GÉANT3 WHITE PAPER

GN3 Proposal Review Board
July 15, 2008

This white paper summarizes the GN3 vision and strategic objectives as inferred from:

1. The *Green Paper* (GN2-08-066) issued on February 2008 by the *Committee on High Level Technical Strategy for GN3* (ToRs in Appendix 2).
2. Written *NREN feedback* to the Green Paper.
3. Deliberations within the *GN3 Proposal Review Board* (ToRs in Appendix 3), the *GN3 Membership Committee*, the *NREN Policy Committee* and the *GN2 Executive Committee.*
4. The GN2 *EARNEST* Foresight Study (GN2-08-142).
5. Related presentations and discussions at the *TNC'2008* (Bruges, May 2008) and the *6th GN2 Workshop* (Berlin, June 2008).
6. Strategic planning exercises undertaken by NRENs in Europe and globally, e.g. the *Strategic Plan for the Internet2 Community (2008-2013)* drafts.

The *Green Paper* was a *Consultation* instrument to incorporate NREN experience, vision and expectations for GÉANT3 within the GN3 Proposal. Responses confirmed adherence to the principle of NREN *subsidiarity*, thus emphasizing coordination of NREN technical advances at a Pan-European level. GÉANT, individual NREN & Campus infrastructures and services are intimately involved in a federated ecosystem that supports multi-domain end-to-end profiles of Research & Education (R&E) *e-Infrastructures*.

The current *White Paper* is structured in three parts:

Part I: **Vision**
Part II: **Guiding Principles**
Part III: **Rationale for the GN3 Structure**

Three Appendices conclude this Paper: **Appendix I** is a Glossary of Definitions and Abbreviations, **Appendix II** reproduces the Terms of Reference (ToR) of the Technical Strategy Committee and **Appendix III** the ToRs of the GN3 Proposal Review Board.

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PART I

Vision

Mission Statement: *GÉANT3 creates an innovative multi-domain hybrid networking infrastructure enabling R&E end-users through their organizations with flexible and scalable production quality services via constituent NRENs.*

GÉANT's accomplishment has been its ability to provide quality services to a vast, demanding and diverse user base. Via its 34+ constituent NRENs and 4000 campus networks it reaches-out to more than 40,000,000 potential end-users, thus creating the world's largest and most advanced R&E networking ecosystem. Such an environment can be managed only with the current multi-domain hierarchy: Campus, NREN and Pan-European interconnect. GÉANT3 must enable scalable expansion of its end-user base, offering diverse robust services within a confederate architectural model.

NRENs and GÉANT2 developed advanced hybrid switching infrastructures, able to reach-out advanced R&E users and support e-Science initiatives. After the roll-out of hybrid facilities, deployment of high performance *Virtual/Optical Private Networks* (VPN/OPN) manifested itself quite early, acting as a catalyst for development of related end-to-end services. It is imperative that the GÉANT3 community further develops robust multi-domain services in order to fulfil the requirements of the fast growing high-end R&E users.

The success of GÉANT2 was also due to the foresight of the NREN community, as spelled out in the *SERENATE* Reports and implemented in deploying a hybrid dark fibre based inter-network. This was a paradigm shift that exceeded predictions and placed GÉANT2 on the top of similar advanced initiatives worldwide. The emphasis is shifted now on consolidating the next generation GÉANT3 into a *robust and stable operational multi-domain hybrid network,* while at the same time contributing to innovative advances towards the *network of the future.*

Concerning core optical network technologies, there are indications that, within the life time of GN3, advances will be evolutionary rather than revolutionary. However, on top of advanced multi-domain substrates, we are witnessing the emergence of a multitude of user-driven virtual networks and this trend may be considered as a new *paradigm shift*. GÉANT3 should evolve as a *network factory* with the network itself being an entity capable to create/host complex objects made of circuits and nodes, enabling community oriented services. Summarizing, there will be a constant need to evaluate the significance of advanced technology without compromising the production quality of the GÉANT3 service portfolio.

The network infrastructures are becoming increasingly important with the deployment of services that deliver advanced capabilities to the end users through the network. It is expected that the *High Performance Computing* community, including growing *Grid* initiatives and fertilized by the emerging *Cloud Computing* concept will continue to exploit the opportunities that access to high speed networks brings. Architecturally, the general adoption of *Service Oriented Architectures* (SOA) will

allow the integration of services from many different providers creating a vibrant and competitive set of offerings built on top of the network.

The NREN - GÉANT community, working together with peer non-European R&E initiatives, will be vital in realizing the opportunities that the service oriented evolution will bring. In particular, deploying network services as an integral part of the network infrastructure, meeting management challenges for federated networked applications and influencing standards for reliable and efficient networking services, are all areas where GN3 can provide innovative leadership. We are entering an era now, where more than ever before, *the network **IS** the computer.*

PART II

Guiding Principles

In this Part, categories of principles are listed that contributed to the success of Pan-European R&E networking (NRENs & GÉANT) and will guide the next generation effort: the GN3 Consortium and GÉANT3.

1.   COORDINATED END-USER SERVICES

The GÉANT family promotes end-user Authentication and Authorization services by coordinating NREN federations serving roaming R&E users and managing ID provisioning across its service area. Similarly, in distributed computing (e.g. Grids) Single-Sign-On (SSO) is practised to authenticate a user for seamless access to various resources and services across domains (NRENs, campuses and autonomous Computing – Storage facilities). The GN3 Consortium will be engaged in related development efforts, promote deployment of confederated services and investigate options of integrating network control plane functionality within distributed computing *middleware*.

Roaming R&E users enjoy authenticated access while visiting a hosting *Intranet* based on their home ID credentials and the trust established amongst *ID Providers*. This enables visitors to access resources (e.g. wireless LANs) via the *eduroam* confederation, a *TERENA* - GN2 success story that is greatly spreading its reach and plans enhancement of its functionality.

Trust federations enable seamless authentication to authorized services e.g. visitors accessing web-based digital library portals using a *Shibboleth* based architecture developed by the *Internet2* community. Further developments of multi-domain services will draw on the GÉANT2 *eduGAIN* access control mechanisms to authenticate collaborating service operators and manage their authorization profiles.

In view of the role of GEANT - NRENs as the networking substrate supporting distributed storage and computing (distributed Data Centres, Grids and Super-Computing) it is of paramount importance to guarantee secure access for e-Science users. GN3 will investigate consolidation of SSO authentication services and evaluate integration of control plane functionality within *distributed computing middleware.* This will lead to transparent and seamless use of *e-Infrastructures*, towards integrated *virtualized sharing* of resources and services.

2.   HYBRID OPTICAL BACKBONE PLANNING & OPERATIONS

GÉANT3 will keep deploying the most advanced hybrid optical technologies available and adopt cost effective backbone architectures. Sustainable business models will be investigated, such as long-term international dark fibre leasing. Network Operations will maintain production quality connectivity and robust multi-domain services by following and perfecting *In-Service-Support* (ISS) best practices.

It is expected that transmission technologies, already enabling DWDM at 40 Gigabits/sec per wavelength, will advance to 100 Gigabits/sec per wavelength within the life time of the GN3 project. The Consortium will monitor these advances and adopt them as they become stable and cost-effective, both in CAPEX and OPEX. Long-term dark fibre leasing, e.g. via 15 years *IRU* arrangements could be investigated taking into account economically sound opt-out measures if needed.

Many Consortium members continuously evaluate, test and deploy cutting-edge technologies at the Data, Control and Management planes; GN3 will act as the concerted technology pusher of European NRENs. Depending on evolving costs and product maturity, topology planning may opt for extensive use of *Layer 1 ROADM's* and *Layer 2 Carrier Ethernet* switching, with *Layer 3* IP functionality provided towards the edges, e.g. within shared logical routers in selected backbone *Points of Presence - PoPs*.

The community feels that the GN3 emphasis will be on *resilient hybrid connectivity* and *robust service offerings*, managed by NREN NOCs and the GÉANT3 NOC working together in a federated structure inferred from current good practices. A *Service Desk* will complement NOC functionality with new service offerings and *In-Service-Support* (ISS) based on formal procedures.

3.   MULTI-DOMAIN NATURE

R&E networking is by nature multi-domain, thus services must be established across confederate (loosely coupled) administrative domains: Campuses, NRENs and International interconnections. The latter include GÉANT3 backbone links, Cross-Border-Fibres (CBFs) and connections with global peers. Expedited, eventually automated multi-domain management is an area where our community will continue innovating, triggered by pressing end-user requirements and profiting from the web of trust amongst partner NRENs and their global peers.

Inter-domain operations in IP based networks are traditionally based on BGP signalling. This control-plane protocol suite was a key factor for the unprecedented success of the Internet as we know it up to now. However, the need to manage robust multi-domain paths, VPNs and OPNs in multi-technology hybrid networks requires control-plane techniques to exchange and process information, beyond simple IP reachability and local path-finding indications.

A measure of success for the GN3 Consortium will be the ability of NRENs and GÉANT to collectively work together in developing and offering multi-domain management services within the diverse technological environment they co-exist. For multi-domain operations & services to succeed, GN3 should (1) encourage the take up of a *common network information exporting schema* among NRENs and (2) invest in efforts to deploy *enhanced control plane protocols* and *management plane techniques across domains*.

The web of trust established in the global NREN community allows for non-competitive joint operations; however security and confidentiality concerns of

participating domains must be respected. This coupled with vendor and technology diversity amongst domains (GÉANT, NRENs, end-user campuses, global peers), points towards *workflows* based on limited access to domain internals. NRENs, via GN3 can be key value-adding players on developing, testing and deploying multi-domain control and management services, relaying their experience to standardisation bodies (e.g. the *IETF*).

Multi-domain requirements stemming from e-Science use-cases prompt development and adoption of manual, semi-manual and automated procedures for monitoring, provisioning, security reporting and coordinated ticketing workflows. In advancing this effort, European NRENs and GÉANT established a working relationship with global peers, manifested in (1) international *circuit stitching* as is currently embodied in achievements such as the GÉANT2 *E2ECU* for the LHC OPN, the integration of NREN Cross-Border-Fibres - CBFs, the establishment of GÉANT global circuits and the use of *GLIF* Open Lightpath Exchanges - *GOLEs*, (2) developing distributed monitoring architectures such as *perfSONAR* that was jointly developed by GÉANT and the US-based *Internet2 & ESnet*, (3) testing automated Trans-Continental provisioning, e.g. by coordinating the GÉANT2-based *AutoBAHN* with NREN initiatives, vendor solutions and the US Internet2 *Dynamic Circuit Network (DCN)* tools.

As necessary prerequisites to multi-domain operations, the GN3 community will (1) tailor federated *Authentication & Authorisation Infrastructures* (AAI) for NREN & GÉANT NOC access such as *eduGAIN* federations, (2) further develop *I-SHARe* for multi-domain data definition, (3) contribute to enriching the global inter-domain control protocol suite such the *DICE IDC* that is being jointly developed by *GÉANT, Internet2 & ESnet*, (4) promote cross-domain security incident reporting, (5) coordinate intrusion (IDS) and anomaly detection, (6) establish distributed trouble-ticketing workflow services and coordinate NREN *Performance Emergency Response Teams* (*PERTs*).

4. R&E NETWORKING CATALYST

> The three level hierarchy (Campus, NREN, GÉANT) empowers users with ubiquitous, cost-effective and secure access to vast digital resources distributed around the Globe. It enables intensive international collaborations amongst dynamic culturally diverse R&E communities towards a *Digital Global Village*. This vibrant human network provides the necessary resources for deploying services and performing innovative R&D on networking and related services.

The GN3 Consortium reaches-out to more than 40,000,000 end-users via its NREN members, mostly concentrated in campuses that enjoy advanced networking services in a scalable federated fashion. Via their Campuses, NRENs, GÉANT and global connections these users enjoy affordable and secure access to digital libraries, digital repositories, Grids and Supercomputing centres, distributed around the Globe. Virtual international collaborations amongst educators, scientists, humanities researchers, enable affordable networked platforms for e-Science, e-learning and remote training.

GÉANT2 (and its predecessors GÉANT1, TEN-155, TEN-34 and EuropaNet) has been instrumental, not only in providing the world's leading networking infrastructure to R&E communities but also in creating a Pan-European human network for innovation and early service adoption. GN3 will profit form this vast knowledge base and act as a catalyst for involving it in NREN and GÉANT concerted activities. The Consortium will reach-out to the broader Academic and Research communities, relying on NREN established bonds and respecting national *subsidiarity*.

5.   ADVANCING TOWARDS THE NETWORK OF THE FUTURE

NRENs and GÉANT historically combined *networking for research with research on networking*. The latter aspect is evolving as a top priority of network strategists and funding authorities around the globe, in view of the limitations of the legacy Internet that is growing out of proportion. The GN3 Consortium will be able to provide advanced testing facilities to Academic and Industrial researchers, while contributing with its research agenda on novel protocols, coordinated security and service *virtualization,* towards the *Network of the Future.*

GÉANT has been deploying the most advanced substrate facilities and orchestrated advanced network research by NRENs, involving the talents of many R&D groups within their service area. In the last 2-3 years we are experiencing a highly publicized international activity on the quest for the network of the future. Funding authorities in the USA, Canada, Japan, China, Australia and Europe are committed to long-term plans, co-funding Academic and Industrial efforts. Although this spur of activity started with the US NSF plans for *GENI* (Global Environment for Network Innovations), Europe entered the scene with aggressive FP7 plans that include the NREN – GÉANT centric *FEDERICA* (Federated E-infrastructure Devoted to European Researchers Innovating in Computing networking Architectures) and the ICT *FIRE* (Future Internet Research & Experimentation) initiatives with emphasis on co-funding industrial efforts.

The GN3 community will be directly involved in the international research effort for the *Network of the Future* via specific Research Activities. GÉANT2/3 is considered as the most advanced production R&E network worldwide; it is within its vision to be an active participant in the path towards virtualization of *e-Infrastructures*, perhaps seen as logical entities combined in user driven work flows over a complex multi-domain environment.

In particular, the hybrid optical infrastructure and distributed testbed of GÉANT and NRENs will provide experimental facilities and resources to Academic and Industrial networking research initiatives. These may include (1) testing state-of-the-art transmission and switching gear, (2) development of novel multi-domain services and protocols and (3) interconnecting *wireless* and *sensor* network testbeds via campus and NREN facilities. The last category involves R&D on edge networks, expected to deploy millions of nodes for mission critical use cases, thus imposing dynamic virtualization and self-healing *autonomic management* requirements on backbone networks, e.g. NRENs and GÉANT3.

Virtualization of converging e-Infrastructures (including Data Repositories, Grid and Cloud Computing) is expected to provide a seamless workplace for researchers and several NRENs, which offer (or plan to offer) this environment to their users. The NREN community cannot be oblivious to these advances and GÉANT3 should be able to coordinate secure access to integrated shared resources by developing and providing generic services for that purpose.

6. NREN ORGANISATION

The Pan-European R&E initiative is based on collaboration, sharing and innovation amongst constituent NRENs and their user communities. Governance, planning and implementation of GÉANT and related concerted activities are undertaken by a consortium of all NRENs in the extended European Research Area, assisted by *DANTE* (Project Coordinator) and *TERENA*, two organizations formed and controlled by them.

GÉANT provides the vehicle for close collaborations involving advanced connectivity services coupled with innovative R&D and human networking. The NREN Consortium consists of all EU NRENs and other nations with FP7 third Country Agreements, with a proven record of universal service. Apart from connectivity, Consortium members are expected to actively participate in GN3 activities and share costs and risks. Other NRENs in the extended European Research Area, with a record of universal service of their R&E communities will also enjoy advanced networking services and participate in related activities but with no voting power. Finally, connectivity services and peering agreements are extended around the Globe, following past and current best practices.

There have been several success stories in our 20 year evolution towards the current NREN - GÉANT2 advanced profile. The Consortium is continuously evaluating this experience and has adapted its *Governance* and *Management* structures to better meet the growing requirements of its global user-base and the expectations of supporters at the National and European levels. This must be accomplished by balancing streamlined policies and practices with the active participation of our NREN members, not only in project joint activities but in policy making as well.

7. e-SOCIETY CATALYST

European NRENs, via GN3 concerted efforts will participate in the quest towards *e-Society*, acting as early promoters of e-Services across digital divides, catalysing (to a certain degree) liberalization of connectivity markets, contributing to testing and standardization of novel networking ideas, and helping reduce global environmental hazards.

The NREN – GÉANT ecosystem will enhance its role as an *e-Society* promoter. It will continue to (i) help bridging digital divides, (ii) boost dark fibre provisions throughout Europe, (iii) contribute to the creation of liberalized connectivity markets within its realm, (iv) encourage vast adoption of advanced e-Services to Schools and

Universities, (v) participate in testing, deployment and standardization of ICT industry novel networking ideas.

The GN3 community is expected to contribute to the *ICT environmental benefits*. Improvement and spreading of collaborative e-Services will result in proliferation of virtual meetings and tele-working, while the amble managed capacity provided to R&E users will enable seamless connectivity to vast data-centres and computing resources concentrated in energy efficient locations.

PART III

Rationale for the GN3 Structure

The technical emphasis of the GN3 project will be three-fold:

1. To plan, provide and manage an *advanced networking infrastructure* interconnecting NRENs via a hybrid optical interconnect that includes GÉANT3 backbone links, direct Cross-Border-Fibres (CBF) and global connections.

2. To develop and support an agreed upon portfolio of *multi-domain services* enabling NREN Operators to manage secure and reliable networking solutions across the extended European Research Area and beyond, around the globe.

3. To empower NRENs and via them campuses and end-users with *federated services* for mobile R&E users and high-end users of distributed e-Infrastructures (e.g. Grid computing and super-computing user communities).

The three areas above are mapped into corresponding *broad service activities.* These in turn trigger *research & development (R&D) containers* aimed at advancing our resource offerings and service portfolio. A separate service activity will support software development across all service and R&D efforts. This activity will also perform quality assurance and propose related *Intellectual Property Right (IPR)* policies.

The service orientation of R&D activities will not suffocate technological innovation. On the contrary such policy will help qualify and select innovative technologies, expected to lead to the *network of the future*.

At the *human networking* level, GN3 must continue nurturing the Pan-European and global web of NREN managers, operators, R&D and end-user support staff. This concerted effort is extended to R&E communities within the GÉANT service area and beyond, across digital divides, and includes industry groups involved in networking research and standardization efforts.

Overall activity proceedings and promotion of new services will be assisted by a *Project Office* on horizontal matters such as administrative and financial logistics, training and security coordination. The Project Office will be a key element of GN3 central project management support. Governance and policy related decisions will be the ultimate responsibility of the GN3 NREN General Assembly, the *NREN Policy Committee – NREN PC*. An executive *Project Board*, elected by the NREN PC will function on specific devolved authorities. NRENs will further supervise GN3 Activities via *Supervisory Committees* and *Working Groups*, appointed by and reporting to the project governance bodies.

APPENDIX I:

Glossary

AAI: Authentication & Authorization Infrastructure

AutoBAHN: Automated Bandwidth Allocation across Heterogeneous Networks, multi-domain dynamic provisioning platform developed within GN2

Autonomic Network: Self-healing, self-managed networking aiming to overcome the rapidly growing complexity of the Internet and other networks and to enable their further growth, far beyond the size of today (http://en.wikipedia.org/wiki/Autonomic_Networking)

BGP: Border Gateway Protocol. IETF inter-domain path-finding protocol for IP routed networks

CANARIE: Canadian R&E Network (http://www.canarie.ca/about/index.html)

CAPEX: Capital Expenses

Carrier Ethernet: Next Generation Transport Solution referring to Ethernet enhancements for layer 2 backbone networks. Currently standardized as Provider Backbone Bridging (PBB) for Metropolitan Area Networks and enhanced with Traffic Engineering options into PBB-TE

CBF: Cross-Border Fibre

Circuit: Explicit end-to-end path with dedicated capacity

Cloud Computing: On demand use of shared computing & storage resources (http://en.wikipedia.org/wiki/Cloud_computing)

Control Plane: Network-wide functions controlling data transfer (e.g. forwarding table computation for packet routing, topology discovery and path establishment signaling, name resolution, address resolution, traffic engineering, activation of back-up).

DANTE: Delivery of Advanced Network Technology to Europe Ltd. (http://www.dante.net/)

Data Plane: Functions involving packet handling operating at the speed of packet arrivals locally at a network element (node) interface, e.g. packet forwarding, filtering, tunnelling, scheduling and queue management

DCN: Dynamic Circuit Network: An Internet2 optical circuit network within their hybrid service portfolio

DICE:	DANTE, Internet2, CANARIE, ESnet: Coordinating initiative on multi-domain intercontinental interoperability and services to the R&E communities. DANTE acts on behalf of the GÉANT community (http://www.geant2.net/server/show/conWebDoc.1308)
Domain:	A network entity with independent management and administration (e.g. a Campus Local Area Network or an NREN)
DWDM:	Dense Wavelength Division Multiplexing
E2ECU:	End-to-end Coordination Unit, developed within GN2 to monitor the state of multi-domain OPNs
eduGAIN:	Authentication and Authorisation Infrastructure (AAI) intended to federate already existing AAIs in GÉANT2 participating networks
eduroam:	Education Roaming: A RADIUS-based infrastructure that uses 802.1X security technology to allow for inter-institutional roaming.
EARNEST:	GN2 foresight study leading to the successor of GÉANT2 (http://www.terena.org/activities/earnest/)
EC:	European Commission
EGEE:	Enabling Grids for E-sciEnce: Pan European Grid initiative (http://www.eu-egee.org/)
End-User:	An NREN subscriber (e.g. single researcher or a campus)
e-Science:	Electronic science. Computationally intensive science over a distributed networking environment (http://en.wikipedia.org/wiki/E-Science)
ESnet:	Energy Sciences Network of the US Department of Energy (http://www.es.net/)
Ethernet:	Media Access Control (MAC) protocol to Local Area Networks, standardized by the IEEE 802.3 committee (http://standards.ieee.org/getieee802/802.3.html)
EuropaNet:	Early predecessor of GÉANT
FEDERICA:	Federated E-infrastructure Dedicated to European Researchers Innovating on Computing networking Architectures. Provision of virtual slices on top of the GÉANT2 – NREN substrate dedicated to emulation experiments on the Network of the Future (http://www.fp7-federica.eu/)
FIRE:	Future Internet Research & Experimentation: EC FP7 Programme, Information & Communication Technologies,

	New Paradigms and Experimental Facilities (http://cordis.europa.eu/fp7/ict/fire/home_en.html)
FP7:	Seventh Research Framework Programme of the European Commission
GÉANT:	Generic name for the optical high speed interconnection networking of European NRENs
GÉANT1:	The older version of Multi-Gigabit IP network interconnecting the European NRENs
GÉANT2:	The current hybrid optical interconnection of NRENs, the successor of GÉANT1
GÉANT3:	The planned optical interconnection of NRENs, the successor of GÉANT2
GENI:	Global Environment for Network Innovations: NSF initiative for establishing an experimental network in the USA (http://geni.net/)
GLIF:	Global Lambda Integrated Facility: A worldwide initiative coordinating the use and development of lightpath services in hybrid networks (http://www.glif.is/)
GN2:	The EC FP6 co-funded project supporting GÉANT2 activities
GN3:	A (tentative) name for the EC FP7 proposal to support GÉANT3 activities
GOLE:	GLIF Open Lightpath Exchange
Grid:	An e-Infrastructure enabling controlled sharing and management of large amounts of distributed data over a data network
ICT:	Information & Communication Technologies
ID Provider:	An authority that provides subscribed users with access credentials to digital resources and services
IDC:	Inter-Domain Control protocols, established by the DICE joint initiative
IDS:	Intrusion Detection System (http://en.wikipedia.org/wiki/Intrusion-detection_system)
IETF:	Internet Engineering Task Force (http://www.ietf.org/)
Internet2:	US R&E networking initiative (http://www.internet2.edu/)
IPR:	Intellectual Property Rights

IRU:	Irrefutable Right of Use: A long-term leasing contract, usually referring to dark fibre leasing
I-SHARe:	Definition of interfaces for information sharing across network domains within GN2
Layer 1 Protocols:	Physical Layer (e.g. data encoding, DWDM and TDM/SDH)
Layer 2 Protocols:	Data Link Layer (e.g. Ethernet MAC, VLAN and ATM)
Layer 3 Protocols:	Network Layer (e.g. IP framing and routing processes)
LHC:	Large Hadron Collider: Scientific facility at CERN (http://public.web.cern.ch/Public/en/LHC/LHC-en.html)
Lightpath:	An end-to-end circuit provisioned within an optical network
Logical Routers:	Distinct routing instances within a physical router. They can enable hosting of customer edge routers as virtual instances within provider routers
Management Plane:	Non real-time functions for monitoring, management and troubleshooting of networks
NOC:	Network Operations Centre
NREN:	National Research & Education Network
NREN PC:	NREN Policy Committee: The general assembly of GÉANT partners that governs GN2/GN3
OPEX:	Operational Exepenses
OPN:	Optical Private Network consisting of 10 Gig wavelength links over the DWDM substrate, forming a managed network dedicated to a community of power users (e.g. a Grid initiative)
perfSONAR:	Performance Service Oriented Network monitoring Architecture: Jointly developed by GN2, Internet2 and ESnet to monitor multi-domain network performance
PERT:	Performance Enhancement & Response Team, based on a ticketing workflow to coordinate performance related issues amongst NREN and GÉANT NOCs
PoP:	Point of Presence
ROADM:	Reconfigurable Optical Add-Drop Multiplexer
R&E:	Research & Education community
R&D:	Research & Development
SERENATE:	Foresight strategy studies prior to the GN2 proposal (http://www.serenate.org/)

Shibboleth:	Architecture developed by Internet2 for managing roaming user credentials amongst trusted organizations for web-based applications
SOA:	Service-Oriented Architecture: Loosely coupled IT services (seen as Web Services) aiming at the creation of business flows (http://en.wikipedia.org/wiki/Service-oriented_architecture)
SSO:	Single-Sign-On: Enables a user to authenticate once and gain access to multiple resources. Important feature in distributed – Grid computing
Sunsidiarity:	An EU principle denoting respect of actions at national, regional or local level, except in the areas which fall within its exclusive competence (http://europa.eu/scadplus/glossary/subsidiarity_en.htm)
TEN-34, TEN-155:	Predecessors of GÉANT
TERENA:	Trans-European Research & Education Networking Association (http://www.terena.org/)
VPN:	Virtual Private Network
Wavelength:	A *lambda* within a DWDM optical network and its associated data stream e.g. 10 Gigabits/sec or 40 Gigabits/sec

APPENDIX II:

Terms of Reference
Committee on High Level Technical Strategy for GN3

September 18, 2007

1. The GN2 Executive Committee, based upon the July 11 2007 NREN PC Decision, established a Committee on High Level Technical Strategy for GN3, mandated to: "Develop on a higher (but not too high) level a technical strategy for the GN3 technical and scientific program, especially working out the innovative elements of that strategy. The amount of pages should be oriented to the GNx proposal format (the first pages normally describe such a strategy), so finally no more than 10-15 pages"

2. The Committee consists of Erik-Jan Bos (SURFNet), Mauro Campanella (GARR), Hans Döbbeling (DANTE), Lars Fischer (NORDUNet), David Foster (CERN), Vasilis Maglaris (NREN PC, Chair), Dorte Olesen (TERENA), Roberto Sabatino (DANTE) and Afrodite Sevasti (GRNET).

3 The Committee meets as it sees fit via face-to-face meetings, video/audio conference calls and e-mail, and uses a Wiki and a mailing list for internal communications. It may seek further advice from the NREN community, including feedback from individual experts within the GÉANT2 service area.

4. The Committee will submit a Summary Interim Report to the GN2 Executive Committee prior to its October 2 2007 meeting.

5. A "green paper" will be submitted to all NREN Directors asking for NREN feedback on strategic technical issues. The green paper should be available at the October 25 2007 NREN PC meeting

6. The Committee will submit to the GN2 Executive Committee and the NREN PC its Final Report by the end of 2007. This will be a "white paper" based on answers to the "green paper", the GN2 foresight study EARNEST and further input from the NREN community.

APPENDIX III:

Terms of Reference
GN3 Proposal Review Board

March 26, 2008

1. The NREN PC appoints a GN3 Proposal Review Board. Its mission is to have a close oversight on the write-up of the GN3 Proposal until its submission, reflecting the views and interests of the NREN Consortium.

2. The Review Board is mandated to approve the initial identification of activities and the assignment of specific persons, responsible to compile per-activity drafts. Per activity drafts will include task descriptions, proposed deliverables - milestones, scheduling and a first pass on resources required from GN3 partners and contractors. In their work, per-activity authors will be supported by experts from DANTE (the Proposal Coordinator) and Consortium members.

3. The Review Board will be responsible to provide the initial overview part of the GN3 Proposal, summarizing the Consortium vision as expressed in the works of the GN3 High Level Technical Committee and the GN3 Membership Committee.

4. The Review Board will report on its progress to the NREN PC and the GN2 Executive Committee in their remaining meetings. Progress will also be presented at the Berlin GN2 workshop and updates will be provided periodically to NRENs via email and the GN3 Proposal Wiki. Partner commitments and final approval will be sought by the NREN PC.

5. Decisions are taken by the Review Board members present in face-to-face or Virtual Conference meetings. The GN2 Executive Committee is mandated by the NREN PC to mediate and resolve disagreements that may arise within the Board.

NOTE: The Board includes NREN affiliated members from the *GN3 High Level Technical Strategy* and *GN3 Membership* Committees as follows:

Eric-Jan Bos (SURFnet)
Thomas Brunner (SWITCH)
Mauro Campanella (GARR)
Dai Davies (DANTE)
Hans Döbbeling (DANTE, Coordinator of the Board)
Lars Fischer (NORDUnet)
Jan Gruntorád (CESNET)
Sabine Jaume (RENATER)
Vasilis Maglaris (NREN PC)
Dorte Olesen (TERENA)
Roberto Sabatino (DANTE)
Afrodite Sevasti (GRNET)
Klaus Ullmann (DFN)
Karel Vietsch (TERENA)

with additional support by Tomaz Kalin & Milos Karapandzic (DANTE)