RENAM-RoEduNet gateway upgrading approaches

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***Abstract* — the described approaches of communication gateway upgrading are devoted to creation of high performance, reliable and effective connection between national scientific – educational networks of Moldova and Romania. These approaches are focused on improving of all basic characteristics of regional and international connectivity channels like capacity, quality of services, multimedia streaming and GRID computing support, GEANT2 community integration, research networking promotion taking in account the ability to enlarge joint R&E collaboration and extension of regional fiber optics infrastructure in the East Europe.**

***Keywords* — backbone infrastructure, fiber optic technologies.**

I. Introduction

THE process of building of global networked information society opens large perspectives for integration of nation-wide research and education resources distributed over different countries as well as for creation of modern facilities for knowledge dissemination, distance learning and collaborative work e-infrastructures. Elaborating and adopting by Moldovan government of the Concept of National Information System for Science and Innovation Development that contains direct indication of necessity to develop networking connections between research and educational institutions of Moldova and Romania, together with Presidential SALT program of implementing ITC-supported education system for all schools from Moldova dictates the necessity of development modern internationally intergraded e-learning and e-science infrastructure platforms.

National Research and Educational Network of Moldova RENAM in accordance with the approved Accessible Use Policy provides connectivity and informational services for research institutions, universities, secondary schools, hospitals and other medical institutions, libraries and museums. Main external connectivity for RENAM network is organized through RoEduNet, a partner NREN of Romania via communication gateway that was created in 2003 due to financial support of NATO Scientific Committee grants [1]. The connection between national scientific – educational networks RoEduNet and RENAM provides regional and international connectivity channels for the whole research and educational community of Moldova. The importance of this gateway determines permanent needs of upgrading of its basic parameters like capacity, performance redundancy, quality of services, multimedia streaming support, GRID computing support, GEANT2 community integration, regional research networking promotion taking in account the ability to enlarge joint fiber optics infrastructure to the East, etc.

RENAM - RoEduNet channel capacity is permanently increasing and till now this connection was based on utilization of radio-relay communication facilities. To overpass limitations of this technology was elaborated and proposed new network infrastructure project that is devoted to creation of high performance, reliable and effective fiber optic backbone connection between national scientific – educational networks of Moldova and Romania [2].

II. Stages of the Gateway Connection Development

RENAM Association has built and permanently develops its own networking infrastructure that contains 12 communication nodes placed in two main cities – Chisinau and Balti. RENAM network provides connectivity to about 5000 scientists and professors, 1000 Ph.D. students and more than 80 000 university and colleges students. RENAM infrastructure provides services to the universities and R&E organizations placed in other localities of Moldova. RENAM network has multi-home Internet connectivity and is connected to two Moldovan Internet Service Provider's information exchange points, which are realized through RENAM external information exchange nodes.

Main external link from RENAM node in Chisinau to RoEduNet node in Iasi since 2003 was created using radio-relay facilities offered to RENAM by State Enterprise “Radiocomunicatii” Moldova and Romanian communication operator JS “S.N. Radiocomunicatii”. Initial capacity of this direct gateway was 8 Mbps and

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consequently it was upgraded up to 16 Mbps in September 2005 and to 32 Mbps in November 2006. After achieving this limit restrictions of the old radio-relay equipment RENAM was forced to announce a tender for selecting new communication operator that could offer modern radio-relay facilities that provide 155 Mbps and more of data transmission bandwidth. After consideration different offers local Company "StarNet" Ltd. was chosen as new operator for providing connection to RoEduNet for RENAM network. Since September 2007 new communication link of 155 Mbps capacity started operating in testing mode.

Simultaneously the necessity to shift toward new perspective networking technologies and services, implementation of modern educational systems and applications, new learning technologies deployment requires to increase the capacity of internal and external communication links, communication equipment possibilities and introducing new communication technologies having high degree of Quality of Service (QoS) parameters. These challenges suggest adoption of new solutions that can satisfy the rising community needs. Current RENAM communication infrastructure development program envisages the following priority actions:

1. Wide installation of "Dark Fiber" (DF) links for transferring principal arterial RENAM network connections to new technological basis. The central, mostly overloaded traffic exchange highways proposed to be realized by means of DF optic communication media and creation fiber segments that use multi Gbit Ethernet technology.
2. Implementation of xWDM communication technology in optical Chisinau MAN backbone taking in account the necessity to implement in near future 2,5-10 Gbps Ethernet connections.

To follow existing requirements and understanding of a vital necessity to construct much more productive fiber optic-based communication infrastructure, that will allow to join RENAM node from Chisinau with RoEduNet node in Iasi in order to vehicle scientific and educational content between neighbour communities and to ensure access to appropriate external resources a detail project of high performance, reliable and effective fiber optic gateway connection between Chisinau and Iasi creation was elaborated by RENAM and RoEduNet specialists in cooperation with partners from the University of Applied Sciences, Stralsund, Germany. The new link construction will allow to save previous investments, rising connection reliability and economical effectiveness. This explains by the fact that existing radio-relay connection will ensure required back-up facilities of the constructing gateway. This back-up channel will be cost-effective and will allow refusing from rent expensive solutions from other providers in Moldova and Romania.

Simultaneously the mentioned fiber gateway can be considered as a one of the basic optical links that will support forming common regional optical infrastructure for neighbour countries of East Europe. Moldovan NREN was participated of the regional initiative that had its aim to investigate mostly suitable approaches for realization of regional optical infrastructure that would be integrated to GEANT. This initiative was formed as "Distributed Optical Gateway from Eastern Europe to GÉANT (Porta Optica Study)" project and supported by European Commission (RI026617). The project consortia experts estimate Chisinau - Iasi direct fiber connection implementation as one of the most cost effective and easy for practical realization solution [3].

Strategic purposes of the gateway upgrading can be formulated as follows:

- Empowering of regional connectivity between National R&E networks of neighbor Eastern Europe countries.
- Creating, improving and widening facilities for research cooperation support and scientific-educational content development in Romanian language.
- Establishing direct fiber optic link between RENAM and RoEduNet, thus creating conditions for broadband joint investigations, teaching activity promotion, online scientific collaborative work assistance and video-conferencing, implementation GRID technologies and getting access to GRID computing etc.
- Integration Moldovan academic community with European informational space by providing more elective and reliable access to the resources of Trans-European research and educational network. Rendering an effective support of regional and international academic cooperation.
- Further increasing the overall reliability, capacity and functioning effectiveness of the joint networking infrastructure of two neighbour NRENs.

III. Fiber Optics Link Implementation Details

Construction of communication fiber optic link between RENAM node from Chisinau and RoEduNet node from Iasi presumes to implement a set of project work-packages. Elaborated project is focusing on the various aspects of RENAM - RoEduNet internetwork connection implementation. Initial position is that construction of communication line between the nearest networking node of RoEduNet in the Iasi "Al. I. Cuza" University and the corresponding node of the RENAM network in Chisinau appears to be the most suitable and well-grounded solution in order to create the new optical gateway for ensuring flexible interaction of two networks. The direct geographical distance between these two nodes is about 125-130 km (Fig. 1). Another postulate is that implementing fiber link will serve as the main data transfer facility that will be supplement by the existing

radio-relay connection for back-up purposes.

At the project elaboration stage two important documents were negotiated and signed by RoEduNet and RENAM authorities - new version of Agreement, which specifies principles of construction and utilization of the internetwork gateway connection and joint application was shaped, signed and submitted to DANTE (Association of European NRENs) - GEANT managing organization.

To determine the most appropriate solution of RoEduNet-RENAM fiber connection realization some available alternative variants were examined, compared and selected. Fist of all the choice of partner that can share link realization costs and more effective perform cable construction works was finalized. After analyzing offers from "Moldtelecom" S.A. Company, "Norma" Ltd., Moldavian Railways Department and State Enterprise "Center of Special Telecommunications" (CTS) the last listed entity was selected as strategic partner for DF link realization and the project co-funding. RENAM used CTS assistance in the process of fiber optics backbone implementation in Chisinau. Accumulated experience estimation had shown a perceptiveness of this collaboration prolongation.

Selection of the prospect technology is based on initial proposition that this technology has to be economically effective, scalable and flexible and has a longtime life circle. Another feature of the selected technical approach has to deal with compatibility aspects realization – it has to be simply and fully operationally integrated in the existing fiber infrastructure. Taking in account real bandwidth requirements installation of multiple Gbit Ethernet devices was chosen. The Gbit Ethernet scalability and intensive usage of cable physical resources can be obtained now by implementation of various Lambda - waves splitting optical technologies.

Practical implementation of optical wave's length variation technology at present can be realized by communication equipment of several suppliers. During technical solutions and appropriate equipment choice negotiations three offers were analyzed.

The widely used, adaptive and well tested in many R&E networks are technologies and technical solutions that are proposed by the Cisco Systems Inc. For utilization of 4-8 separate λ-s on 1 Gbit data transfer rate many experts recommend to use perspective Cisco Coarse Wavelength-Division Multiplexing (CWDM) technique with Gigabit Interface Converter (GBIC)/Small Form-Factor Pluggable (SFP) modules. This technological solution can provide further scalability, has full compatibility with the existing Gbit Ethernet switching equipment, but it is not very effective from the cost point of view.

Another technical solution was proposed by "Meriton Network" Company. The essence of the proposal is that 2 x 1Gbit flows are organized by multiplexing 2 x 1Gig Ethernet signals into a 2.5G Payload and then sending the resulting signal over WDM. For CWDM use, the distance is not very long due to dispersion issues and can be reachable without intermediate amplifying. 2 x 1Gbit flows can be implemented by utilization of DWDM with EXLR optics. In this case it can be obtained the longest reach and the dispersion tolerance of the SFP is high so that the penalty is low, therefore even for the target distance this solution doesn't require additional amplification. The proposed solutions assume that fibre loss has to be 0.23 dB/km or less at 1550 nm wave length.

"Meriton Network" 10 Gbps solution on a WDM link allows reaching the max distance before dispersion becomes a factor on the signal attenuation of approximately 80 Km. Therefore the 10G solution will either require an amplifier and dispersion compensation modules at each end of the network or a regeneration node in the middle of the 2 sites. It has to be mentioned that "Meriton Network" solutions are more cost attractive in comparison with Cisco ones.

The third offer was elaborated and proposed by ADVA AG Optical Networking Company. The sense of this offer is that various data flows can be realized by using basic communication equipment with separate modules. This approach allows realizing the necessary scalability and flexibility of proposed solution. Three types of the equipment configuration provide three variants of data flows processing: 1 x 1 Gbit Ethernet, SX, 850 nm; 2 x 1 Gbit Ethernet, SX, 850 nm; 1 x 10 Gbit Ethernet, 850 nm or 1310 nm. Up to 8 lambdas can be available for mixed services providing without intermediary amplification. Full set of communication modules (CORE Cards, ACCESS Cards, Transponders, Muxponders, SFPs and XFPs) are proposed and supported by the Company. Cost analysis shows that this solution is very effective and is the cheapest taking in consideration 1 Gbit Ethernet link creation cost.

As a backbone cable was chosen the single mode optical fiber cable. It is supposed to be used a 24 fibers cable and xWDM multiplexing transport technology. The selected cable will corresponds to the ITU-T G.652 standard that provides zero dispersion at the wave length of 1312 nm and the coefficient of attenuation of 0,33 dB/km at the wave length of 1310 nm.

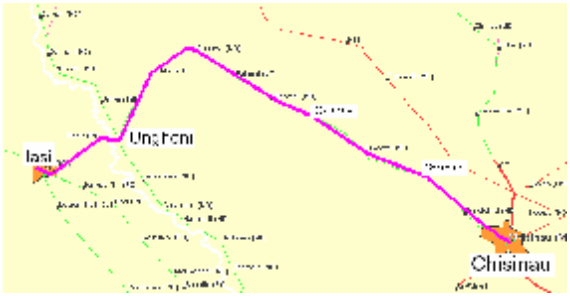

Figure 1. The topology of new fiber optical gateway channel

The proposed solutions supplement and develop achieved results in fiber optics infrastructures

implementation in RENAM Chisinau backbone, RoEduNet Iasi node metropolitan network and in the whole national RoEduNet backbone.

The link construction conceptual and technical decisions, prepared and analyzed herein suggestions are based on the possibility for further stepwise scaling up to 10 gigabit - networking and development, renewing communication technology and ensure interaction with other neighbor research and educational networks. The proposed concept can be considered as significant contribution in resolving of more complicated task that oriented on regional research networking promotion – bridges implementation to connect East and South-East countries with European Union via Central Europe states. The considered ideology presumes the next extension of the proposed initiative, which will be devoted to providing reliable and reserved connectivity of regional R&E community to the basic GEANT infrastructure, implementation of EU adopted and in GEANT and GEANT2 projects realized fundamental principles of research networking in the Eastern and South-Eastern European countries.

IV. Conclusion

The proposed variants of communication gateway upgrading and realization based on new communication technologies described above will permit to establish new significantly improved conditions of regional collaboration and will contribute to science and higher education infrastructures development, as well as raise the overall performance, accessibility, transparency, reliability and readiness of RoEduNet and RENAM networks connection.

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