

European Research and Academic Networking – at the Edge of Technology

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The success of the common pan-European activity in the area of R&E (Research and Education) networking can not be considered only on purely technical terms, but must be placed in the common political context of the expanding European Union and a long tradition of joint research activities within the EU and beyond.

The European Commission and the 32 participating national networks jointly finance the common European networking infrastructure. EC is contributing 93 Million Euros for the 4-year project. DANTE is the coordinating partner of the Project. A sustainable financial and operational model has been developed within the GÉANT 2 Consortium.

To be able to accept a large numbers of broadband connections from the rest of the World, and to secure efficient communications within Europe, the Consortium had to develop a World-class infrastructure composed of broadband links, and high performance IP routers. The international connectivity bottleneck that was present in the previous generations of the pan-European backbone has completely disappeared already in the earlier GÉANT network. The radically decreasing communication costs allowed over - provisioning of the transmission capacity, resulting in unprecedented reliable backbone operations.

The needs of the advanced projects, like DEISA, for connection of European supercomputing centres, JIVE for connecting radio astronomer sites to the correlator facility in the Netherlands, or connection of the participating centres to the CERN computing centre, all at bandwidths of at least 1 Gbps cannot be economically answered by the IP based methods (MPLS, VPN...). Thus, a change in the architecture of the backbone was logical.

The GÉANT 2 network is employing two, complementary, communication technologies:

- An underlying switched network employing multiple 10 Gbps connections between most of the nodes in the core area of the network, which reaches from Ireland to the Czech Republic on the West-East line, and from Nordic area to Greece and Spain in the North-South direction. SDH/Ethernet switches are placed in each node. The NRENs can connect with various interfaces: 10 Gbps and 2.5 Gbps SDH, 10 GE and GE are the most common interfaces. On many routes 10 year IRUs for dark fibres were purchased. Carrier class transmission equipment to enable the dark fibres and switching equipment was purchased and deployed. This arrangement will allow very cost effective addition of new wavelengths (λ s) on dark fibre routes, as needed. This layer of the backbone will serve the most advanced users, demanding dedicated very high bandwidth connectivity. A good example is the fast growing GRID community.
- In addition, GÉANT 2 will be maintaining an IP network, similar in topology to the previous GÉANT network, with upgraded bandwidth on numerous links. The underlying L2 switched network is providing another level of resilience to the packet network.

Such new, high performance, complex network requires new management tools, particularly in view of the paradigm: “End-to-end Quality of Service.” The technical tools, which are under development, are:

- Bandwidth on Demand (BoD): Automated system for assigning bandwidth to the authorised users. BoD will be applied to the IP network (using MPLS based method), as well for the e2e switched infrastructure. The System design is completed, implementation is starting now, in the second year of the GÉANT 2 projects.
- Monitoring of the packet network and of the e2e links. One of the Joint Research Activities is devoted to the development of the multi-domain monitoring system. . The architecture is designed to allow autonomous network operators to create measurement tool daemons open to the world but governed by locally-defined policies and limits, allow discovery of measurement tool proxies along the end-to-end path, and facilitate, but not require, the use of federated trust models. The design is “services-based,” allowing multiple autonomous systems performing authentication, discovery, data creation, data transformation, and data storage roles to work together in a modular fashion. The design is largely decentralized, maximizing scalability and minimizing administrative overhead. To monitor the metrics of interest, some existing tools will be modified to suit the needs of the activity. Some examples of initially identified metrics include: link usage, one-way delay, packet loss, delay variation and achieved data rates. For the monitoring of the e2e links on Layer 2, the information will be gathered from Network Monitoring Systems, provided by the vendors of the infrastructure equipment, in the analogue way as for the IP based data, taking into the account different policies of the NRENs involved in the monitoring activity.
- Monitoring tools will be utilised by the PERT group whose task is to react in the instances of performance problems.
- For the supervision of the e2e links, crossing different domains, from the campus network of the end-user, through one NREN, GÉANT 2 core network, second NREN and terminating in the second end-user local network, an e2e Network Operations Centre will be established.

Past track record of GÉANT consortium guaranties comparable results for the future R&E networking in Europe and continuous influence on the global developments.

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