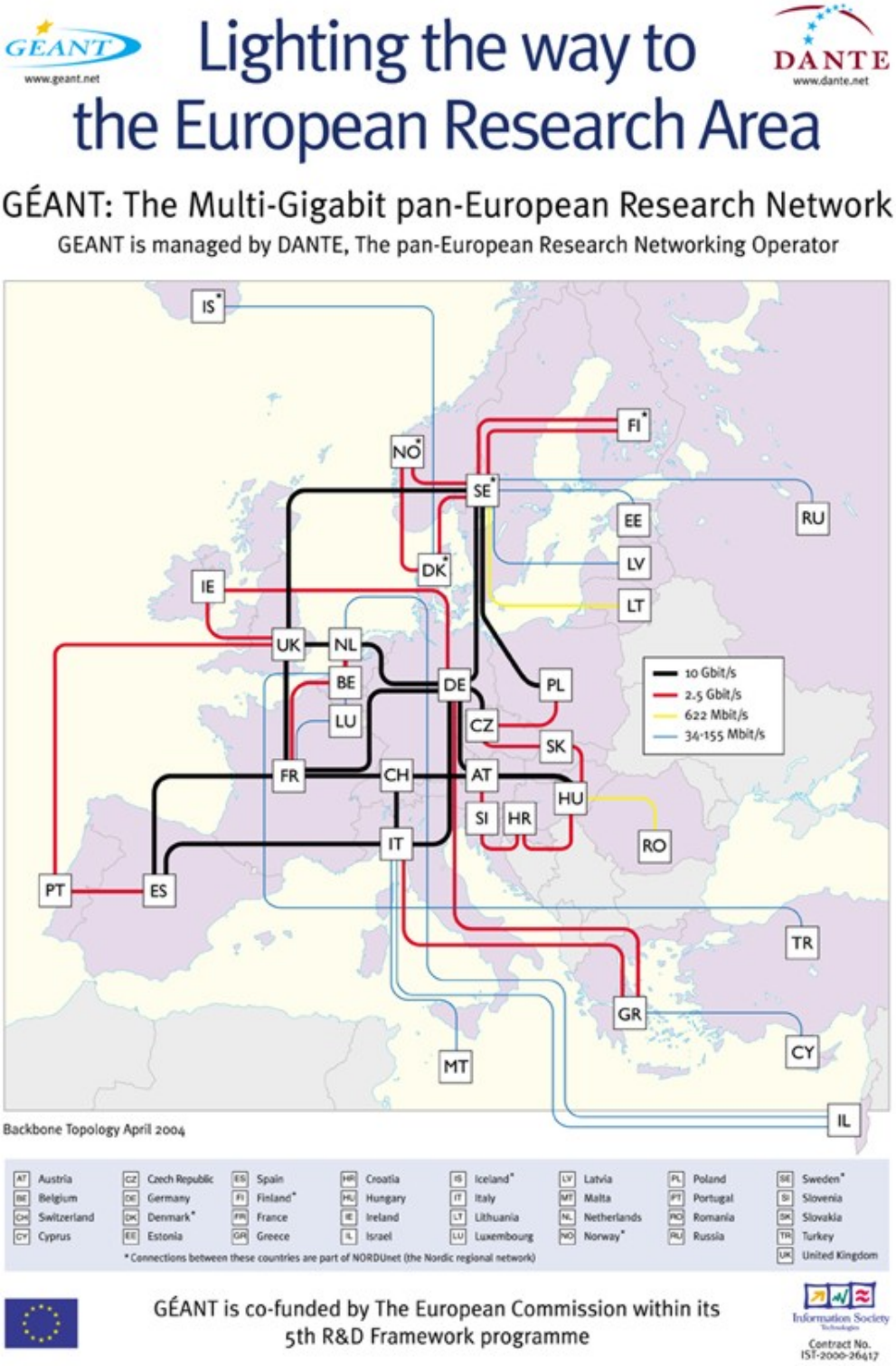
Notes:

- The data above is an anonymised form of the dark fibre technical details as supplied to DANTE during the currently ongoing connectivity tender;
- Span data such as the number of fusion splices in line and the attenuation have often been estimated by the suppliers;
- Other parameters such as optical return loss, chromatic dispersion and polarization mode dispersion were mostly estimated or expected bounds specified or reference was simply made to the relevant fibre manufacturer's data sheets. Typically optical return loss was quoted as being >30dB and PMD was quoted as being <0.1 ps/km^{½}. Standard values for chromatic dispersion can be assumed;
- The responses in the column labeled "number of mechanical connectors" in some cases appears to include the terminating couplers on the span (i.e. where 2 are specified) and in other cases appears not to include the terminating couplers (i.e. where 0 is specified).

Annex 2 – Possible GN2 PoP locations

Amsterdam	Budapest	Luxembourg	Riga
Ankara	Dublin	Madrid	Sofia
Athens	Frankfurt	Maribor	Stockholm
Barcelona	Geneva	Milan	Tallinn
Berlin	Hamburg	Msida	Tartu
Bologna	Karlsruhe	Nicosia	Tel Aviv
Bratislava	Kaunas	Paris	Vienna
Brno	Lisbon	Petach Tikva	Zagreb
Brussels	Ljubljana	Poznan	Zurich
Bucharest	London	Prague	

Annex 3 – Current GÉANT Network



10. Appendix 2 – Questionnaire

10.1. DF based NREN organisation

10.1.1. Background information

No.	Question	Example answer
1	Total number of personnel employed or engaged in NREN	Please give total number and numbers of managers, technicians, engineers and other staff
2	Types of institutions connected to NREN, and their total number	Institutes, universities, schools, other…
3	Number of PoPs and end-institutions connected to NREN by dark fibre	Please give the number at the moment, and planned number in one year and in two years, or the progress rate of the introduction of the DF in the network
4	Type of ownership of DF used by NREN	Owned, Leased, Both. Please specify approx. amount in km of each and specify if it is used in intercity or metro connections.
5	For rented or leased fibre, please specify the type and duration of the arrangement with DF provider (contract, IRU, number of years,…)	
6	Who is maintaining DF used by NREN?	Please specify: NREN, fibre owner, maintenance company, other, or if there are different cases on different DF spans, name all.
7	In case of existing maintenance contract with other company or fibre owner, please specify the main properties of the contract (sorts of outages covered, response time, etc)?	
8	What is the demarcation point (border of responsibility) between the company which maintains DF and NREN	
9	Number of unexpected or unannounced incidents (interruptions) on DF based lines in past three years	
10	Types of fibre used in network	(G652, G655, other, if possible the approx. percentage of each)
11	Multiplexing technologies used in NREN	No, DWDM, CWDM, other
12	Length of the longest DF span between two PoPs in your NREN	
13	Amplification used in NREN	No, Yes, if yes, then type of amplification
14	Existing dark fibre cross-border connections	No, Yes, if yes, please name all

10.1.2. Organisation of the NREN based on DF

	Question	Example answer
15	Number of specialists for fibre technologies in NREN	
16	Number of specialists for fibre technologies per PoP (engineers, technicians). Please describe briefly their role	

17	Do those specialists for DF technologies have some other duties or responsibilities in NREN (L2 L3 configuration or other)?	
18	Special courses attended by NRENs DF specialists	
19	Does your NREN plan to hire more specialists for DF based technologies?	
20	DF measurement equipment used in NREN (OTDR, power meters, other)	Please specify type and number of measurement equipment (vendor, type, model, modules etc)
21	Functionalities and types of measurements equipment your NREN can perform with that equipment.	Attenuation (up to which distance/signal power), chromatic dispersion, polarization mode dispersion, signal power, other
22	Does your NREN plan to purchase more DF measurement equipment (if yes, please specify type)?	
23	Is splicing equipment used in your NREN	Yes, No, if yes, which vendor, type, model, for which fibre types
24	Does your NREN plan to purchase more splicing equipment (if yes, please specify)?	
25	Is your NREN planning to plant fibres which will be NREN owned?	
26	Fibre and connector cleaning equipment used in NREN	Isopropyl alcohol, cotton swabs, soft tissues, pipe cleaner, compressed air, microscope, ultrasonic bath, warm water and liquid soap, premoistened cleaning wipes, polymer film, or other
27	Is there any other equipment that it uses for dark fibre network maintenance (special equipment for df planting, vehicles for solving remote incidents, etc.)	
28	Are there any improvements in the organisation of your network that you think that should be made?	
20	Any comments and remarks?	

10.2. DF topology in metro or intercity

	Question	**Example answer**
30	Please, if it is available, provide a Figure of the physical topology of dark fibre in the core of your NREN (intercity links). If possible specify PoPs and amplification/regeneration points.	Please paste it with the number of the question after these questionnaire tables
31	Please, if it is available, provide a Figure of the physical topology of dark fibre in one of your PoPs (the most typical one). Please just state if there are PoPs with other topologies and enumerate them with brief description (Full mesh, hub and spoke (star), expanded star, or something else).	Please paste it with the number of the question after these questionnaire tables

10.3. L2 and L3 organisation of the network

	Question	**Example answer**
32	Which L2 technologies does your NREN use on DF lines in core (intercity) network? (1GEthernet (802.1q or not), 10G Ethernet (802.1q or not), multiplexed 1G or 10G Ethernet, EoMPLS, RPR/DPT, serial, PoS, other, please	

	enumerate all). Also, if there is some pointer available (on presentation, paper, etc.) on this issue please provide it.	
33	Which L2 technologies does your NREN use on DF lines in metro (intracity) networks? (1GEthernet (802.1q or not), 10G Ethernet (802.1q or not), multiplexed 1G or 10G Ethernet, serial, PoS, other, please enumerate). Also, if there is some pointer available (on presentation, paper, etc.) on this issue please provide it.	
34	If your NREN has dark fibre cross-border connections (CBC), please give a brief description of the L2 and L3 organisation of it. If there are more CBCs, give one typical. If there are differences in the L2 and L3 organisation between them, please describe in details one, and give brief description of differences in others. Detailed description should have: brief description of the BGP connection with another NREN over DF, denote BGP peers and L2 and L3 organisation on all the segments between BGP peers with IP addresses and types of equipment and if possible parts of the configurations. Also, if there is some pointer available (presentation, paper, etc.) on this issue please provide it.	
35	Please describe L2 and L3 organisation of a typical connection between two nodes (PoPs) connected by dark fibre in your NREN. If there are differences in the L2 and L3 organisation between some PoPs, please describe in details one (that is used in majority of links), and give brief description of differences in others. Detailed description should have: types of pieces of equipment (switches, routers, amplifiers, etc) between PoPs, routing protocols, L2 encapsulation, L3 organisation (addressing), etc.	