RoEduNet

RoEduNet dark fiber topology, technologies used and the experience of using the network

Octavian Rusu

Agenda

- About RoEduNet – Romanian NREN
- Major milestones in the evolution towards DWDM
  - Major steps in the evolution of RoEduNet
  - Evolution of the transmission capacities
- RoEduNet2 – Romanian DWDM network for education and research
  - The project of the network
  - DF footprint
  - Technologies
  - Lambda services
- Future plans

RoEduNet – Romanian NREN (1)

- RoEduNet – **Ro**manian **Edu**cation **Net**work, the name of the "*private*" network for the education and research in Romania, the short name of the institution that operates the network, introduced in 1996
- The Agency for Administration of the National Education and Research Network – governmental institution that operates the network and have two primary objectives (according government decision):
  - act as a high-capacity information and communication infrastructure based on state-of the-art technologies to support the work of researchers and national education by using:
    - RoEduNet2 network based on DWDM technologies
    - A few hundreds of layer 2 and layer 3 networking equipments installed all over t`e country
  - facilitate research in their own right by providing a platform to implement new services and advanced networking technologies through the establishment of experimental test-beds, participating in research projects:
    - GEANT (GN1, GN2, GN3), SEERA, SEEREN (1 and 2), SEEFire
    - NATO Science projects (two projects for MANs and another two projects to provide connectivity to Republic of Moldova)
    - National projects funded through structural funds (SIS-NET – implementing new services into RoEduNet, eEduNET – videoconference for high schools)

RoEduNet – Romanian NREN (2)

- The Institution:
  - First official recognized in 1996 by the Ministry of Education and then in 1998 by the government (official document: governmental decision 515/1998), reorganized in 2008 to accommodate the changes in the network structure.
  - Agency ARNIEC/RoEduNet - governmental institution subordinated to the Ministry of Education and Research.
  - Number of employers: was 30 for the entire country – half in Bucharest and half in the country (reduced to 20 from September 1st 2010).
  - Financed from the state budget through Ministry of Education and research and through own research activities/projects.

- The network:
  - There layer network:
    - ***National NOC*** (Bucharest) provides international (GEANT and) and national backbone connectivity
    - ***Regional NOCs*** in Bucharest, Iasi, Cluj-Napoca, Timisoara, Galati, Tg. Mures and Craiova to provide connectivity for the regions to the national backbone
    - ***Local PoPs*** located in all counties capitals connected to the regional NOCs and offering services connectivity to the research and education in their area – remotely operated network nodes
  - Most important assets:
    - Own national optical based network using DWDM with ROADM and CWDM – 55 sites and more than 4000 km of fiber
    - Layer 2 and layer 3 equipments in all NOCs and PoPs (two Cisco CRS and more than 60 Cisoc 76xx routers)
    - The (reduced) human network!!!

RoEduNet – Major Milestones

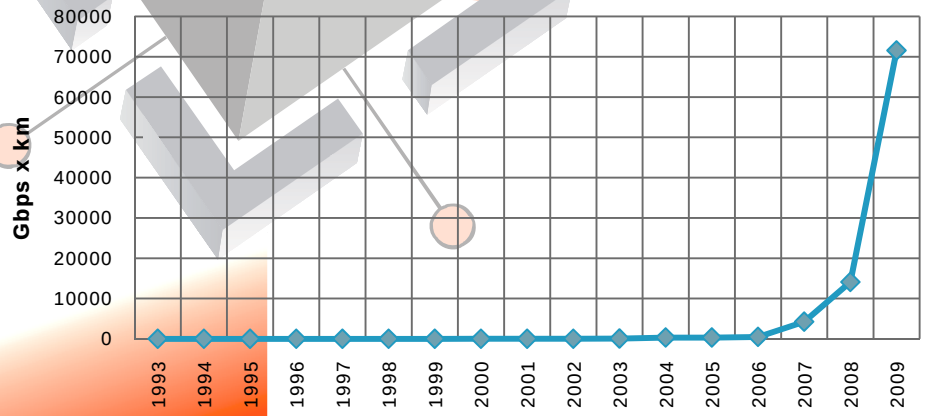
- **1990 – 1998** :: bottom-up approach
  - 1990 – first Internet connection (dial-up) in Romania – joint research project to introduce e-mail service by Politehnica University in Bucharest and *Technische Universitat Darmstadt* Germany
  - 1992 – first dedicated Internet connection - joint research project between Politehnica University Bucharest and *Deutsches Forschungsnetz* (DFN - Verein)
  - 1993 – first national network connections – Universities in Cluj-Napoca and Iasi installed dedicated connections to the Politehnica University in Bucharest
  - 1996 – network is recognized by the ministry of education (the evolution is still based on the contributions from Universities)
    - International connectivity provided through satellite links, no real national network
  - 1998 – RoEduNet was officially established and the first budget approved
    - National connectivity goes from analogue leased lines to digital leased lines
    - Optic based MANs was installed in Cluj-Napoca and Iasi
- **1998 – present** :: top-down approach
  - 2001 – RoEduNet joined GEANT as partner
  - 2006 – RoEduNet2 project approved – get access to one pair of the optic fiber from Telecomunicatii CFR – state owned company
  - 2007 – new modern data centers in Bucharest: National NOC and Bucharest NOC
  - 2007 – more than 40 new routers installed in the network (including one Cisco CRS in the national NOC), layer 3 of the network completely upgraded
  - 2008 August – GEANT POP installed in Bucharest: 10 Gbps to GEANT, 2.5 Gbps committed DWS
  - 2008 December – RoEduNet2 network in production
  - 2010 – First CBF from Romania installed: Iasi – Chisinau DWDM segment operational

RoEduNet :: Communication Capacities Evolution

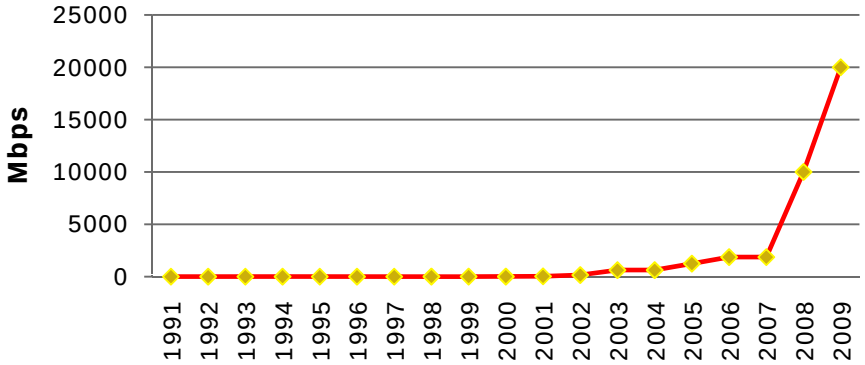
- The evolution of network was driven, in most important decisions, by the experience gained from other NRENs in the community of the GEANT project – *lessons learned*.

- Major inputs for the important evolution of the network in the period 2007-2010 were:
  - The results of the SEEFire project - South-East Europe Fibre Infrastructure for Research and Education – *The Varna Statement*
  - The results of the SERENATE project - Study into the evolution of European Research and Education Networking – important input for the feasibility study of RoEduNet2
  - The example of other NRENs in Europe
  - The opportunity provided by the fact that Romanian government own a fiber communication infrastructure dedicated for the railway company

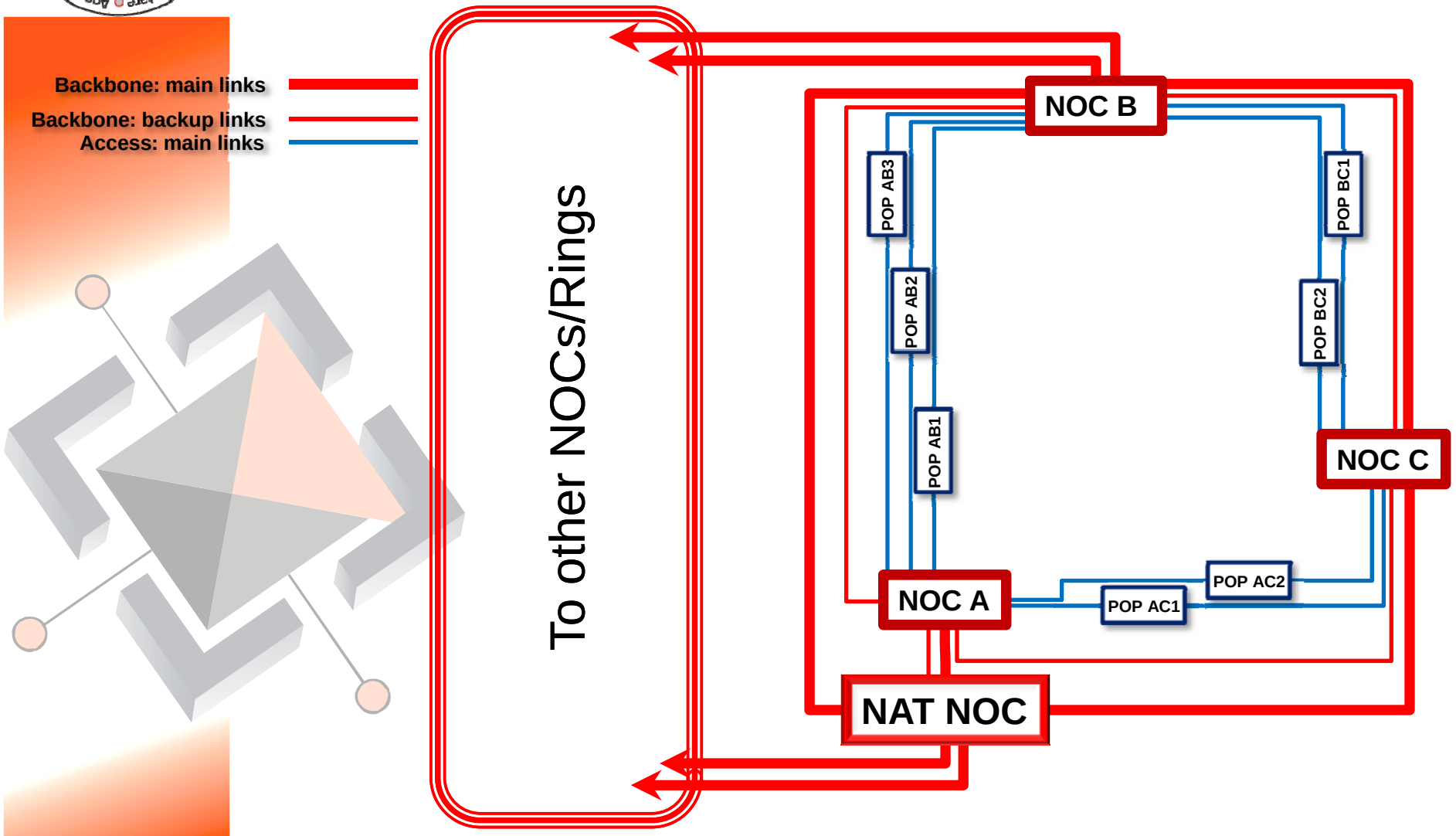
Evolution of National Network



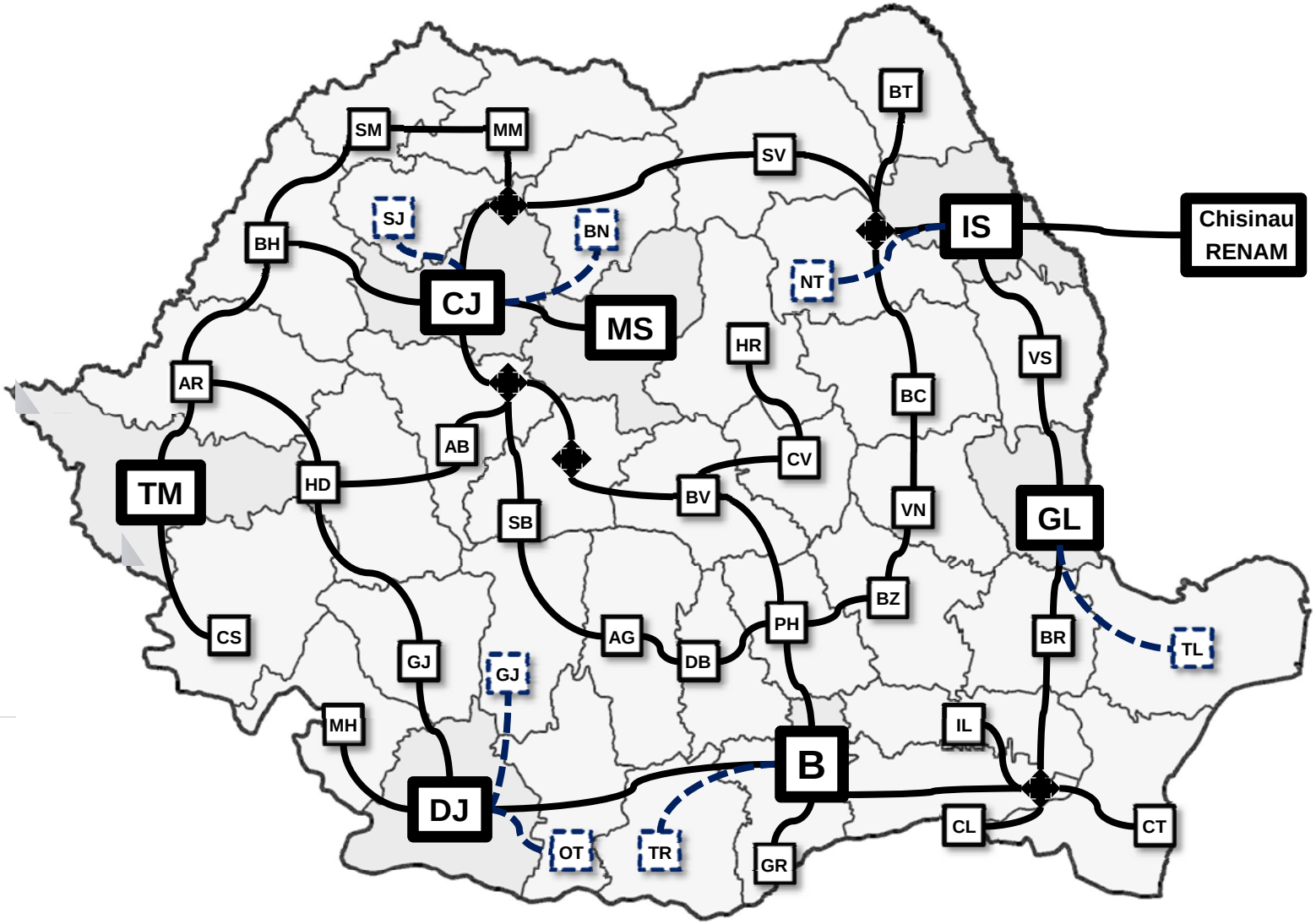
Evolution of International Connectivity



RoEduNet2 – Considerations about Topology

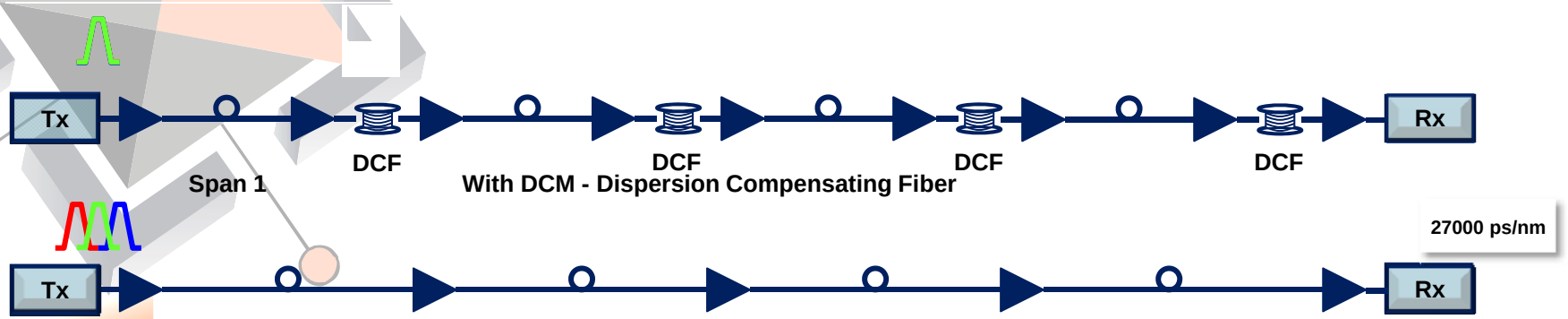


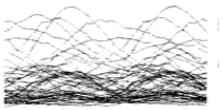
RoEduNet2 – National Topology and CBF to Moldova



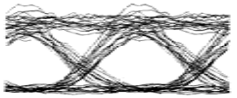
RoEduNet2 - Most Important Features

- ROADM – Reconfigurable Optical Add and Drop Multiplexers with 5 directions for all sites with three or more fibers directions
- No RAMAN amplifiers: good OSNR and good safety for operators
- No regeneration for any lambda (the longest lambda is about 1000 km, 1600 km supported by equipments)
- Separate optical plane (CPL – Common Photonic Layer) and service plane (OME 6500 and OM 5100/5200)
- No DCMs in the network due to the fact that eDCO is used and compensation of the dispersion is done by the transponders for each lambda (some disadvantages so far)





Eye Diagram: Pre distorted

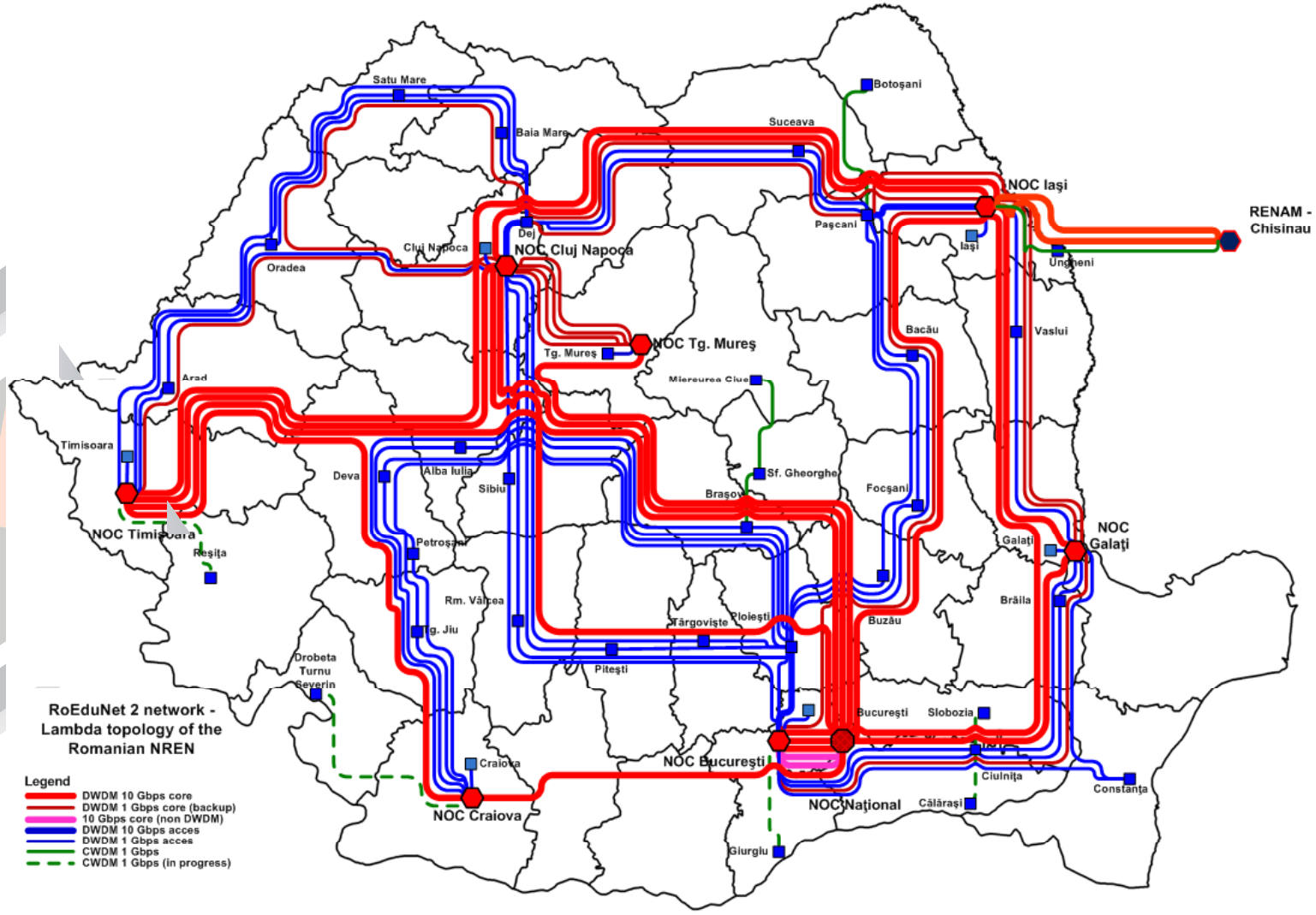


Eye Diagram: Focalized

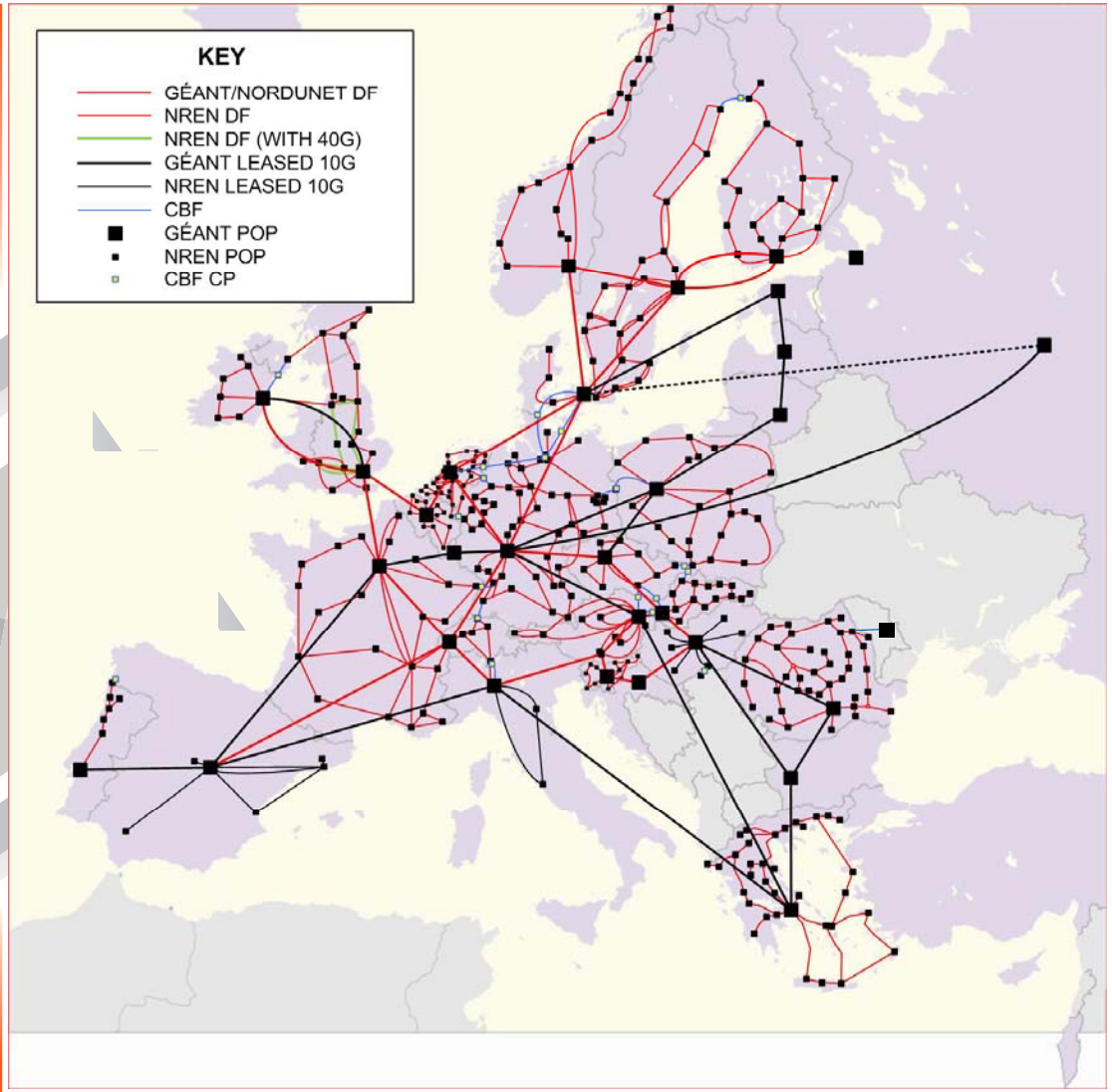
RoEduNet2 – Numbers

- Dark Fiber
  - 4238.8 km DWDM equipped
  - About 600 km equipped with CWDM
  - Number of fiber segments: 46
- Sites: 56 :: ROADM: 18, ADM: 23, Amplifiers: 15 (no RAMAN)
  - In the premises of Telecomunicatii CFR: 48
  - RoEduNet: 8 – with redundant connections to the sites of Telecomunicatii CFR in the same city (two local loops with automatic switch-over)
- Lambdas (all of 10 Gbps): **79**
  - 10 G = 19 + 16 + 3(SDH)=**38**, 10 x 1G = **41**
- RoEduNet2 metric: **71557 Gbps*km**
  - After (*according TERENA Compendium 2009*): Germany - DFN: 394000, Sweden - SUNET: 290000, Netherlands - SURFnet: 265500, Poland - PIONIER: 84000

RoEduNet2 Services – Installed Circuits including RENAM



GEANT Network from GN2 to GN3



10 Gbps August 2004

10 Gbps June 2009 RO-MD first CBF

Maps by Michael Enrico - Network Engineering & Planning Team DANTE

Future plans

- Within GN3 projects
  - Test and install 100 Gbps lambda in RoEduNet2 network
  - Test foreign lambda in RoEduNet2 network: discussions with Cisco to test 40 Gbps lambda through CPL of Nortel
- Extend RoEduNet2 network
  - to integrate the most important traffic consumer in Romania: the physics research campus near Bucharest
  - Integrate Iasi – Chisinau DWDM link into RoEduNet2 network to be able to provide transparent lambda for RENAM to the GEANT POP in Bucharest
- Install new services – in progress
  - Most important GEANT services will be available in an integrated interface: eduroam, CSIRT, educonf, digital certificates, circuits on demand and later lambdas on demand
  - Equipment collocation and resource allocation for connected institutions

Thank you!

- Questions