10.09.08

# Multi-Gigabit European Research and Education Network and Associated Services (GN3):

## Combination of Collaborative Project and Coordination and Support Action (CCPCSA)

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## List of Participants

| Participant number | Participant organisation name | Participant short name | Country |
|---|---|---|---|
| 1 (Coordinator) | Delivery of Advanced Network Technology to Europe | DANTE | n/a |
| 2 | Trans-European Research and Education Networking Association | TERENA | n/a |
| 3 | Vienna University Computer Centre | ACOnet | Austria |
| 4 | Univerzitet u Beogradu | AMRES | Serbia |
| 5 | Akademska in raziskovalna mreza Slovenije | ARNES | Slovenia |
| 6 | The Belgian Telematics Research Network | BELNET | Belgium |
| 7 | Bulgarian Research and Education Network | BREN | Bulgaria |
| 8 | Croatian Academic and Research Network | CARNet | Croatia |
| 9 | CESNET, zajmove sdruzeni pravnickych osob | CESNET | Czech Republic |
| 10 | Cyprus Research and Academic Network | CYNET | Cyprus |
| 11 | Verein zur Foerderung eines Deutschen Fors chungsnetzes eV | DFN | Germany |
| 12 | Estonian Educational and Research Network | EENET | Estonia |
| 13 | Fundação para a Computação Científica Nacional | FCCN | Portugal |

| Participant number | Participant organisation name | Participant short name | Country |
|---|---|---|---|
| 14 | Consortium GARR | GARR | Italy |
| 15 | Greek Research and Technology Network | GRNET | Greece |
| 16 | HEAnet Limited | HEAnet | Ireland |
| 17 | Inter University Computation Centre | IUCC | Israel |
| 18 | JANET (UK) | JANET | United Kingdom |
| 19 | Kaunas University of Technology | KTU - LITNET | Lithuania |
| 20 | University STS Cyril and Methodius Skopje | MARNET | FYROM |
| 21 | Javna Ustanova Univerziteta Crne Gore Podgorica | MREN | Montenegro |
| 22 | Hungarian Academic and Research Network Association | NIIFI | Hungary |
| 23 | NORDUnet A/S | NORDUnet | Nordic countries (Denmark, Finland Sweden, Norway, Iceland) |
| 24 | Poznan Supercomputing and Networking Centre | PIONIER | Poland |
| 25 | Entidad pública empresarial RED.ES | RedIRIS | Spain |
| 26 | Groupement d'Intérêt Public Réseau National de Télécommunications pour la Technologie, l'Enseignement et la Recherche | RENATER | France |
| 27 | Réseau Téléinformatique de l'Education Nationale et de la | RESTENA | Luxembourg |

| Participant number | Participant organisation name | Participant short name | Country |
|---|---|---|---|
| | Recherche, Foundation | | |
| 28 | Oficiul pentru Administrare si Operare de Comunicatii de Date | RoEduNet | Romania |
| 29 | Slovak Academic Network Association | SANET | Slovakia |
| 30 | Institute of Mathematics and Computer Science of Latvia University | SigmaNet | Latvia |
| 31 | SURFnet bv | SURFnet | Netherlands |
| 32 | SWITCH Telematikdienste für Lehre und Forschung | SWITCH | Switzerland |
| 33 | Turkish Academic Network and Information Centre | ULAKBIM | Turkey |
| 34 | University of Malta | UoM | Malta |

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# 0 Executive Summary

## 0.1 Main Objectives

The objective of this proposal is the creation of a leading edge network supporting a much enhanced range of services, both network and added value services, targeted at end-users across the GÉANT service area. A principal goal will be to create a portfolio of seamless multi-domain services. In contrast to GN2, its predecessor project, much more emphasis is placed on service development and service introduction.

Initiatives are planned in the areas of multi-domain network service operation, where it is planned to organise quick and efficient provisioning of advanced services, develop operational support crossing management domains and security to ensure service integrity and protection of network resources. This will be complemented by the development of end-users services in a federated environment which will focus on the creation of generic “meta-services” particularly in the context of security as well as further developments in the area of Roaming Services

Individual Tasks within the Joint Research Activities (JRAs) will be of shorter duration and more targeted than in GN2. The initial JRAs will deal with a critical analysis of future networking technologies as well as research into new services both from the point of supporting the development of new services as well as researching into enhancements to the emerging service portfolio (monitoring, mobility and resources management).

These will be supported by Networking Activities (NAs) dealing with both internal and external project communications. A particular emphasis of the NAs will be to support and encourage the take up of services among end-users by working closely with NRENs. The need to develop this theme co-operatively with other world regions is recognised by the inclusion of an activity specifically targeted to achieve this.

A committee of the NREN proposers deals with overall policy and an Executive Committee (Project Board in GN3) oversees its implementation. This will be strengthened by the creation of a Project Management Team of the Activity Leaders together with a Project Office to provide financial, administration and co-ordination functions.

## 0.2 List of Activities

| **Networking Activities (NAs)** | **Service Activities (SAs)** | **Joint Research Activities (JRAs)** |
|---|---|---|
| NA1: Management | SA1: GÉANT Network Architecture Design, Procurement and Operation | JRA1: Future Network |
| NA2: Joint Dissemination and Outreach | SA2: Multi-domain Network Service Operation | JRA2: Multi-domain Resources and Services |
| NA3: Status and Trends | SA3: End User Services in a Federated Environment | JRA3: Enabling Communities |
| NA4: Liaison and Support | SA4: Software Governance | |

Table 0.1: Activities List

## 0.3 Consortium

The GÉANT Consortium consists of 36 National Research and Education Networks (with NORDUnet representing Forskningsnet/Denmark, FUNET/Finland, SUNET/Sweden, UNINETT/Norway and RHnet/Iceland), TERENA and DANTE as the Coordinator, as well as four associate partners (BASNET/Belarus, RENAM/Moldova, JSCC/Russian Federation and URAN/Ukraine.

## 0.4 Funding

| | |
|---|---|
| Duration | 48 months |
| EC contribution requested (€) | 93,000,000 |
| Total budget (€) | 181,446,353 |
| Total funded manpower (MY) | 555 |

Table 0.2: Funding

# 1 Section 1: Scientific and/or Technological Excellence

## 1.1 Concept and objectives

The GN3 workplan builds on the solid experience and developments gained from GN2.The main difference in GN3 is that where GN2 was revolutionary in its technology objectives (for example, in the acquisition and lighting of dark fibre and the creation of a hybrid network), GN3 will be revolutionary in terms of the services it provides. Whilst the underlying technology at the lower layers of the network is not going to undergo substantial change, there will be a dramatic change in the services that will be developed and offered to end users. This will be particularly true for those high-end users who demand leading-edge services and not just underlying technology. GÉANT2 is currently a state-of-the-art network. The next step is to develop state-of-the-art network services that will leverage the already significant investment made in GN2.

GN3 will place more emphasis on developing Service Activities (SAs) to create this range of network services. These services will form the foundation for creating European and, where possible, global research collaborations and virtual communities.

The GN3 workplan is built upon three key inputs:

- The experience gained in GN2 from implementing both services and software development processes. This will be invaluable, as will the general lessons learned from managing a multi-partner I3 project.
- The EARNEST study, which stated the need for a much greater range of network services delivered seamlessly in the multi-domain environment of the European National Research and Engineering Network (NREN) community.
- The development of new technologies and their adoption for the service developments.

The emphasis on SAs will be complemented by a series of focussed Joint Research Activities (JRAs). JRAs in GN3 will consist of shorter-term, goal-focussed tasks targeted at supporting the developing service environment. This is building on the JRA work in GN2, which has already delivered pilot services.

The services will be focussed on the needs of the research and education community (for example, support to Grids and middleware development initiatives) and will be developed in line with best practise.

The change of emphasis in development will also be reflected in the approach to dissemination. A more targeted approach to communications will be implemented. In cooperation with the NREN partners, this will establish mechanisms to promote and encourage service take-up. It will also help and develop feedback mechanisms from users by implementing more systematic approaches to understanding the needs of pan-European user groups. The segmented structure of the GN2 workplan will form a helpful basis for this more targeted approach.

Further developments in network technologies are expected to provide further opportunities, for example 100Gbps transmissions. Also, emerging Ethernet and optical technologies are expected to provide more cost efficient solutions for transmission and switching. The GN3 technical programme will contribute to developing the "Network of the Future" through its JRAs, which are dedicated to testing state of the art transmission and switching equipment, developing novel multi-domain services and protocols, and providing technologies (for example eduGAIN) that enable secure user-oriented services.

### 1.1.1 Vision

**Mission Statement:** The GN3 programme creates an innovative, multi-domain hybrid networking infrastructure that enables R&E end-users and their organisations by providing flexible and scalable, production-quality services via constituent NRENs.

GÉANT's great achievement has been to provide quality services to a vast, demanding and diverse user base. Through its 36 NRENs serving 4000 campus networks, GÉANT has a potential user base of more than 40,000,000 end-users, thereby forming the world's largest and most advanced and diverse R&E networking system. Such a service can only be managed efficiently by using the current multi-domain hierarchy: Campus, NREN and Pan-European interconnect.

To progress even further, GN3 must enable the scalable expansion of its user base, and offer diverse robust services within a confederated architectural model. GÉANT2 and the NRENs developed advanced hybrid switching infrastructures that are able to reach advanced R&E users and support e-Science initiatives. After the roll-out of these hybrid facilities, deployment of high-performance Virtual/Optical Private Networks (VPN/OPN) swiftly followed. These acted as a catalyst for the development of related end-to-end services. It is vital that the GN3 community further develops robust multi-domain services in order to fulfil the requirements of the growing number of high-end R&E users.

To a great extent, the success of GÉANT2 has been due to the foresight of the NREN community, as shown by the SERENATE Reports [http://www.serenate.org/] and by the implementation and deployment of a hybrid dark fibre based inter-network. This implementation was a huge leap forward that exceeded predictions and placed GÉANT2 ahead of similar advanced initiatives worldwide. GN3's mission is to consolidate this innovation into a robust and stable operational multi-domain hybrid network, while at the same time contributing to future advances in network technology and developing the state-of-the-art advanced and robust services needed by the research and education communities throughout Europe and beyond.

It is envisaged that within the life time of the GN3 network, advances in core optical network technologies will be evolutionary rather than revolutionary. However, as well as advanced multi-domain systems, a multitude of user-driven virtual networks are being developed, and this trend may be considered as a revolutionary step. Therefore, GÉANT should evolve as a network "factory", with the network itself being an entity capable of creating and/or hosting complex systems made up of circuits and nodes that enable community oriented services. However, there will also be a constant need to evaluate the significance of advanced technology without compromising the production quality of the GN3 service portfolio.

Network infrastructures are becoming increasingly important because of the provision of advanced capabilities to end users through the network. Naturally, these high-performance end users will continue to exploit the opportunities that access to high speed networks brings (including growing Grid initiatives and other concepts encouraged by Cloud Computing). Architecturally, the general adoption of Service Oriented Architectures (SOA) will allow the integration of services from many different providers, thereby 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 realising the opportunities that the service oriented evolution will bring. In particular, GN3 will provide innovative leadership in such areas as 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.

## 1.2 Progress beyond state of the art

### 1.2.1 Present development

To fully appreciate the potential of the GN3 project, the present development of research networking in Europe needs to be examined.

European research networking provides state-of-the-art advanced services to the research and educational community. Nowhere else in the world has services to the R&E community at this level of performance, flexibility and choice.

The unique advantages of GN3 are:

- High performance compared to all commercial operators. A particular advantage is the easy and cost-efficient access to bandwidth (through new technologies).
- Flexibility to provide innovative solutions at the different network layers of the network in a much shorter timescale.
- Specific focus on research and education support.
- Driven by its users as NRENs are well connected to their R&E user bases.

Currently, the European networking environment offers the following from the GÈANT2 hybrid network and management services:

- Full integration of all connected NRENs with a resilient Internet Protocol (IP) network, offering IPv4 and IPv6 services, based predominantly on leased dark fibres (with an increasing preference for using NREN-owned cross-border fibres). In areas where dark fibre is not available or not cost-effective, connectivity is established using leased lines with up to 10 Gbps capacity.

  Due to the fact that the leased dark fibres are lit using state-of-the-art Dense Wavelength Division Multiplexing (DWDM) equipment wholly owned and operated by the GÉANT consortium, the GÉANT network can be sized in such a way that all demands from users can be served. It can therefore provide outstanding performance in terms of vital quality parameters (for example, availability, packet loss and one-way delay characteristics).

  On the IP network, innovative services are provided; next-to-best effort IPv4 unicast, including IPv4 unicast, multicast for both IPv4 and IPv6, and Multi-protocol Label Switching (MPLS; used extensively in GÈANT1, but usage has now shifted to Virtual Private Networks (VPNs)).

- Users who are very demanding in terms of requirements use the dedicated links provided by the GÈANT2 infrastructure, together with the corresponding connectivity provided by the NRENs.

  Success stories include radio astronomy (VLBI - Very Long Baseline Interferometry), connection of the European supercomputing centres (DEISA - Distributed European Infrastructure for Supercomputing Applications) and the data distribution network for the Large Hadron Collider, where data is sent from CERN to eleven Tier 1 academic institutions in Europe, Asia, and North America, over dedicated 10Gb/sec links, mainly based on the GÈANT and NREN infrastructure. It is an important objective of GN3 to extend the user base for its dedicated networks and end-to-end services to include more European research disciplines, projects, and institutions. The project will liaise with life sciences, space projects (ESA), earth observation, climate research, meteorology, fusion research (ITER), high performance numerical computing (PRACE) and other emerging initiatives. The aim is to become a dependable service component of the European e-Infrastructure for a wide range of scientific disciplines.

  GÉANT can be configured flexibly to support new projects, and is directly under the control of the European R&E networking community. This means that its policies and operating procedures can be changed to meet the current and future R&E community needs. Having an infrastructure focused on R&E should offer a lot more flexibility and responsiveness to R & E.

#### 1.2.1.1 International Scenario

The NRENs outside the European Community are a strong and growing environment. The not-for-profit nature of the NRENs and the focus on highly demanding research requirements favour the creation of research networks. The international nature of today's advanced research groups, and the need for accessing the data repositories and information worldwide in real time, foster tight interconnections between the NREN networks.

The GÉANT2 network strengthened the physical links with others regions worldwide, and the GN2 project and the NRENs have fostered the development of research networking in other regions (in particular Latin America and in the Mediterranean region; projects ALICE and EUMEDCONNECT respectively). In the past year, a specific effort has been initiated to create direct connections to Far Eastern counties (project TEIN2/3).

On technical and architectural grounds alone, the GÉANT2 and NREN networks are at the forefront of development. Their architecture components (such as hybrid optical and packet switched networking, optical wavelengths and circuit provisioning on demand, multi-domain extensions and research on AAI infrastructures, monitoring and capacity services) are the common pillars of next-generation networks. For example, both the

recent versions of the Internet2 network (Abilene) and the Energy Science Network (ESnet) follow the same architectural principles of the GN2 network.

In addition to the traditional collaboration for network interconnection at high speed, the service specifications and related research are now carried out in close collaboration with other key NRENs; examples include the PerfSONAR monitoring service and the Bandwidth on Demand service.

In addition to network-specific research and deployment, the international collaboration is also very active to serve specific research communities, like radio astronomers and high energy physics, to provide and operate ad-hoc networks for their specific, high demanding needs.

### 1.2.2 Progress beyond the present state

The world of data communications is developing rapidly, and the European NRENs realise they must work closely together to make sure they can offer increased value to their R&E constituency throughout Europe by staying at the forefront of data communications technology and continuing to provide innovative services. Therefore, the work on an overall Architecture Study for GN3 and the definition of Cost Sharing Principles will be undertaken by the NRENs and DANTE before the project actually starts, in order to preserve the momentum of network development.

The NREN community believes that in GN3 the emphasis will be on consolidating the infrastructure into a truly pan-European, robust and stable operational, multi-domain hybrid network. Creating a user provisioned multi-domain hybrid network is a radical step, and GN3 will be the first to do it on a continental scale and across a very diverse group of NRENs using diverse technologies.

However, user-driven virtual networks are emerging, and this trend may become an important leap forward. Therefore, there will be a constant need to evaluate the significance of advanced technology without compromising the production quality of the GN3 service portfolio.

The GN3 programme includes the JRAs and corresponding SAs developing new technologies into network-wide services. This will drive GN3 towards exciting technology targets, such as:

- **Hybrid network planning and operation**: GÉANT will continue deploying the most advanced hybrid optical technologies available, and adopt cost-effective backbone architectures. Sustainable business models (such as long-term international dark fibre leasing) will be investigated. 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 Gigabit/sec/wavelength, will advance to 100 Gigabit/sec per wavelength within the lifetime of the GN3 project. The Consortium will monitor these advances and adopt them as they become useful. It is possible that sustainability reasons may point to long-term dark fibre leasing (for example, using 15-year Indefeasible Right of Use (IRU) arrangements). Many consortium members continuously evaluate, test and deploy cutting-edge technologies at data, control and management levels, and GN3 will act as the coordinator of this effort to encourage European NREN technology.

  Many collaborative activities world wide now contribute to the ability to connect circuits for mission-critical applications. Such achievements as the GÉANT2 End to End Coordination Unit (E2ECU) for VPNs like the LHC OPN, the integration of NREN Cross-Border-Fibres (CBFs), the establishment of GÉANT global circuits and the use of lightpath exchanges are all expected to be elements in the architecture of GÉANT.

  To obtain value for the money realised by all the project partners, the GN3 project will be sufficiently flexible to accommodate new cost effective routes realised by CBFs negotiated between individual NRENs. However these will need to be brought into an agreed framework within GN3 backed by agreed policies, procedures, SLAs etc., to ensure reliability and robust service delivery.

  Depending on costs and product maturity, topology planning may indicate extensive use of Layer 1 Reconfigurable Optical Add/Drop Multiplexers (ROADM's) and Layer 2 Carrier Ethernet switching, with Layer 3 IP functionality provided by virtual instances within shared logical routers. The community feels that the GN3 emphasis will be on resilient hybrid connectivity and robust service offerings, managed by NREN NOCs and the GÉANT NOC working together in a structure inferred from current best practice.

  Support for services using different layers of the network will be key in realising a flexible set of services that will support the R&E community. This in turn means that GN3 has to have more robust policies and agreements between the NREN partners to realise this flexibility.

- **Multi-domain services**: R&E networking spans multiple domains. Therefore, services must be established across confederate administrative domains: Campuses, NRENs and international interconnections,

composed of GÉANT backbone links enriched with CBF and connections with global peers. Automated multi-domain management is an area where the GN3 community will continue research and development, triggered by end-user requirements and profiting from the collaboration between partner NRENs and their global peers.

Control-plane techniques are needed to manage robust multi-domain paths, VPNs, and OPNs in multi-technology hybrid networks. This enables the exchange and processing of information beyond simple IP reachability and manual path-finding indications. A prerequisite for the success of the GÉANT consortium will be the ability of all European players and their global partners to work together in developing and offering multi-domain management services within their diverse technological and cultural environment. For multi-domain operations and services to succeed, GN3 should encourage the adoption of a common network description schema among NRENs, and deploy enhanced control plane protocols and management plane techniques across domains. This, coupled with vendor and technology diversity amongst domains (GÉANT, NRENs, end-user campuses, global peers), presents the challenge for the GN3 project; to be one of the key players for developing, testing and deploying multi-domain control and management services, and also relaying the experience to standardisation bodies.

The most important advanced services to be developed and deployed on a wide scale are:

- International circuit stitching (e.g. the GÉANT2 E2ECU, which also incorporates NREN Cross-Border-Fibres, global circuits and lightpath exchanges).
- Distributed monitoring architectures (perfSONAR jointly developed by GÉANT and the US Internet2 and ESnet).
- Automated Trans-Continental provisioning by coordinating the GÉANT2 AutoBAHN with NRENs, vendors, the US Internet2 Dynamic Circuit Network (DCN) tools.

For the above multi-domain functions, the following set of tools is required:

- Federated Authentication and Authorisation Infrastructures (AAI) for NREN & GÉANT NOC access (eduGAIN federations).
- Specification of a common Network Description Schema, I-Share, incorporating multi-layer, multi-domain aspects. In essence this is complementary to the current cNIS service. cNIS could be either fully adopted by an NREN for its intra-domain needs, or at least be part of its obligation to export network description primitives in a common format to enable multi-domain management (e.g. monitoring and provisioning).
- Global inter-domain control (IDC) protocol suite (jointly developed by the DICE group - DANTE, Internet2, CANARIE & ESnet).
- Promotion of cross-domain security incident reporting, coordinated intrusion and anomaly detection, and establishment of distributed trouble-ticketing workflow services and coordinate NREN PERTs (Performance Emergency Response Teams). This will encourage the further development of NREN PERTs whilst improving the coordination of PERT activities.

- **Network of the future**: The provisioning of a robust, high-performance R&E infrastructure is a dominant requirement. However, the GÉANT consortium will now also be able to provide advanced testing facilities to academic and industrial researchers, while contributing with its research agenda to new protocols, coordinated security and service virtualisation.

- **Security**: Security activities in GN3 can be described in two broad categories:

  - Those intended to stop, mitigate and counteract intrusions and unwanted activities performed for malicious reasons. This is a mixture of reactive and proactive actions. These are covered in SA2 Task 4 (T4) and the JRA2 T4 developments.
  - Those intended to ensure that services and resources are accessible only to those who have the correct rights of access. This is a mixture of enabling and protecting access and resources, and is covered by a wider set of SA Tasks, enhanced by the complementary JRAs.

  The general rationale behind security is to develop management and protection (the second category of activities) in order to minimise the requirement for policing and observation (the first category of activities). The development and introduction of AAI activities in GN3 is therefore considered essential for the deployment of services. An additional difficulty is the multi-domain environment, which requires the research into and deployment of ways to exchange secure information

  To enable and protect services the following elements are required:

- ˜Services providing an identity and a "role" to users. These are called "identity provider" services. They reside close to the end user, within the single institutions where they belong. They can, and already do, use a wide range of protective methods (such as passwords, smart cards, onetime keys, and biometric identification). Public key infrastructure X.509 certificates as issued by certification authorities (CA) represent yet another possible tool for authentication. These are implemented via various protocols and devices such as LDAP, RADIUS, and SSL connections.
- The facility for network services to demand authentication from users, and the ability to accept identities provided by the identity providers, and decide who can use them.
- The ability for national/local services to federate (e.g. technical methods to enable cross trust) the identity provided, and the service providers.
- International confederations, joining together national/local federations.

These activities must collaborate closely and need to be coordinated to ensure a homogeneous implementation and overall ease of use of the services by the end-user. A Security Coordination role is identified in the GN3 Project Office and has been appointed to facilitate this.

In the context of the GN3 proposal, the following points are important with regards to security:

- The SAs' role is to run the operations of international confederations and the presence of national federations.
- The JRAs' role is to provide the missing technical interfaces between existing "identity providers" and "services provided", and the federation protocols and requirements.

- The different technologies and differing strategies in existing security components should be developed to belong to a single federation and confederation.

- **International collaboration**: This will be actively pursued to define and implement multidomain services and to provide such input to the standardisation bodies.

  Today's connections and service offerings in the international scenario are rather static and are limited mainly to static circuit provisioning, IPv4 and IPv6 best effort service, multicast.

  GN3 will aims at adding monitoring services, on demand capacity (in terms of circuits and wavelengths) provisioning and secure Identity management to fulfil better the user requirements. These goals require development and standardisation effort in various areas, which will be pursued actively seeking international collaborations.

### 1.2.3 Conclusion

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

1. To plan, provide and manage an advanced and cost-effective networking infrastructure, interconnecting NRENs via a backbone optical interconnect, supplemented where cost-effective and needed with direct CBF connections that fit into the overall strategy for service delivery. The infrastructure will be expanded to new countries (probably including an increase of the dark fibre footprint), providing better services to all partners.
2. To develop and support an agreed-upon portfolio of advanced multi-domain services, enabling NREN operators to manage secure and reliable networking solutions across the extended European Research Area and globally, and deliver these to end-users.
3. To empower NRENs, and therefore campuses and end-users, with federated services for mobile R&E and high-end users of distributed e-Infrastructures (for example, grid computing and super-computing user communities).

The most innovation is expected from points two and three. GÉANT will therefore not only provide a better and wider set of services and coverage, but also step towards the future with an innovative approach to the integration of communication and computing through the provision of advanced and robust services delivered in line with research and education users' requirements.

## 1.3 Methodology to achieve the objectives of the project, in particular the provision of integrated services

### 1.3.1 Introduction

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 organisations formed and controlled by these NRENs.

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 large-scale service provision. Apart from connectivity, Consortium members are expected to actively participate in GN3 activities and share costs and risks. Finally, connectivity services and peering agreements are extended around the Globe, following past and current best practices. The three-level hierarchy (Campus, NREN, GÉANT) empowers users with ubiquitous, cost-effective and secure access to access vast digital resources distributed around the Globe. It enables intensive international collaborations amongst dynamic culturally-diverse R&E communities to work towards a common digital space, decisively facilitating the European Research Area. This vibrant human network provides the necessary resources for deploying services and performing innovative R&D on networking and related service.

The GN3 Consortium reaches-out to more than 40,000,000 end-users via its NREN members. They enjoy advanced networking services in a scalable federated fashion, and affordable and secure access to digital libraries, digital repositories, Grids and Supercomputing centres, distributed around the Globe. Virtual international collaborations amongst educators and researchers from all fields of study enable affordable networked platforms for e-Science, e-learning and remote training. GÉANT2 and its predecessors (GÉANT1, TEN-155, TEN-34 and EuropaNet) have been instrumental in providing not only the world's leading networking infrastructure to R&E communities, but also in creating a Pan-European human network for innovation. GN3 will profit from this vast knowledge base.

The basis for this cooperative foundation is primarily the three tiers of the backbone (Campus, NREN, GÉANT), combined with global connectivity. This connectivity provides almost (but not quite) all the required conditions for seamless inter-working of users; some vital services are already in existence but need wider dissemination and implementation, while some have still to be developed further to achieve routine service.

Multi-domain requirements stemming from e-Science use-cases prompt the 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 will continue establishing a working relationship with global peers, manifested in international circuit stitching as is currently embodied in achievements such as the GÉANT2 E2ECU, the integration of NREN Cross-Border-Fibres (CBFs), the establishment of GÉANT global circuits and the use of GLIF Open Lightpath Exchanges (GOLEs).

Integration of evolving NREN resources within the shared GÉANT infrastructure is essential for the success and sustainability of GN3. The Consortium, via the NREN PC, will establish common policy guidelines that will enable a harmonised, shared multi-domain environment. Specific implementation issues will be devolved to the Project Board or the Management Team depending on their anticipated impact.

### 1.3.2 Proposed methodology

The Project has three main technical objectives. The first is provision and operation of the backbone, coordination of the GÉANT NOC and all NREN NOCs etc.

Objectives 2 and 3 are to develop and support a portfolio of multi-domain services and empower end-users with federated services. These objectives need careful and advance management so that research definition and development (carried out by the JRAs) and transition to service (carried out by both JRAs and SAs) follows the correct sequence to result in timely delivery:

Research definition – Research – Transition to pilot stage – Transition to service.

#### 1.3.2.1 Management approach

One of the most important elements of a project is its organisational approach. This must supply the tools for professional operation on one hand, concentrating the operational elements for maximum efficiency and responsiveness, but on the other hand provide mechanisms for the Consortium members to influence decision making at the policy, technical and implementation level as much as possible.

Therefore, the Organisational setup of GN3 project described in section 1.7.4 as Network Activity 1 (NA1) establishes a firm management structure; the NREN Policy Committee is at the top of the hierarchy, the Project Board running the project at the executive level, and two Project Managers running it at the operational level, who are responsible for the coordination of the activities, supported by the Project Office. New to this organisation, compared to previous structures, are the Supervisory Committees. These will be composed of experts from project participants, mostly not actively involved in the activities on which they will advise. They will be formed to give advice about network planning, service strategies and research directions. The operational duration will depend on the specific objectives of each Supervisory Committee. They will enable an in-depth involvement of experts from NRENs or associated academic institutions in the strategic planning of the GN3 Project. In addition to the added value of this wider circle of experts, Supervisory Committees will assist in the process of the adoption of new services by the NRENs.

#### 1.3.2.2 Backbone planning, establishment and operation

This activity, which will call for almost three quarters of the expected financial expenditure, will be backbone planning, network architecture definition, technology assessment, procurement and transition to new operations. It will be performed in the SA1 activity with the close involvement of participating NRENs. SA1 is divided into the following Tasks:

- Task 1. Network Planning and Procurement Preparation. This will investigate NREN requirements examining possible network architectures and considering the results of investigations into technological developments (including those undertaken within JRA1: Future Network). It will provide technical input on the requirements for the services and equipment to be purchased.
- Task 2. Procurement This Task's role is to achieve best value for money, using established and well-known best practices, as defined by the EU directive, using the DANTE's extensive. In this endeavour the CBF and other suitable infrastructure and connectivity owned by the NRENs will be considered equally with other options for incorporation into the backbone to achieve flexibility and cost effectiveness.
- Task 3: The Provisioning and Operation of the GÉANT Network. This Task will undertake the operational developments that are needed in the state-of-the-art GÉANT pan-European backbone to provide an efficient service to the network users.

The interaction with JRA1 will assist SA1, although SA1 must be able to provide the initial network architecture design well in advance of when first results from JRA1 are expected (Month 9). Nevertheless, input from JRA1 on technologies (including carrier class Ethernet and T-MPLS, optical switching and developments in network control techniques and new architectural paradigms applicable to backbone networks to optimise the use of resources, e.g. Virtualisation services, protocol layering and scaling) will be instrumental for further development of the GÉANT network, both backbone and national networks.

#### 1.3.2.3 Move from research to service

One of the requirements for the planning of GN3 has been to provide a logical dependence between the JRAs and SAs, bearing in mind that the purpose of the JRAs is not pure networking research, but contribution to the improvement of services. Thus each JRA should be able to indicate the service that will benefit from its developments.

Accordingly, the majority of the Tasks in the JRAs are based around the requirements of the SAs (past and future) to facilitate faster deployment in the whole NREN community. therefore, the results of the JRAs should be able to directly move to a service activity via a prototype stage, or aim to provide some missing elements in already existing services, either as prototypes or with limited functionality.

An integrated approach to software development is considered to be the best way for providing software developers with guidance and best practices. This will happen through SA4 (Software Governance), which will provide common software development policies, standard procedures, quality assurance audits and post implementation support. The actual software development work will take place in the JRAs and SAs.

It is important to note that although in most of the JRA descriptions the indicated duration is provisionally for the duration of GN3, the intention is to closely supervise the work so that unproductive research directions can be terminated early, and new research proposed.

#### 1.3.2.4 Networking Activities

The Networking Activities will in general follow seamlessly on from those in GN2. However, the allocation of Tasks to individual activities has been rationalised. A description of the Networking Activities is given in section 1.7. New elements introduced in the GN3 proposal are:

- A Task devoted to promotion of the services. In collaboration with NRENs, this Task's aim is to support NREN PR activity to speed-up the dissemination and deployment of the services by the NRENs, and the take-up by end-users. This Task will coordinate with the JRAs and SAs that have developed services.
- A task on Campus Best Practice, helping NRENs offer their user organisations advice on best practices in campus network management.
- Activity NA4 Liaison and Support, which will coordinate with global activities (Internet2, ESnet, CLARA, CAMREN, APAN, GLIF, etc), facilitate increased internal (GN3) cooperation and consultation with partners, as well as liaise with projects and initiatives. It will provide assistance to the development of research and education networking in less advanced regions. Finally, it will provide the organisation and support required to enhance standardisation across the project. This activity was distributed across a number of separate activities and Tasks in GN2

This complete coverage of the human networking arena, including increased standardisation and the very important new Task for providing support for quicker dissemination of services, will bring added value to the Project and further increase its impact.

#### 1.3.2.5 Conclusion

This integrated approach to management, with augmented contributions to strategy development by the NRENs, will have a positive influence on the wider acceptance of the new services, as well as on the basic connectivity (IP or dedicated links). Stronger logical coupling between JRAs and corresponding SAs, and the support of the NA2 activity offering help to the NRENs for deployment of the services, will speed-up transition to service.

## 1.4 Overview of GN3 Activities

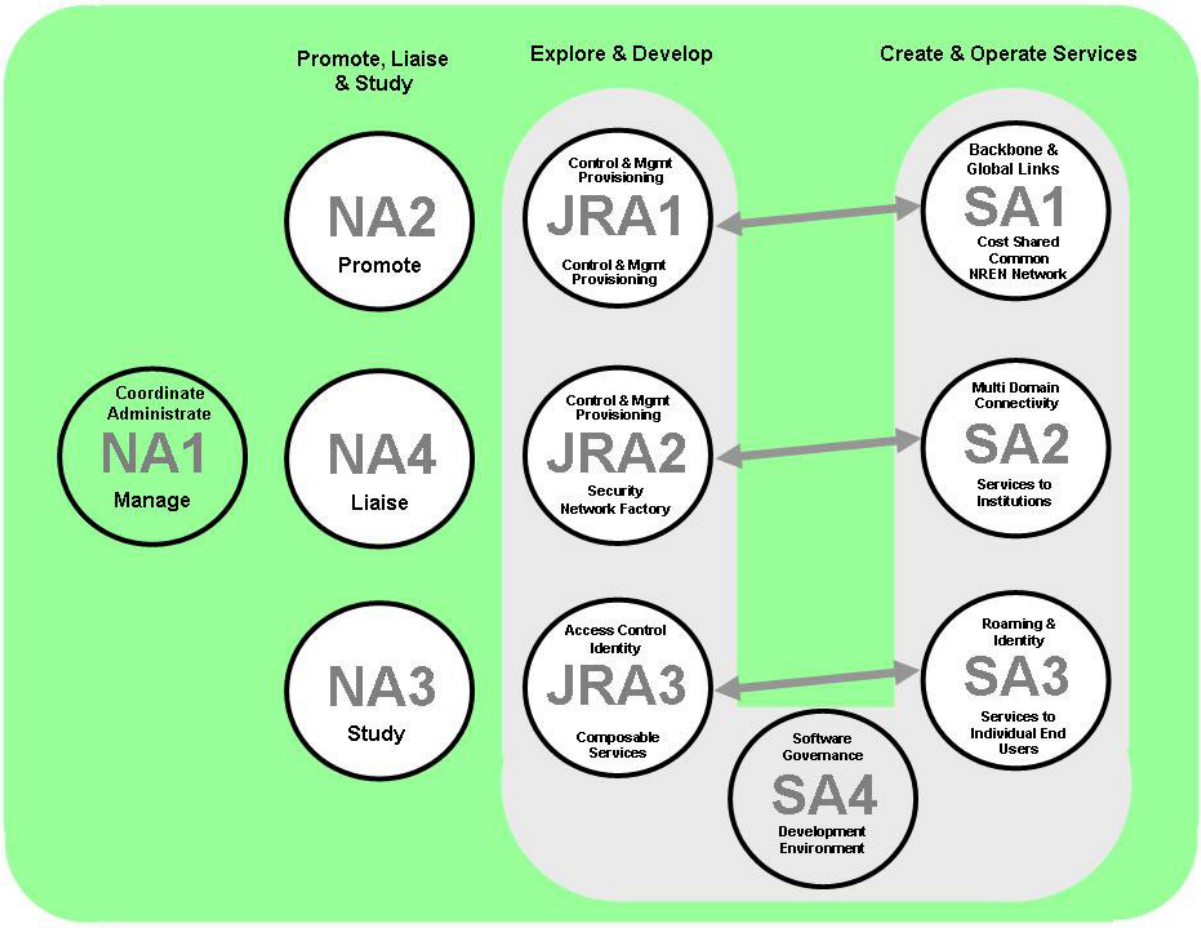


Figure 1.1: Overview of GN3 Activities

## 1.5 List of Deliverables

| Deliverable Code | WP/Activity | Title | Description | Nature | Dissemination Level | Delivery Date |
|---|---|---|---|---|---|---|
| DN1.1.1,1<br>DN1.1.1,2<br>…<br>DN1.1.1,12 | NA1 | Quarterly Project Management Report | Overall Project Management report | R | RE | M3<br>M6<br>…<br>M45 |
| DN1.1.2,1<br>DN1.1.2,2<br>DN1.1.2,3<br>DN1.1.2,4 | NA1 | Annual Project Management Report | Overall Project Management report | R | RE | M12<br>M24<br>M36<br>M48 |
| DN2.1.1<br>DN2.1.2 | NA2 | Strategy, Planning, Messaging Reports | Communication strategy and a strategy update. | R | PU | M8, M20 |

| Deliverable Code | WP/Activity | Title | Description | Nature | Dissemination Level | Delivery Date |
|---|---|---|---|---|---|---|
| DN2.2.1,1<br>…..<br>DN2.2.1,4 | NA2 | Partner Services Promotion Reports | Annual report on national dissemination activity to promote the deployment and uptake of GN3 services. | R | PU | M9, M21, M33, M45 |
| DN2.3.1<br>DN2.3.2 | NA2 | Report on the Web/wiki | Report on the establishment/operation of the Web/wiki sites | R | PU | M9, M29 |
| DN2.4.1<br>DN2.4.2<br>DN2.4.3 | NA2 | Materials – printed and A-V | Reports on printed materials produced (brochures, leaflets, maps).<br>Report on DVD produced | R | PU | M6, M38<br><br>TBD |
| DN2.5.1<br>DN2.5.2 | NA2 | Press & News Coverage | News strategy and results report | R | PU | M14, M32 |
| DN2.6.1,1<br>DN2.6.1,2<br>DN2.6.1,3 | NA2 | External Events Results | From Year 2, annual report on representation of GN3 at events | R | PU | M15, M27, M39 |
| DN2.7.1 | NA2 | Focussed market outreach | Focussed market outreach or service user studies as required. | TBD | PU | TBD |
| DN3.1.1,1<br>….<br>DN3.1.1,4 | NA3 | Compendium of National Research and Education Networks | Printed edition of that year's Compendium of National Research and Education Networks in Europe. | O | PU | M10<br>M22<br>M34<br>M46 |
| DN3.2.1,1<br>…..<br>DN3.2.1,4 | NA3 | Annual Report on Task Force Activities | An annual report on the Task force activities, with emphasis on the relevance for other parts of the GN3 project. | R | PU | M12<br>M24<br>M36<br>M48 |
| DN3.3.1 | NA3 | Foresight Study | A report on the (2-4) specific studies that will be carried out | R | PU | M44 |
| DN3.4.1,1<br>…..<br>DN3.4.1,4 | NA3 | Campus Best Practices | An annual report on the best-practice documents produced and on the progress of the rollout in the pilot NREN | R | PU | M12<br>M24<br>M36<br>M48 |
| DN3.5.1 | NA3 | Study of environmental impact | Energy audit of the GÉANT backbone services | O | PU | M12 |
| DN3.5.2 | NA3 | Study of environmental impact | Comparison of Network Services Environmental Impact to Alternatives | O | PU | M24 |
| DN3.5.3 | NA3 | Study of environmental impact | Study of Environmental Impact: Final Results | R | PU | M36 |
| DN4.1.1,1<br>….<br>DN4.1.1,4 | NA4 | Feedback on Discussions with Global RE Organisations | Regular provision of feedback to partners related to discussions with global R&E organisations. | O | PP | M6<br>M12<br>M24<br>M36 |

| Deliverable Code | WP/Activity | Title | Description | Nature | Dissemination Level | Delivery Date |
|---|---|---|---|---|---|---|
| DN4.2.2<br>DN4.2.3 | NA4 | Case Study into the Use of International Connectivity | Development of content for a case study on the use of international connectivity. | R | PP | M24<br>M48 |
| DN4.2.1 | NA4 | GÉANT Service Portfolio | Creation of GÉANT service portfolio document and associated on-line resource for service-related information. | R | PU | M12 |
| DN4.3.1 | NA4 | Reference Site Documentation | Documentation of a reference site, a case study or a proof of concept demonstration | R | PU | M18 |
| DN4.4.1,1<br>….<br>DN4.4.1,4 | NA4 | Contribution to standards | Annual reports summarising contributions and achievements | R | PU | M12<br>M24<br>M36<br>M48 |
| DN4.5.1,1<br>DN4.5.1,4 | NA4 | Annual Reports on Country Needs Assessments and Development Support Actions | Annual reports on country needs' assessments and development support actions performed. | R | PU | M12<br>M24<br>M36<br>M48 |
| DS1.1.1 | SA1 | Report on the Backbone Architecture Study | Report on the initial results of the backbone architecture study setting out the options. | R | PU | M6 |
| DS1.1.2 | SA1 | Procurement Plan | Short term procurement plan for the geographic expansion and ongoing short-term upgrades to the backbone. | R | PU | M6 |
| DS1.1.3,1<br>DS1.1.3,2<br>…<br>DS1.1.3,4 | SA1 | Annual Report | Annual report containing an implementation plan for the longer term and addressing the outcome of the architectural studies. | R | PU | M12<br>M24<br>…<br>M48 |
| DS1.2.1,1<br>DS1.2.1,2<br>…<br>DS1.2.1,4 | SA1 | Annual Procurement Report | Annual report detailing the results of or updates on the progress of the major public procurements undertaken during the preceding year. | R | PU | M12<br>M24<br>…<br>M48 |
| DS1.3.1,1<br>…<br>DS1.3.1,48 | SA1 | Monthly Service Report | These deliverables will report on the technical status of the GÉANT network services on a monthly basis (they are also distributed to the NREN APMs). | R | PP | M1-48 |

| Deliverable Code | WP/Activity | Title | Description | Nature | Dissemination Level | Delivery Date |
|---|---|---|---|---|---|---|
| DS1.3.2,1<br>…<br>DS1.3.2,4 | SA1 | Annual Advanced Services Usage Report | This deliverable will report on the usage of the advanced services of GÉANT such as Layer-2 VPN and Circuit services. | R | PU | M12<br>…<br>M48 |
| DS2.1.1 | SA2 | Multi-domain service architecture | High-level outline of planned multi-domain service architecture. | R | PU | M14 |
| DS2.2.1 | SA2 | Operations Deployment Commitments | GN3 Partner Multi-domain Service Procedure Deployment Commitments | R | PU | M18 |
| DS2.3.1 | SA2 | Monitoring service portfolio | Definition of a monitoring service portfolio. | R | PU | M10 |
| DS2.3.2 | SA2 | Multi-domain Service Performance Experiences | Lessons Learned during the Operation of a Federated PERT | R | PU | M34 |
| DS2.5.1 | SA2 | Workflow Tools Deployment Commitments | GN3 Partner Multi-domain Workflow Tools Deployment Commitments | R | PU | M24 |
| DS3.3.1 | SA3 | eduGAIN service definition and policy. | Initial definition of service model and a first draft of policy. | R | PU | M12 |
| DS3.3.2,1<br>DS3.3.2,2<br>DS3.3.2,3<br>DS3.3.2,4 | SA3 | eduGAIN service Annual Report | Annual report on the development of the service. | R | PU | M12<br>M24<br>…<br>M48 |
| DS3.2.1,1<br>DS3.2.1,2<br>DS3.2.1,3<br>DS3.2.1,4 | SA3 | Annual Report on the eduroam Service Operations and Enhancements | Report on the eduroam service operations and implementation of improvements in the eduroam technology and service support elements. | R | PU | M12<br>M24<br>…<br>M48 |
| DS3.1.1 | SA3 | Report on the Establishment and enhancement of the Policy Management Authority Repository. | Report on the establishment of the PMA, repository enhancements and catch-all PKI. | R | PU | M14 |
| DS3.1.2,1<br>DS3.1.2,2<br>DS3.1.2,3 | SA3 | Annual Report Of Identity Federation | Annual Report on the operations of the PMA, repository and catch-all PKI. | R | PU | M24<br>M36<br>M48 |
| DS4.1.1 | SA4 | Initial Best Practice Docs | Initial set of best practice documents namely the GN3 software architecture strategy, a software developer guide and a quality assurance guide. | R | PU | M8 |

| Deliverable Code | WP/Activity | Title | Description | Nature | Dissemination Level | Delivery Date |
|---|---|---|---|---|---|---|
| DS4.2.1 | SA4 | QA Audit Report | Report on the results of QA audits, software metrics, compliance issues and resolutions. | R | PP | M21 |
| DS4.3.1 | SA4 | Specification of software development infrastructure | Specification of required software development support infrastructure and tools. | R | RE | M4 |
| DJ.1.1.1 | JRA1 | Transport Network Technologies - Study | Initial report on state of the art hybrid connection-oriented transport technologies such as Carrier Class PBT and T-MPLS with regards to classification of each technological approach, listing of transport functionalities , addressing the status of the interoperability in order define requirement from the research and education community including evaluation whether new standardisation developments should be tested. | R | PU | M6 |
| DJ.1.1.2 | JRA1 | Transport Network Technologies – Study and testing | Final report paper based on the same scope as outlined in DJ.1.1.1. In addition founded by test results. This report will act as basis for GÉANT and NREN's strategically future transport network architectures. | R | PU | M20 |
| DJ.1.2.1 | JRA1 | State of the Art Photonic Switching Technologies | Initial report outlining the state of the art with regard to photonic switching solutions, address photonic interoperability in order define requirement from the research and education community, study different control and management plane protocols and outline the functions considered important to OAM&P with regards to future photonic layer management. | R | PU | M7 |

| Deliverable Code | WP/Activity | Title | Description | Nature | Dissemination Level | Delivery Date |
|---|---|---|---|---|---|---|
| DJ.1.2.2 | JRA1 | State of the art Photonic Switching Technologies – Study and testing | Mid stage report on testing state of the art photonic technology, interoperability, transmission capacity and granularity with focus on 100G+ solutions, control and management plane protocols in coordination with JRA2, OAM&P with regards to photonic layer management. Including update of DJ.1.2.1 | R | PU | M19 |
| DJ.1.2.3 | JRA1 | State of the art Photonic Switching Technologies – Final Study and testing | Final report paper based on the same scope as outlined in DJ.1.2.1 and DJ1.2.2. In addition founded by test results. This report will act as basis for GÉANT and NREN's strategically future photonic network architectures | R | PU | M30 |
| DJ.1.3.1 | JRA1 | Architecture considerations for federated backbone networks – Study | Initial report outlining various models of architectural options available for a multi-domain backbone network, operational and administratively aspects including local influences like geography and liberalisation of markets. It will outline the best operational and administratively structure and optionally form the basis of a specification requirement for a test case in cooperation with JRA2 | R | PU | M12 |
| DJ.1.3.2 | JRA1 | Architecture considerations for federated backbone networks including – Study and optionally test case studies | Final report based on the same scope as outlined in DJ.1.3.1. The report will act as guidance for important design decisions that will be made in relation to future GÉANT and NREN network procurements. | R | PU | M18 |
| DJ1.4.1 | JRA1 | Virtualisation Services and Framework – Study | Initial report describing the result and findings from analyzing the current and possible use of virtualisation in a single-domain environment. In addition conduct a risk analysis of the virtualisation services in relation to the NREN community. | R | PU | M9 |

| Deliverable Code | WP/Activity | Title | Description | Nature | Dissemination Level | Delivery Date |
|---|---|---|---|---|---|---|
| DJ1.4.2 | JRA1 | Virtualisation Services and Framework – Study | Final report based on the same scope as outlined in DJ.1.4.1. In addition founded by test case results. The report will act as guidance with regards to virtualisation service in the GN3 community. | R | PU | M18 |
| DJ2.1.1 | JRA2 | Information schemas and workflows for multi-domain control and management functions | This deliverable will produce the specification of the information schemas and workflows, which will allow for information sharing and provide the means for coordinated management and control of the infrastructure and incidents across domains in a harmonised way. | R | PU | M16 |
| DJ2.2.1 | JRA2 | Specification of enhancements and developments for the AutoBAHN system | A specification for delivering an enhanced prototype of AutoBAHN, which is used for dynamic circuit provisioning over different technologies in a multi-domain environment. | R | PU | M4 |
| DJ2.3.1 | JRA2 | Specification of advanced features for a multi-domain monitoring infrastructure | A specification for delivering an enhanced prototype of GN2-developed perfSONAR and additional monitoring functionality for multi-domain operations and services | R | PU | M08 |
| DJ2.4.1 | JRA2 | Specification of advanced methods for incident and security threats' detection and mitigation in a multi-domain environment | A specification of advanced methods for incident and security threat detection, with solutions to be deployed both within the NRENs and in the inter-domain environment, embedded in the multi-domain management processes. | R | PU | M20 |
| DJ2.5.1 | JRA2 | Network factory footprint | Deliverable documenting the coverage of the Network Factory and the technologies used to realise it | R | PU | M24 |
| DJ2.5.2 | JRA2 | Updated network factory footprint and usage report | An update deliverable for the Network Factory footprint, together with a report on its usage by user groups and applications | R | PU | M46 |

| Deliverable Code | WP/Activity | Title | Description | Nature | Dissemination Level | Delivery Date |
|---|---|---|---|---|---|---|
| DJ3.1.1 | JRA3 | RadSec standardization and definition of eduroam extensions | Specification of the standardization work on RadSec and definition of eduroam extensions. | R | PU | M7 |
| DJ3.1.2,1 DJ3.1.2.2 | JRA3 | Roaming developments | Deliverable covering a full development cycle for new eduroam service elements, including eduroam new software release and Standardisation Activity Report | R | PU | M19, M30 |
| DJ3.2.1.1 DJ3.2.1.2 | JRA3 | Identity Federations | Deliverable covering a full development cycle for the issues identified in the Task description above, namely:<br>• Interconnection of federations within the academic community and beyond;<br>• Pilot service specification for new SAML2.0 profiles,<br>• SLO<br>• VO support.<br>• The software will be enhanced to also include reports from its utilisation in other JRAs/SAs. | R | PU | M11, M23 |
| DJ3.3.1 | JRA3 | Composable Network Services use cases | Description of the state of the art in the architectures to compose services. Requirements and use case definition. | R | PU | M9 |
| DJ3.3.2 | JRA3 | Composable Network Services Framework and General Architecture | Specification framework and architecture for composite services. | R | PU | M21 |
| DJ3.3.3 | JRA3 | Composable Network Services developments | Yearly deliverable reporting on the upgrades and development on the research on the architecture of composable Network Services | R | PU | M34 |

Table 1.1: List of GN3 Deliverables

## 1.6 List of Milestones

| Milestone Code | WP/ Activity | Title | Description | Delivery Date | Means of Verification |
|---|---|---|---|---|---|

| Milestone Code | WP/ Activity | Title | Description | Delivery Date | Means of Verification |
|---|---|---|---|---|---|
| MN2.1.1 | NA2 | Project internal communication | Public GN3 project website and GN3 project intranet/wiki for project internal communications – ready for the start of the project. | M1 | Website and intranet plus management reports |
| MN2.4.1 ….. MN2.4.7. | NA2 | Materials – printed & A-V | GN3 leaflet/brochure/map | M5, M8, M17, M20, M29, M32, M41 | Materials – printed & A-V |
| MN2.5.1,1 ….. MN2.5.1,7 | NA2 | Press & News Coverage | Series of external and internal newsletters and newswires, | M4, 10, 16, 22, 28, 34, 40 | Management reports |
| MN2.6.1 | NA2 | Events | GN3 Launch Event, GN3 workshop at TNC, GN3 participation at ICT Conference and focused user workshops/seminars as required. General event representation will be reported as part of the overall NA2 annual deliverable report. | TBD | Management reports |
| MN4.2.1 | NA4 | Agreements for Delivery of Point-to-Point Circuits | Agreements relating to the delivery of point-to-point circuits to other world regions. | M24 | Management reports |
| MN4.2.2 | NA4 | Single point of contact for NREN utilisation of GÉANT services | Establishment of a single point of contact for NREN utilisation of GÉANT services and consultation on international network requirements. | M6 | Management reports |
| MN4.2.3,1 …. MN4.2.3,3 | NA4 | Annual Service Review Workshop for NRENs | Joint organisation of and participation in an annual Service Review Workshop, for the purpose of inter-project dissemination on existing and future services (in collaboration with NA2, SA1 and SA2 ) | M12 M24 M36 | Management reports |
| MN4.2.4 | NA4 | Presentational material for New Users and Communities | Content for presentational material focused on enabling the target users to understand the service portfolio and network connectivity options ready to be used | M6 | Material |
| MN4.3.1 MN4.3.2 | NA4 | New User Communities and Application Areas | New user communities and application areas making use of GÉANT. | M18 M36 | Report |
| MN4.4.X | NA4 | Meetings, Working Groups and Standards | Participation in standards meetings and meetings with key manufactures and suppliers. | TBD | DN4.4.1,n |
| MN4.4.Y | NA4 | Involvements in Standards | Involvement in the creation of new standards-related working group or research group, documents or draft standards | TBD | DN4.4.1,n |
| MN4.5.1 | NA4 | Networking in less advanced regions | Selection, focus and priority setting for countries to be targeted together with an initial description of the workplan | M9 | DN4.5.1,n |
| MS1.2.1,1 … MS1.2.1,4 | SA1 | Procurement Conclusions | The conclusion of discrete procurement activities as recommended by Task 1 | M12, .. M48 | DS1.1.2 and management reports |

| Milestone Code | WP/ Activity | Title | Description | Delivery Date | Means of Verification |
|---|---|---|---|---|---|
| MS1.2.2,1 … MS1.2.2,4 | SA1 | Updates of Ongoing Contractual Arrangements | These milestones will be associated with the ongoing process of ensuring best value for money by regularly updating ongoing contractual arrangements through annual revisions of extant contracts or full re-procurements. | M12, .. M48 | DS1.2.1,n and management reports |
| MS2.1.1,1 … ,4 | SA2 | Service Portfolio Review | Review of portfolio of multi-domain service and multi-domain services architecture. | M10 M22 M34 M46 | Management reports |
| MS2.2.1 | SA2 | Multi-domain Operations Procedures | Operational procedures complete and feedback obtained from a majority of NREN Service Managers. | M15 | Management reports |
| MS2.3.1 | SA2 | Monitoring development delivery infrastructure | Implementation of development tools and processes for software build, test, problem management and release functions to comply with SA4 standards. | M7 | Management reports |
| MS2.3.2 | SA2 | Wavelength service monitoring tool | Delivery of wavelength service monitoring tool. | M10 | Prototype |
| MS2.3.3 | SA2 | Monitoring Service Desk operation procedure | Multi-domain monitoring Service Desk operation procedure defined, including wavelength monitoring. | M12 | Management reports |
| MS2.3.4 | SA2 | Delivery of monitoring tools for two network services. | Delivery of the monitoring tools for the monitoring of the two network services defined by task 1 priorities.. | M22 | Prototype |
| MS2.3.5 | SA2 | Delivery of monitoring tools for two additional network services | Delivery of the monitoring tools for the monitoring of the two network services defined by task 1 priorities. | M38 | Prototype |
| MS2.3.6 | SA2 | Central PERT Services | Central PERT services fully functional. | M3 | Management reports |
| MS2.3.7 | SA2 | Backbone PERT support monitoring infrastructure | Specification of the backbone PERT support monitoring infrastructure (tools and GUIs). | M6 | Technical report |
| MS2.3.8 | SA2 | Campus PERT support monitoring infra | Specification of the campuses PERT support monitoring infrastructure (tools and GUIs). | M10 | Technical report |
| MS2.3.9 | SA2 | PERT Operation Rollout Plan | GN3 Partner PERT Certification Rollout Schedule | M12 | Management reports |
| MS2.4.1 | SA2 | Security Consultancy Service | Rollout of consultancy service | M6 | Management reports |
| MS2.4.2 | SA2 | Security teams operational requirements | Definition of security teams operational security requirements, tools and procedures agreed | M10 | Technical report |

| Milestone Code | WP/ Activity | Title | Description | Delivery Date | Means of Verification |
|---|---|---|---|---|---|
| MS2.4.3 | SA2 | Security standards for multi-domain incident detection and reaction | Definition of processes for detection of and reaction to multi-domain security incidents agreed | M11 | Technical report |
| MS2.4.4 | SA2 | Deployment of support tools | Deployment of support tools to share and store information about relevant multi-domain service related incidents and actions | M23 | Prototype |
| MS2.5.1 | SA2 | Workflow tools development delivery infrastructure | Implementation of development tools and processes for software build, test, problem management and release functions to comply with SA4 standards. | M6 | Management reports |
| MS2.5.2 | SA2 | cNIS in 5 NRENs | Operational deployment of cNIS in 5 NRENs. | M6 | Management and service reports |
| MS2.5.3 | SA2 | i-SHARE in 5 NRENs | I-SHARe initial deployment in 5 NRENs. | M18 | Management and service reports |
| MS2.5.4 | SA2 | I-SHARe continued development | I-SHARe continued development based on new use cases for multi-domain services. | M24 | Management and service reports |
| MS2.5.5 | SA2 | Initial AutoBAHN rollout | Initial roll-out of AutoBAHN in 5 NRENs. | M24 | Management and service reports |
| MS2.5.6 | SA2 | Further cNIS and I-SHARe rollout | Further roll-out of cNIS and I-SHARe in NRENs. | M32 | Management and service reports |
| MS3.1.1 | SA3 | PMA Establishment | Establish the PMA. | M3 | Prototype |
| MS3.3.1 | SA3 | eduGAIN use-case analysis | An analysis of the community's use-cases and requirements of the eduGAIN service. | M6 | DS3.3.2,n |
| MS3.1.2 | SA3 | Status Report | Status report on NRENs' PKIs and GÉANT services requirements | M8 | Management and service reports |
| MS3.1.3 | SA3 | Accreditation Process | Specification of the accreditation process. | M11 | Technical report and DS3.1.1 |
| MS3.2.1 | SA3 | Training Programme | eduroam training program establishment. | M12 | DS3.2.1,n |
| MS3.1.4 | SA3 | Minimum Requirements | Minimum requirements for the participating PKIs. | M12 | DS3.1.1 |
| MS3.1.5 | SA3 | TACAR | TACAR ready to serve the PMA | M12 | Prototype |
| MS3.1.6 | SA3 | Support Co-ordination Service | Introduction of revised support co-ordination service based on GN2 experiences. | M12 | Management and service reports |
| MS3.1.7 | SA3 | Catch-all PKI | Catch-all PKI in operation. | M13 | Prototype |

| Milestone Code | WP/ Activity | Title | Description | Delivery Date | Means of Verification |
|---|---|---|---|---|---|
| MS3.3.2 | SA3 | eduGAIN service Roll-out Plan | Roll-out plan developed. | M18 | Technical report |
| MS3.3.3 | SA3 | eduGAIN service Pilot Phase | Pilot phase with five NRENs. | M24 | Management and service reports |
| MS4.1.1 | SA4 | Guidelines and processes | Guidelines and processes for software packaging, configuration management, release management, deployment management, change management and problem management. | M14 | Technical reports |
| MS4.3.1 | SA4 | SW Development Infrastructure in Place | The required SW Development Infrastructure for the project SA4 will be made available | M6 | Prototype |
| MJ1.1.1 | JRA1 | Testing | Testing system architecture, deployment and test trial services ready | M12 | Management reports and DJ1.1.2 |
| MJ1.2.1 | JRA1 | Test phase one | Initial test phase based on the study and analyse | M14 | Management reports |
| MJ1.2.2 | JRA1 | Test phase two | Second test phase including final report | M26 | Management reports |
| MJ1.3.1 | JRA1 | Study and Requirement specification | Requirement specification for a multi-domain architecture forming a federated network. Optionally:<br>• Development of tools and application including logistical planning<br>• Test case based on the specification requirement, developed tools and applications and co-operation with JRA2 | M19 | Technical report and DJ1.3.2 |
| MJ1.4.1 | JRA1 | Tool development and logistical planning | Specification requirement for a prototype of virtualisation services. Optionally:<br>• Development of tools and application including logistical planning<br>• Test case based on the specification requirement, developed tools and applications and co-operation with JRA2 | M14 | Management reports |
| MJ2.1.1 | JRA2 | Definition of a multi-domain control and management architecture | The milestone concerns the definition of the basic architecture for the harmonisation and integration of the control and management functions required in a multi-domain environment | M6 | Technical report |

| Milestone Code | WP/ Activity | Title | Description | Delivery Date | Means of Verification |
|---|---|---|---|---|---|
| MJ2.1.2 | JRA2 | Delivery of a common platform for multi-domain control and management | The milestone concerns the delivery of pilot implementation and documentation of a common platform for multi-domain operations together with an integrated approach to agreement on procedures, well-defined and consistent sharing of service-specific fundamental information and fixed policies for information disclosure. | M34 | Prototype and technical documentation |
| MJ2.2.1 | JRA2 | Delivery of an advanced release of AutoBAHN | This milestone concerns the delivery of an enhanced and updated release of AutoBAHN, with additional features that will be ready for migration to its service-level release. | M21 | Prototype |
| MJ2.3.1 | JRA2 | Delivery of advanced features for a multi-domain monitoring infrastructure | The milestone concerns the delivery of pilots and research results in different areas of multi-technology, multi-domain monitoring, as emerging from Task 3 | M30 | Management reports |
| MJ2.4.1 | JRA2 | Advanced methods for incident and security threats' detection and mitigation in a multi-domain environment | The milestone concerns the delivery of advanced methods and pilots for the detection and mitigation of security threats, as emerging from Task 4 | M42 | Management reports |
| MJ3.1.1 | JRA3 | New eduroam software release | Release of new eduroam software | M15 | Prototype |
| MJ3.2.1 | JRA3 | Identity federation laboratory | Identity federation laboratory estabilished, as an environment to test new software elements without effecting the production services | M17 | Prototype |
| MJ3.3.1 | JRA3 | Prototype for composable network services | Prototype for composable network services completed | M25 | Prototype |

Table 1.2: List of GN3 Milestones

## 1.7 Networking Activities (NAs) and associated work plan

### 1.7.1 Overall strategy of the work plan

The NAs deal with both the general management of the project (NA1) as well as its communication with partners. As with other elements of GN3, the NA's build on the experience gained in GN2 and have adapted the management structures and processes successfully deployed in GN2 in accordance with lessons learned.

NA1 represents the overall management of the project. External networking will be carried out by NAs 2 to 4, whose principle Task will be to communicate with, and seek feedback from, interested partners. In view of GN3's concentration on end-user services, much greater emphasis will be put on communications with service managers within NRENs and seeking feedback from end-users and end-user service providers. NAs 2 to 4 have separate focus areas, but it is recognised that some topics will cross NA boundaries. To deal with these cross-over areas, the NA activity leaders will co-operate to ensure organised management.

The NAs are divided into four groups of work:

- NA1: Management.

- NA2: Joint Dissemination and Outreach. This will be responsible for both general and targeted communications. For general communications, the successful tools employed in GN2 will be continued and refined. Recognising the need for developing multi-domain user services, the new Task “Partner services promotion” will be carried out to engage in dialogue with NREN resources to encourage the consistent roll out of advanced services
- NA3: Status and Trends. This will provide intelligence from both within and outside the NREN community to guide the strategic development of GN3, as well as ensure that there is a strong link between the project and the campus to assist in service take-up. It will also encourage the use and spread of best practice. GN3 partners are deeply concerned with environmental issues. This concern, when applied to the GN3 project and partners, is related to:
  - The reduction of travel to the minimal required level, to reduce the CO2 emissions.
  - Energy efficiency of the equipment used in the GN3 backbone and in the NRENs.

  To underline the commitment concerning the environmental issues, Task 5 in the Network Activity 3 “Study of environmental impact” has been proposed.
- NA4: Liaison and Support. This activity recognises the need for stronger ties between the project and other groups. It is a new activity for GN3. NA4 formalises and strengthens project interactions with partners, with peer organisations, and with standards bodies and industry. By explicitly managing these relationships the project will have more effective impact and influence outside the direct sphere of its partners.

## 1.7.2 Timing of WPs/Activities and their components

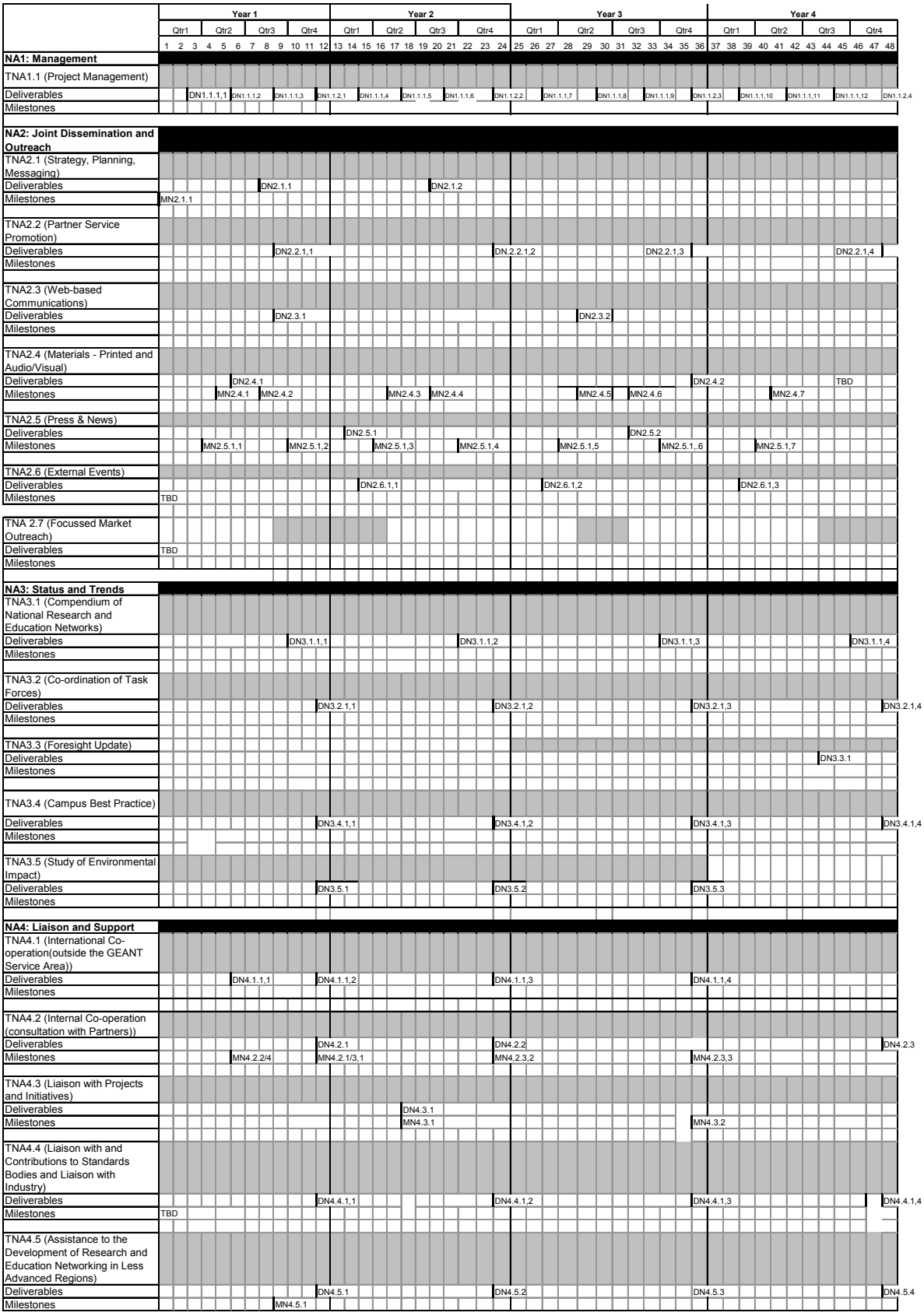

Figure 1.2: Timing of Work and Components

### 1.7.3 Work package list

| Activity number | Activity Title | Type of activity[1] | Lead participant number[2] | Lead participant short name | Person months | Start month | End month |
|---|---|---|---|---|---|---|---|
| NA1 | Management | MGT | 1 | DANTE | 566 | 1 | 48 |
| NA2 | Joint Dissemination and Outreach | COORD | 1 | DANTE | 186 | 1 | 48 |
| NA3 | Status and Trends | COORD | 2 | TERENA | 337 | 1 | 48 |
| NA4 | Liaison, Standardisation and Support | COORD | 1 | DANTE | 434 | 1 | 48 |
| | TOTAL | | | | 1523 | | |

Table 1.3: List of GN3 Networking Activities

### 1.7.4 Networking Activity 1 (NA1): Management

| WP Number | NA1 | | | | | Start date | | | |
|---|---|---|---|---|---|---|---|---|---|
| WP Title | Management | | | | | Activity Type | Networking Activity | | |
| Participant name | DANTE | TERENA | ACOnet | AMRES | ARNES | BELNET | BREN | CARNET | CESNET |
| Participant number | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| Person months | 458 | 22 | 0 | 0 | 0 | 0 | 5 | 0 | 14 |
| | | | | | | | | | |
| Participant name | CYNET | DFN | EENET | FCCN | GARR | GRNET | HEANET | IUCC | JANET |
| Participant number | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
| Person months | 0 | 0 | 0 | 0 | 24 | 0 | 0 | 5 | 0 |
| | | | | | | | | | |
| Participant name | KTU-LITNET | MARNET | MREN | NIIFI | NORDUNET | PIONIER | REDIRIS | RENATER | RESTENA |
| Participant number | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 |
| Person months | 0 | 5 | 5 | 5 | 0 | 5 | 5 | 0 | 0 |
| | | | | | | | | | |
| Participant name | RoEduNet | SANET | SIGMANET | SURFNET | SWITCH | ULAKBIM | UOM | TOTAL | |
| Participant number | 28 | 29 | 30 | 31 | 32 | 33 | 34 | | |
| Person months | 5 | 0 | 5 | 0 | 5 | 0 | 0 | 566 | |

[1] Types of activities (EC classification):
RTD = Research and technological development; COORD = Co-ordination;
MGT = Management of the consortium; SVC = Service activities.
[2] Number of the participant leading the work in this work package (see List of Participants in the beginning).

Table 1.4: NA1 Participant List

### 1.7.4.1 Project Management

NA1 represents the overall management of the project. It is centred on a policy committee of all the consortium members who are jointly responsible for the delivery of GN3 results (NREN Policy Committee), both nationally and at the pan-European level. Key to the success of the project is the correct balance between oversight of overall project goals. This will be carried out by the consortium members, with the authority for supervision devolved to an elected Project Board (PB), the Project Managers and the Activity Leaders. Project Managers and Activity Leaders together form the Project Management Team (PMT). Project Management will combine the practical requirements of activity leadership with the oversight of a light-weight Project Office responsible for horizontal Tasks. These structures are illustrated in Figure 1.3and Figure 1.4 below.

These formal structures will be complemented by ad-hoc and/or permanent Supervisory Committees (SC) of experts, who can be called together to deal with specific short- or long-term issues. Attention will be given to both internal and external communication. This is vital in such a multi-faceted project and will be achieved by holding project management conventions and an annual project symposium.

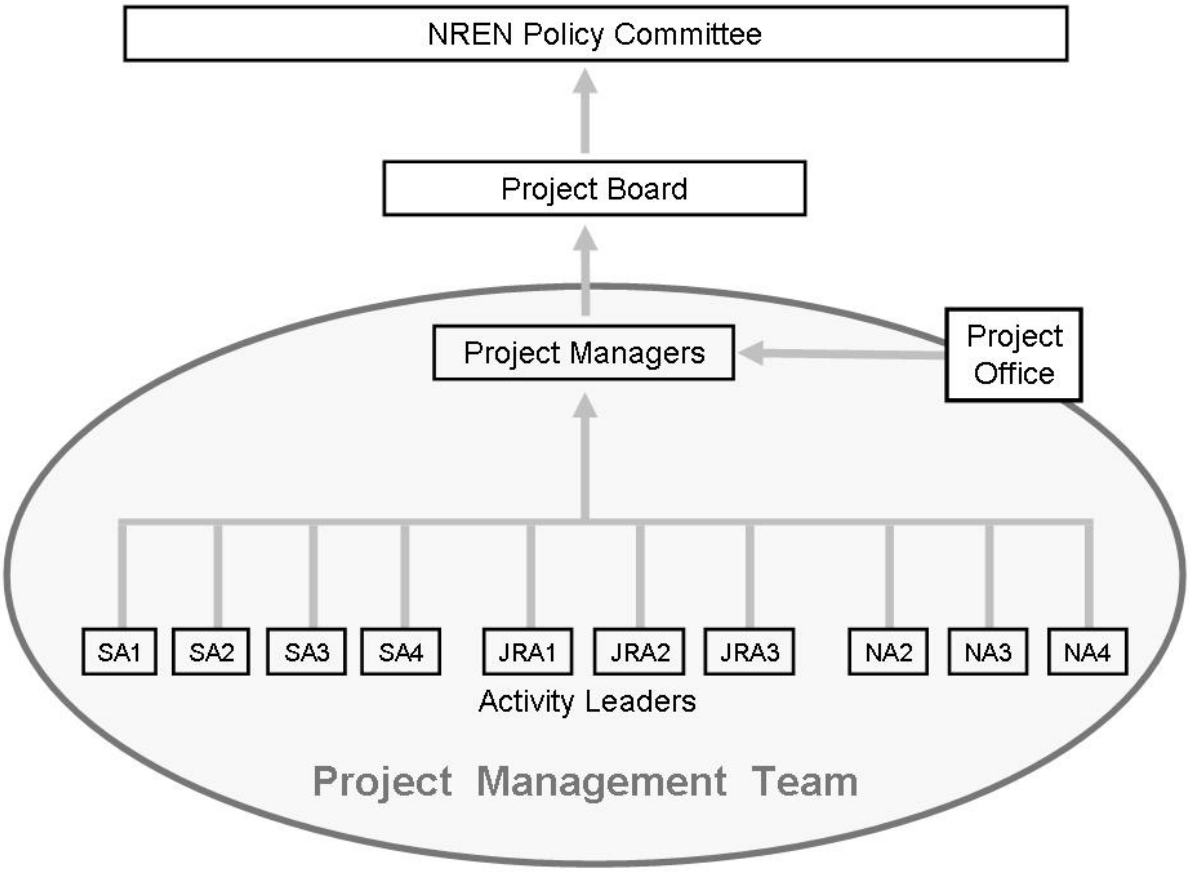


Figure 1.3: Project Management Structure

***Project Managers and the Project Management Team***

The GN3 project will be led by two Project Managers, who will report to the GN3 Project Board. These Project Managers will be assisted by the Project Office. They will work together with the Activity Leaders to form the Project Management Team, which will provide a forum for dealing with day-to-day cross-activity issues. The Project Managers will delegate responsibility to the Activity Leaders according to rules set by the Project Board. The Activity Leaders will have appropriate devolved authority for the day-to-day management of their activity,

including the management of the Task Leaders. The Project Managers will assemble the Project Management Team regularly and as necessary.

***Project Office***

To achieve an efficient leadership it is planned to have a lightweight Project Office (PO) that will oversee the day-to-day management of the project. The PO will handle horizontal Tasks in the project, serving all activities. Besides financial administration, technical authoring, training, and logistic support, the PO will perform an advisory and coordinating role on a technical, service introduction, security, intellectual property rights, and standards level. Each of these areas will be dealt with by an experienced coordinator with in-depth knowledge of the relevant area.

A Project Secretary assists the Project Managers in the day-to-day running of the PO, and will also co-ordinate the Project Management Team. In particular, the Project Secretary will be responsible for the operation and maintenance of all project management tools and procedures, including the operation of the project issue and risk logs, change control, financial reporting, documentation management and all other administration.

The PO will report to the Project Managers:

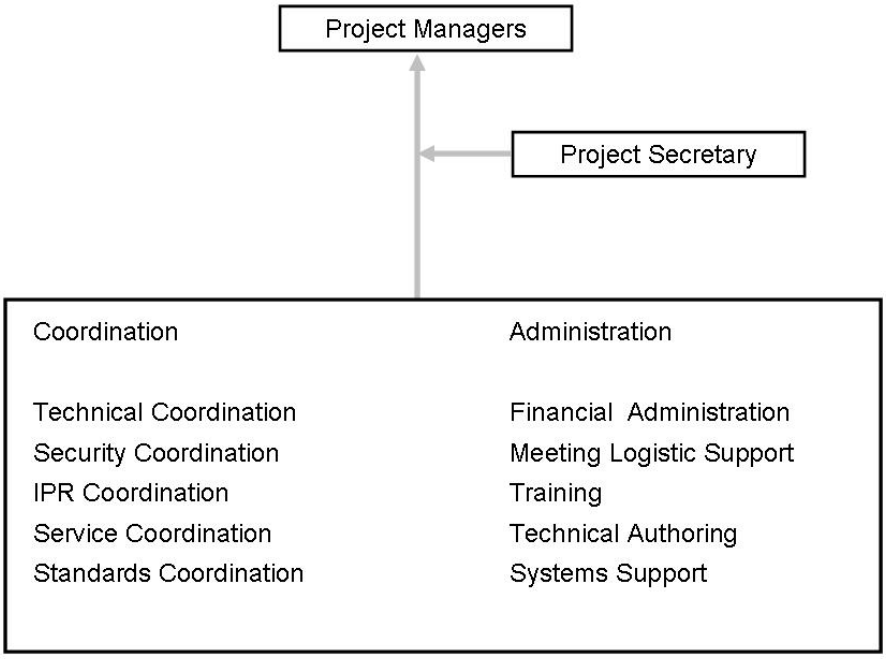


Figure 1.4: Functions of the Project Office

### 1.7.4.2 Internal Communication, Transparency and Participation in Management

A system of Supervisory Committees will be installed. This will provide guidance to individual activities, as well as to the overall direction of the project, by encouraging the strong involvement of partners at a management level. Regular management meetings, working meetings and an annual project symposium are proposed.

***Supervisory Committees***

The NREN PC, the GN3 Project Board, the Project Managers, Activity Leaders, and Task Leaders can each request the setting up of Supervisory Committees (SC). An SC must have terms of reference defining its aim, duty period and membership. These terms of reference require the approval of the Project Board. SCs formulate their own recommendations and convey them to the appropriate bodies. Recommendations will be made visible higher-up in the project management hierarchy.

SCs will be composed of experts from project partners and, where appropriate, from sources outside the project. SCs will be formed to give advice about service strategies and research directions. They will advise either the Activity Leaders or the Project Managers, who will decide upon and be responsible for carrying out the proposals if appropriate.. Some of the SCs will be formed as required or for short periods. Others will be needed for the duration of the project. Although they may relate to any type of GN3 activity, the SCs are part of NA1. The project management will make extensive use of SCs in order to implement an open and transparent interface to partners.

#### *GN3 Project Management Conventions*

The GN3 Project Management Conventions will be face-to-face management meetings, lasting two to four days, held at regular intervals. They will provide the framework for internal coordination among project managers, meetings of the supervisory committees, evaluation of new R&D proposals, service development, research results and internal progress reviews. Participation in the Project Management Convention will be by role and by invitation. The Project Management Conventions agenda will be defined by the Project Management as appropriate. Logistics of the Management Conventions will be supported by the Project Office.

#### *GN3 Activities Working Meetings*

Working meetings of the teams collaborating in the project activities will be organised regularly. The agenda of working meetings and participation at these meetings will be drafted by the respective activity or Task leaders. Logistics of the Working Meetings will be supported by the Project Office.

#### *GN3 Project Symposium*

Once per year the GN3 project will hold a Project Symposium. This will be a meeting of two to four days duration, involving those people who are actively contributing to the work of the project's activities. The Symposium provides an opportunity to present the progress of the individual Activities to persons active in other Activities, and to discuss common issues between Activities. The Symposia will also be used to liaise with selected user communities, projects, scientific disciplines or global connectors, to solicit end-user feedback or to discuss particular networking topics of interest to the project. The Symposium programme will defined by project management.

### 1.7.4.3 Deliverables

| Deliverable Code | Title | Description | Delivery Date |
|---|---|---|---|
| DN1.1.1,1<br>DN1.1.1,2<br>…<br>DN1.1.1,12 | Quarterly Project Management Report | Overall Project Management report | M3<br>M6<br>…<br>M45 |
| DN1.1.2,1<br>DN1.1.2,2<br>DN1.1.2,3<br>DN1.1.2,4 | Annual Project Management Report | Overall Project Management report | M12<br>M24<br>M36<br>M48 |

Table 1.5: NA1 Deliverables

### 1.7.5 Networking Activity 2 (NA2): Joint Dissemination & Outreach

| WP Number | NA2 | | | | | Start date | | | |
|---|---|---|---|---|---|---|---|---|---|
| WP Title | Joint Dissemination and Outreach | | | | | Activity Type | Networking Activity | | |
| Participant name | DANTE | TERENA | ACOnet | AMRES | ARNES | BELNET | BREN | CARNET | CESNET |
| Participant number | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| Person months | 122 | 40 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | | |
| Participant name | CYNET | DFN | EENET | FCCN | GARR | GRNET | HEANET | IUCC | JANET |
| Participant number | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
| Person months | 0 | 0 | 0 | 0 | 12 | 0 | 0 | 0 | 0 |
| | | | | | | | | | |
| Participant name | KTU-LITNET | MARNET | MREN | NIIFI | NORDUNET | PIONIER | REDIRIS | RENATER | RESTENA |
| Participant number | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 |
| Person months | 0 | 0 | 0 | 5 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | | |
| Participant name | RoEduNet | SANET | SIGMANET | SURFNET | SWITCH | ULAKBIM | UOM | TOTAL | |
| Participant number | 28 | 29 | 30 | 31 | 32 | 33 | 34 | | |
| Person months | 0 | 0 | 7 | 0 | 0 | 0 | 0 | 186 | |

Table 1.6: NA2 Participants

#### 1.7.5.1 NA2: Objectives

The overall objective of Activity NA2 will be to develop and implement an integrated, project-wide communications strategy for outreach and promotion of the GN3 project and its services in the NREN environment to external target audiences in order to generate awareness of, interest in, and uptake of services. Also important is the provision of an internal communications service among the project participants to foster inclusion, understanding, cooperation and cross-fertilisation of ideas and opportunities.

The core objective of NA2 is the provision of a communications service to the NRENs and other GN3 Activities in order to develop and implement respective pan-European and country-specific dissemination plans and tools. This will be done in collaboration with the NRENs and their PR-teams, and the GN3 Activity Leaders. It will include the multi-domain network operation services, the end user services common to the GN3 and NRENs' portfolios, the joint research activities, the market studies, and any other activities as appropriate."

#### 1.7.5.2 NA2: Work Plan

***Task List and Descriptions***

The work of the NA2 activity is divided into the following Tasks:

- Task 1: Strategy, Planning, and Messaging.
- Task 2: Partner Services Promotion.
- Task 3: Web-based Communications.
- Task 4: Materials – Printed & A/V.
- Task 5: Press & News.
- Task 6: External Events.
- Task 7: Focussed Market Outreach.

The interworking relationships of NA2 Tasks are shown in Figure 1.5. There will be a great deal of co-ordination and sharing of tools, documentation and materials with the project's other Activities (NA/SA/JRA), and with the NRENs, to ensure an integrated approach to the project's dissemination.

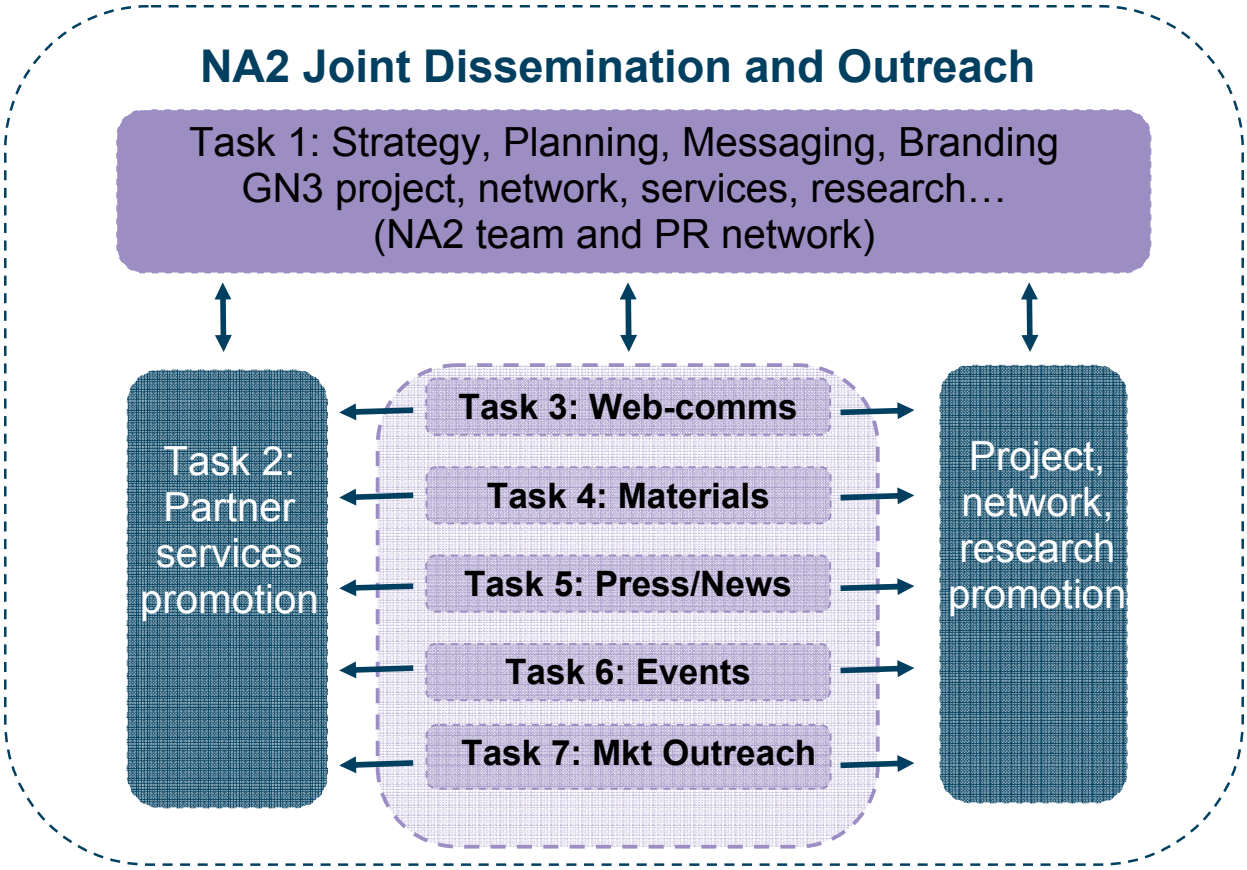


Figure 1.5: Relationships between NA2 Tasks

**PR Network:** Central to the success of the dissemination and outreach activities will be the effective collaboration in the PR Network (a network of PR practitioners from NRENs, TERENA and DANTE) on providing outreach to users in countries across Europe. The NREN PR practitioners will provide dissemination channels in their countries in order to generate awareness and uptake of services in target audiences (including campuses and end users). To aid these objectives, the currently established GN2 PR Network will continue working with the TERENA Task Force on PR (TF-PR) as appropriate, as well as having a dedicated email news group and an Intranet resource area.

**The core responsibilities of NA2 will be to:**

- Develop and implement communications plans in collaboration with Activity Leaders and the PR Network for the project, network, services, JRAs and NAs, in order to generate interest and demand for services across identified (potential) user communities, and awareness of the GN3 project.
- Support NREN PR-teams to provide effective dissemination strategies in their countries for outreach and service promotion, and in order to promote uptake of GN3 services.
- Build on the branding policy developed in GN2.
- Promote the GN3 project, network, services, research and networking activities using a variety of tools including news releases, literature, events, user demonstrations and web services.
- Provide a consistent, user-friendly GN3 web presence to maximise dissemination across all target audiences, and to support the project's internal and external communications.
- Organise external events, including GN3-specific events (e.g. launches), and assure representation of GN3 at other events (e.g. TNC, ICT, EU conferences and workshops).
- Enable and enhance the project's internal communications.

- Promote visibility of GN3's contribution towards the EU's research and education goals, including the European Research Area and achieving its e-Infrastructures vision.
- Perform research and analysis of specific pan-European audiences and market areas, and developing tailored outreach strategies to any particular user group.

#### 1.7.5.3 Task 1 of NA2: Strategy, planning, messaging

***Task 1 of NA2: Objectives***

The project-wide communication strategy, planning and messaging will be developed by NA2 within Task 1. A substantial level of co-operation with other Activities and NRENs is essential during both the strategic planning stage and the implementation stage, via the NA2 Tasks. This is in order to provide an integrated communications plan and timely dissemination service capable of contributing to achieving the Activities' and NRENs' respective objectives, and those of the project as a whole. The work will build on the brand identity and branding policy from GN2, allowing for individuality across the services in a commonly presented GN3 portfolio.

***Task 1 of NA2: Outline of Work Plan***

The strategy, plans, branding and messaging for the project and its activities will be established in collaboration with other Activity Leaders, and kept up to date as the project progresses, for roll-out across all NA2 Tasks and tools to ensure consistency.

#### 1.7.5.4 Task 2 of NA2: Partner Services Promotion

***Task 2 of NA2: Objectives***

The objective of this Task will be to promote the deployment and uptake of GN3 services at a local level (i.e. through national promotion actions) by providing information on existing or newly developed services to the campus/institution and end-users. The leading role in this lies with the NRENs, and it is the purpose of this Task to assist by providing the NRENs with tools, materials and assistance so they can conduct such dissemination actions in their countries.

Where at all possible, this activity should go hand-in-hand with writing "cookbooks" by the relevant SA or JRA for service implementation, and developing and distributing training materials and organising "train the trainers" workshops (see NA1).

***Task 2 of NA2: Work Plan***

The Partner Services Promotion Task will provide support to NRENs undertaking dissemination actions aimed at promoting the GÉANT network and other GN3 services in the NREN environment at a national level. Such actions will be planned in collaboration with the NREN PR practitioners. Consequently this Task will dovetail with the other NA2 Tasks to provide NRENs with the information, materials and tools they need for localised dissemination activities (such as production of different language versions of brochures or web material, or adaptations of certain materials).

The Task will also coordinate with the relevant SAs, JRAs and NAs to ensure efficient management of resources and dissemination effort.

#### 1.7.5.5 Task 3 of NA2: Web-based Communications

***Task 3 of NA2: Objectives***

This Task's objective will be to provide a consistent and user-friendly web presence for the project. This will consist of an external-facing website and an internal-facing project intranet/wiki. A web-based information system will be particularly appropriate to the geographically dispersed audiences being targeted by the project, and will also be heavily used by the project participants to assist their collaboration. The GN3 web site will provide for dissemination, collaboration and document management.

***Task 3 of NA2: Work Plan***

A co-ordinated web presence will be provided for the GN3 project. This will most likely be made up of a number of separate, but interlinked, web (and wiki) sites. It is planned to conduct a usability study of the web and intranet/wiki of the GN2 project, by collecting feedback from project participants and representatives of the target audience to provide input for the GN3 web development.

The GN3 public Internet site will host comprehensive information about the project and be the principle source of information about GN3, the GÉANT network and GN3 services and activities, for all audiences. This

information will be presented in a clear and easily navigable manner with a consistent look and feel, following the project's branding policy. It will be updated regularly to communicate the latest project developments.

The services applications pages (e.g. perfSONAR, eduroam) will be accessible from the GN3 website. This will identify them as a family of related services all benefiting from GN3 project funding, whilst still recognising their individual status.

A password-protected intranet/wiki site will also be provided as support for the project participants in the performance of their work and will be populated by the GN3 Activity participants.

As an important repository of information, the Task will work closely with other NA2 Tasks and will support the other project Activities in order to build and maintain suitable web presences for each Activity and for the project as a whole. DANTE will provide overall editorial control of the project's web presence, as well as design and navigation structure.

#### 1.7.5.6 Task 4 of NA2: Materials – Printed and Audio-Visual

***Task 4 of NA2: Objectives***

This Task will produce a comprehensive range of printed, audio-visual (AV) and online materials for the GN3 project to illustrate the full extent and operation of its network, services, and research activities. The materials will be used for dissemination across all target audiences and stakeholders, in order to generate awareness, interest and demand for the project's services. This portfolio of promotional materials will be developed in accordance with the project-wide branding guidelines.

***Task 4 of NA2: Work Plan***

A portfolio of materials will be developed, including; services promotional brochures and leaflets, general GN3 project brochures, interactive demos and video material, user case studies, network maps (e.g. GN3 network topology), posters, newsletters, leaflets and materials in support of specific Activities or Tasks (e.g. global GÉANT, JRAs and other NAs).

Where appropriate these materials will be posted on the GN3 website or intranet in a format suitable for online viewing and for download. Where there is demand from specific NRENs, different language versions of key items will be produced in collaboration with the relevant NREN PR practitioners.

The Task will also provide NREN PR practitioners with print, AV or web-based materials and tools for use in their own onward dissemination to the campus level and end users.

#### 1.7.5.7 Task 5 of NA2: Press & News

***Task 5 of NA2: Objectives***

Through a programme of news dissemination, this Task's objective will be to raise the profile of the project's activities, build brand recognition across all services, and generate awareness and interest in them by keeping all external target audiences informed of the operation, progress, achievements and technical capabilities of the GN3 project, its network, services, events and research activities.

***Task 5 of NA2: Work Plan***

Using press relations and a combined newswire and newsletter service, this Task will aim to maximise the dissemination of news and information to external target audiences, thereby maximising press coverage across Europe and other world regions, and building up relationships with key media.

Project internal communications will also be aided by a news service that will involve timely distribution of news items across the project (either as web articles or emails), and compilation of news into a regular internal newsletter.

#### 1.7.5.8 Task 6 of NA2: External events

***Task 6 of NA2: Objectives***

This Task's objective will be to raise visibility of the benefits and achievements of the project, network, services, research activities and networking activities across the target audiences, by participation in, and/or organisation of, external events.

***Task 6 of NA2: Work Plan***

External events will offer opportunities to raise the project's profile, convey selected and highly targeted messages to audiences (including the press), and increase brand awareness. Technical demonstrations at events will offer delegates direct and detailed explanations of the project's technologies and services, supported by project literature. This Task will be responsible for the production and logistics of NA2-organised events (e.g. GN3 Launch), and will provide representation at events organised outside the auspices of GN3 (such as NREN conferences, European Union conferences (e.g. ICT), and conferences dedicated to specific academic disciplines). This includes researching and selecting events at which GN3 should be represented, and arranging appropriate representation in collaboration with other GN3 Activities and NRENs. This Task will also work with TERENA to organise a distributed GN3 workshop at every annual TERENA Networking Conference (TNC), in order to disseminate information about GN3's ongoing work to the wider research and education networking community.

For GN3-organised events the Task will be responsible for all aspects of the production and logistics, ensuring integration with other PR Tasks and liaising with the appropriate Activities and NRENs involved.

### 1.7.5.9 Task 7 of NA2: Focussed Market Outreach

***Task 7 of NA2: Objectives***

The objective of this Task is to provide an "on demand" research service to the other Activities, primarily to gather intelligence about the audiences to whom communications activities are directed and for whom the project's services are intended. Such work is likely to include performing studies of specific pan-European audiences, market areas or user experience; and developing tailored outreach strategies for a particular user group. The Task will use a range of methods (desk research, focus groups, surveys, segmentation project results, intelligence gained from other activities), to undertake the work, as and when required by other Activities.

***Task 7 of NA2: Work Plan***

The effective and efficient provision of targeted communications activities in GN3 requires a foundation of intelligence about the audiences (for example network users, academic decision-makers, funding bodies, politicians, standards bodies) to whom the communications and services are directed. Thus, the results of these studies will be incorporated into the overall communications strategy and plan, and specific communications activities (e.g. a brochure or leaflet, a targeted workshop or other event, per-country communications activities) will be implemented to address the studies' findings.

This Task will liaise with NA3 and NA4 in particular to ensure harmonisation of objectives and Tasks, and to use relevant existing research that will contribute to this focussed outreach programme. Similarly, any intelligence learned will be shared with those and other Activities as appropriate.

### 1.7.5.10 Deliverables

| Deliverable code | Title | Description | Delivery Date |
|---|---|---|---|
| DN2.1.1<br>DN2.1.2 | Strategy, Planning, Messaging Reports | Communication strategy and a strategy update. | M8, M20 |
| DN2.2.1,1<br>…..<br>DN2.2.1,4 | Partner Services Promotion Reports | Annual report on national dissemination activity to promote the deployment and uptake of GN3 services. | M9, M21, M33, M45 |
| DN2.3.1<br>DN2.3.2 | Report on the Web/wiki | Report on the establishment/operation of the Web/wiki sites | M9, M29 |
| DN2.4.1<br>DN2.4.2<br>DN2.4.3 | Materials – printed and A-V | Reports on printed materials produced (brochures, leaflets, maps).<br>Report on DVD produced | M6, M38<br><br>TBD |
| DN2.5.1<br>DN2.5.2 | Press & News Coverage | News strategy and results report | M14, M32 |

| | | | |
|---|---|---|---|
| DN2.6.1,1<br>DN2.6.1,2<br>DN2.6.1,3 | External Events Results | From Year 2, annual report on representation of GN3 at events | M15, M27, M39 |
| DN2.7.1 | Focussed market outreach | Focussed market outreach or service user studies as required. | TBD |

Table 1.7: NA2 Deliverables

### 1.7.5.11 Milestones

| Milestone Code | Title | Description | Delivery Date |
|---|---|---|---|
| MN2.1.1 | Project internal communication | Public GN3 project website and GN3 project intranet/wiki for project internal communications – ready for the start of the project. Thereafter, ongoing site development will be reported as part of the overall NA2 annual deliverable report. Any specific projects may be reported on in their own deliverable if appropriate. | M1 |
| MN2.4.1<br>…..<br>MN2.4.7. | Materials – printed & A-V | GN3 leaflet/brochure/map | M5, M8, M17, M20, M29, M32, M41 |
| MN2.5.1,1<br>…..<br>MN2.5.1,7 | Press & News Coverage | Series of external and internal newsletters and newswires, | M4, 10, 16, 22, 28, 34, 40 |
| MN2.6.1 | Events | GN3 Launch Event, GN3 workshop at TNC, GN3 participation at ICT Conference and focused user workshops/seminars as required. General event representation will be reported as part of the overall NA2 annual deliverable report. | TBD |

Table 1.8: NA2 Milestones

## 1.7.6 Networking Activity 3 (NA3): Status and Trends

| WP Number | NA3 | | | | | Start date | | | |
|---|---|---|---|---|---|---|---|---|---|
| WP Title | Status and Trends | | | | | Activity Type | Networking Activity | | |
| Participant name | DANTE | TERENA | ACOnet | AMRES | ARNES | BELNET | BREN | CARNET | CESNET |
| Participant number | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| Person months | 0 | 121 | 0 | 24 | 0 | 0 | 0 | 0 | 24 |
| | | | | | | | | | |
| Participant name | CYNET | DFN | EENET | FCCN | GARR | GRNET | HEANET | IUCC | JANET |
| Participant number | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
| Person months | 0 | 0 | 0 | 0 | 0 | 0 | 7 | 0 | 0 |
| | | | | | | | | | |
| Participant name | KTU-LITNET | MARNET | MREN | NIIFI | NORDUNET | PIONIER | REDIRIS | RENATER | RESTENA |
| Participant number | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 |
| Person months | 0 | 0 | 0 | 5 | 144 | 12 | 0 | 0 | 0 |
| | | | | | | | | | |
| Participant name | RoEduNet | SANET | SIGMANET | SURFNET | SWITCH | ULAKBIM | UOM | TOTAL | |
| Participant number | 28 | 29 | 30 | 31 | 32 | 33 | 34 | | |
| Person months | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 337 | |

Table 1.9: NA3 Participants

### 1.7.6.1 NA3: Objectives

Activity NA3 will monitor the status and trends of various developments in and around the research networking environment that are directly relevant to the GN3 project. It will promote developments that will have a positive impact on research and education networking in and around Europe. NA3 will provide input for initiatives that can be undertaken in the GN3 project's lifetime, as well as input for the development of research and education networking in Europe after the completion of the GN3 project.

### 1.7.6.2 NA3: Work Plan

One of the major challenges facing European research and education networking is the disparity between the level of networking services that is available to researchers, teachers and students in different parts of Europe. Narrowing this digital divide is of the utmost importance for achieving the European Union's political goal of equal opportunities for researchers throughout the European Research Area. The SERENATE (2002-2003) and EARNEST (2006-2008) foresight studies have produced reports on the digital divide problems. EARNEST concluded that although some improvements have been made in some regions, the digital divide still exists and in some respects is becoming an increasingly urgent problem. Task 1 of NA3 will provide systematic information that will allow monitoring of the digital divide, while concrete actions to address the digital divide problems will be undertaken in Task 5 of NA4

To provide a conduit between the Joint Research Activities in the GN3 project and research and technical development work in the wider research networking environment, Task 2 of NA3 will assemble Task forces of experts from organisations and groups that are active in technical development work relevant to research and education networking.

The planning of the development of research networking infrastructure and services after the lifetime of the project will be vital, and Task 3 will provide a targetted foresight study as the policy input for initiatives that will

keep the European research networking at the forefront of worldwide developments, and enhance the competitiveness of the European Research Area

One of the main findings of the EARNEST study was that services that are available in theory are often not deployed in practice, nor used to the extent that one would expect. Often this is due to problems at the local (campus) level of research networking, or in the collaboration between local and national and European-level networkers. Task 4 will address campus issues by identifying best practices that can be taken up Europe-wide.

Finally, Task 5 will examine the environmental impact of networking to ensure that GN3 services meet ambitious sustainability goals, and promote energy-saving and ecologically sound applications layered over the GÉANT infrastructure.

***Task List and Descriptions***

- Task 1: Compendium of National Research and Education Networks. This Task will publish annual editions of the Compendium of National Research and Education Networks in Europe.
- Task 2: Coordination of Task Forces. This Task will bring various experts together in Task forces for the exchange of information, coordination of activities in the technical area and (where possible) preparation of new joint initiatives, including JRAs in the GN3 project.
- Task 3: Foresight Update. This Task will provide a limited foresight study to provide policy input for initiatives to keep the evolution of European research networking at the forefront of worldwide developments.
- Task 4: Campus Best Practice. This Task will address key challenges for the European campus networks and provide an evolving and to-the-point set of best-practice documents for the community.
- Task 5: Study of environmental impact. The Task will ensure that GÉANT services meet ambitious sustainability goals, and to promote energy-saving and ecologically sound applications layered over the GÉANT infrastructure

### 1.7.6.3 Task 1 of NA3: Compendium of National Research and Education Networks

***Task 1 of NA3: Objectives***

Task 1 will publish annual editions of the Compendium of National Research and Education Networks in Europe. These provide detailed information about the status of, and a general description of trends in, research and education network service provision at the national level in countries in and around the GÉANT service area. This information will assist in the planning of new initiatives, including both the evolution of Activities in the GN3 project and actions to be undertaken outside, or after the lifetime of, the GN3 project. In particular it will help in measuring and addressing the problems of the digital divide in research networking.

The Compendium will continue to be a comprehensive reference work providing an accurate picture of the state of NRENs in Europe and surrounding regions. It will be a tool that can be used by NRENs and others in planning of national and e-Europe services.

***Task 1 of NA3: Work Plan***

In order to compile the Compendium, detailed information is collected on a range of topics, including organisation, staffing, finances, user base, network capacity, services and plans for future developments.

As in previous years, a Compendium Review Panel of up to six knowledgeable members of the European research and education networking community will be appointed, responsible for defining and approving the appropriate questions for the Compendium questionnaire. Data will be collected using a custom-built Web interface designed and implemented by the TERENA Secretariat.

### 1.7.6.4 Task 2 of NA3: Coordination of Task Forces

***Task 2 of NA3: Objectives***

Throughout Europe, technical experts from many different organisations are active in developing, evaluating, testing, integrating and promoting new networking, middleware and application technologies. Task 2 will bring these experts together in Task forces for the exchange of information, the coordination of activities, the provision of feedback to the GN3 project, and (where possible) the preparation of new joint initiatives, including JRAs in the GN3 project.

Exchange of information between experts working in the GN3 project and other technical experts active in the foreseen Task forces will aid GN3 developments by collecting feedback from outside experts and early adopters on the (intermediate) results of research and development work in the GN3 project. Task 2 will

provide input to the evolution of JRAs and SAs in the GN3 project by ensuring that any innovation taking place in the wider environment (that is, the environment from which experts participate in Task Forces) is promptly introduced into the GN3 project as it becomes relevant.

Task 2 will also provide a mechanism for informing the network research and development community at large on the progress of GN3, and particularly progress in the JRAs.

#### *Task 2 of NA3: Work Plan*

Task forces will be organised and supported by members of the TERENA Secretariat staff, who will organise Task-force meetings and related events, maintain Task-force web pages and mailing lists, produce meeting reports, and monitor the progress of Task-force work items.

Currently, TERENA supports five technical Task forces in the broad areas of security, communication services, middleware, mobility and storage. Task forces will be created and dissolved by the TERENA Executive Committee in consultation with the Project Board and normally have a mandate of two years. Several of the Task forces referred to above will continue during (part of) the lifetime of the GN3 project, while new Task forces will be created during the project.

### 1.7.6.5 Task 3 of NA3: Foresight Update

#### *Task 3 of NA3: Objectives*

Task 3 will provide a foresight study. The study will provide policy input for initiatives that can help keep European research networking at the forefront of worldwide developments, and enhance the competitiveness of the European Research Area. It will prepare the ground for the planning of the development of research and education networking infrastructure and services after the completion of the GN3 project, at the local, national, European and intercontinental level.

The objectives mentioned above are largely the same as those of the large-scale foresight studies that were conducted in the SERENATE project (2002-2003) and, as part of the GN2 project, in the EARNEST study (2006-2008). Both SERENATE and EARNEST covered a wide range of aspects of research and education networking.

In the period 2004-2005, there was a major paradigm shift in research and education networking in Europe. Nevertheless, EARNEST did not find that there had been significant changes in all aspects under study as regards the actual situation and future expectations compared to those found by SERENATE. As EARNEST does not expect another major paradigm shift in the 2008-2011 time frame, it is not considered worthwhile to conduct another full-scale foresight study during the lifetime of the GN3 project. Instead, a smaller-scale action will be undertaken exploring questions arising at the time

#### *Task 3 of NA3: Work Plan*

Task 3 will start at the beginning of the third year of the GN3 project (March 2011). A large number of experts will be consulted to identify which aspects of research networking have experienced major developments since the EARNEST study (especially including deviations from the EARNEST predictions) and in which aspects of research networking major developments are expected in the next five years. On the basis of these investigations, a limited number (for example, 2 to 4) of small-scale studies will be undertaken to address promising developments. Reports on these studies will be published in the period January-July 2012.

The study reports are expected to contribute to the plans for the successor project to GN3, which will cover the final three years of the 7$^{th}$ Framework Programme, as well as to initiatives for the development of research and education networking at national and local level.

### 1.7.6.6 Task 4 of NA3: Campus Best Practice

#### *Task 4 of NA3: Objectives*

The overall objective of Task 4 is to address key challenges for the European campus networks and provide an evolving and to-the-point set of best-practice documents for the community.

An objective will be the ability to challenge individual NRENs to reinforce their national efforts. Better synchronisation of national research networking and campus issues is essential for viable end-to-end services. Another target is to find the means to develop and maintain national, and possibly Europe-wide, best-practice recommendations/documents. As in the GigaCampus project (see below), the IETF working model can be considered for these purposes.

#### *Task 4 of NA3: Work Plan*

Task 4 will base its work on the recommendations given in the EARNEST foresight study. The EARNEST study of campus issues formulated a number of essential conclusions in the areas of campus networking policy, infrastructure and services, mobility, security, end-user awareness and collaboration.

The work will take into account the experience gained in the GigaCampus project run by UNINETT, the Norwegian National Research and Education Networking organisation. A key success factor for GigaCampus has been the ability to gather campus network communities in working groups and meetings, discussing and defining common best-practice recommendations for the campus networks, jointly coupled with hands-on work in the field. Collaboration is also emphasised by EARNEST, which recognised that there is an unrealised potential in identifying and harvesting the good and solid practices carried out on individual campuses across Europe, and in turn benefiting from the resulting synergies for the whole of the community.

Task 4 will define the focus areas (for example, physical infrastructure, network, mobility, security, operations/measurements, multimedia etc.). The Task will elaborate how the emphasis on services and end-user needs is to be achieved. The needs of the modern student will be addressed; infrastructure should be provided and services harmonised with the needs of the "Google generation", i.e. dealing with new and arising services from the outside world.

The Task will provide technical background material for "buyers clubs" and other calls for tender on information and communication technologies in education, based on best practices from the activities.

### 1.7.6.7 Task 5 of NA3: Study of Environmental Impact

#### *Task 5 of NA3: Objectives*

The objectives of Task 5 are to ensure that GN3 services meet ambitious sustainability goals, and to promote energy-saving and ecologically sound applications layered over the GÉANT infrastructure.

The intention is to provide a clear account and understanding of total direct energy expenditure (e.g., energy consumed by the GN3 infrastructure), indirect energy savings caused by virtual meetings and other "dematerialisation" measures (e.g., by replacing travelling with Web communication when possible) and systematic effects due to, for example, the change in commuting distances due to mobile communication and the use of online resources.

#### *Task 5 of NA3: Work Plan*

The Task 5 is further divided into subTasks:

- Sub-Task 1, Baseline audits: This will gauge the direct, current energy and carbon footprints of GÉANT and of the four NRENs that take part in this Task. These will indicate where targets can be set to deliver service with reduced energy consumption and emissions of greenhouse gases.
- Sub-Task 2, Best Current Practice: This will produce a report on the best current practice of gaining indirect energy savings by using GÉANT and similar networks. This report will be prepared and made available at the second milestone in Month 24 of the project. This sub-Task will need help from external consultants. It will survey a subset of NRENs and some large education/research institutions.
- Sub-Task 3, Final results. In this sub-Task, the final results will be collated and disseminated. Recommendations will be made for GÉANT and for NRENs on environmental sustainability from strategic, operational and service perspectives. There will also be an outline of next steps to be taken in monitoring and improving environmental responsibility in the NREN community.

### 1.7.6.8 Deliverables

| Deliverable Code | Title | Description | Delivery Date |
|---|---|---|---|
| DN3.1.1,1<br>….<br>DN3.1.1,4 | Compendium of National Research and Education Networks | Task 1 will have one formal Deliverable each year - the printed edition of that year's Compendium of National Research and Education Networks in Europe. | M10<br>M22<br>M34<br>M46 |
| DN3.2.1,1<br>…..<br>DN3.2.1,4 | Annual Report on Task Force Activities | Task 2 will have one formal deliverable each year: an annual report on the Task force activities, with emphasis on the relevance for other parts of the GN3 | M12<br>M24<br>M36 |

| | | | |
|---|---|---|---|
| | | project. | M48 |
| DN3.3.1 | Foresight Study | Task 3 will have one formal deliverable:<br>A report on the (2-4) specific studies that will be carried out | M44 |
| DN3.4.1,1<br>…..<br>DN3.4.1,4 | Campus Best Practices | Task 4 will have one formal deliverable per year:<br>An annual report on the best-practice documents produced and on the progress of the rollout in the pilot NREN | M12<br>M24<br>M36<br>M48 |
| DN3.5.1 | Study of environmental impact | Energy audit of the GÉANT backbone services | M12 |
| DN3.5.2 | Study of environmental impact | Comparison of Network Services Environmental Impact to Alternatives | M24 |
| DN3.5.3 | Study of environmental impact | Study of Environmental Impact: Final Results | M36 |

Table 1.10: NA3 Deliverables

### 1.7.7 Networking Activity 4 (NA4): Liaison and Support

| WP Number | **NA4** | | | | | Start date | | | |
|---|---|---|---|---|---|---|---|---|---|
| WP Title | Liaison and Support | | | | | Activity Type | Networking Activity | | |
| Participant name | DANTE | TERENA | ACOnet | AMRES | ARNES | BELNET | BREN | CARNET | CESNET |
| Participant number | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| Person months | 264 | 24 | 0 | 0 | 0 | 0 | 2 | 0 | 65 |
| | | | | | | | | | |
| Participant name | CYNET | DFN | EENET | FCCN | GARR | GRNET | HEANET | IUCC | JANET |
| Participant number | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
| Person months | 0 | 0 | 0 | 0 | 5 | 0 | 0 | 5 | 24 |
| | | | | | | | | | |
| Participant name | KTU-LITNET | MARNET | MREN | NIIFI | NORDUNET | PIONIER | REDIRIS | RENATER | RESTENA |
| Participant number | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 |
| Person months | 0 | 0 | 19 | 0 | 0 | 19 | 0 | 0 | 7 |
| | | | | | | | | | |
| Participant name | RoEduNet | SANET | SIGMANET | SURFNET | SWITCH | ULAKBIM | UOM | TOTAL | |
| Participant number | 28 | 29 | 30 | 31 | 32 | 33 | 34 | | |
| Person months | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 434 | |

Table 1.11: NA4 Participants

#### 1.7.7.1 NA4 Objective

This activity will increase digital and geographic inclusion across the GN3 community through an overall strengthening of the relationships within the GN3 community itself, as well as between the GN3 community and stakeholders from outside the community. The activity will enable European and international users of the GN3 infrastructure to make best use of the existing and future service portfolio recognising, in particular, the increasing importance of end-to-end services. This will be pursued by giving support to NRENs as well as individual user initiatives and projects in co-operation with the appropriate NRENs involved. The activity also aims to actively seek dialogue with standardisation bodies and industry to strengthen and emphasise GN3 technological developments, as well as to bring the results of the GN2 and GN3 work into the global standardisation processes. The activity will feed information directly into SA1, SA2 and NA2 and there will also be close collaboration with JRA1.

#### 1.7.7.2 NA4: Work Plan

Dialogue will be carried out with R&E organisations across the globe. Close collaboration is necessary in the support of demanding international users or projects. Identification of possibilities for collaboration with international partners in the specific areas of e-health, e-learning and arts and humanities is also required. Cooperation will be continued with other world regions so that the common service and joint development activities of GN3 will complement and relate to similar initiatives in other world regions.

One specific goal is to establish a single point of contact for NREN enquiries (account management). Continuous dialogue with, and regular visits to, NRENs will be performed as required for the identification of NREN needs and specific technical support for the implementation of the full GN3 service portfolio. In addition the needs of demanding international user groups (HEP, Astronomy, Supercomputing, Earth Sciences, etc) will be adequately addressed.

To augment the global influence of the technical developments in GN2 and GN3, resources will be made available to actively bring the results of that work into the global standardisation processes. This will include developing existing relationships with standards bodies such as The Open Grid Forum, Internet Research Task Force (IRTF), and Internet Engineering Task Force (IETF). Meetings will be organised with key GN3 suppliers and manufacturers to exchange road-maps of product development and GN3 requirements.

Following the selection of focus countries and the priority setting for needs assessments, suitable support action plans will be developed to diminish the digital divide for less advanced countries.

***Task List***

NA4 is structured into the following Tasks:

- Task 1: International Cooperation (Outside the GÉANT Service Area)
- Task 2: Internal Cooperation (Consultation with Partners
- Task 3: Liaison with Projects and Initiatives
- Task 4: Liaison with and Contributions to Standards Bodies and Liaison with Industry
- Task 5: Assistance to the Development of Research and Education Networking in Less Advanced Regions

#### 1.7.7.3 Task 1 of NA4: International Cooperation (Outside the GÉANT Service Area)

***Task 1 of NA4: Objectives***

In line with fostering global research networking, it is the overall objective of this Task to strengthen the GN3 project through attractive, stable and long-term relations and strategic partnerships across the globe. Close collaboration between the GN3 community and its international peers will lead to the digital inclusion and geographic integration of the global R&E networking community.

The Task aims to increase the dialogue between the GN3 community and global or regional R&E networking organisations, and to strengthen existing partnerships. The Task aims at close collaboration with, and support to, international projects and will seek synergies with GÉANT's regional activities (such as EUMEDCONNECT, TEIN and ALICE). New international peering opportunities will be sought through dialogue with regional R&E networking organisations in, for example, Sub-Saharan Africa or the Middle East.

This work will be supported by the identification of key users and projects in Europe that have a global dimension, and the exploring of synergies across the different regional activities.

***Task 1 of NA4: Work Plan***

To influence the international developments in R&E networking it will be necessary to develop and maintain a dialogue with international organisations across the globe (including Internet2, ESnet, CLARA, Ubuntunet Alliance, CAMREN, APAN, etc.), with participants from key international R&E Projects, and with the respective funding organisations. The project will facilitate participation of European NREN's in such initiatives.

A capacity and product portfolio of the current set of links will be developed, together with financial and cost sharing models, and a strategy for the optimal sharing of available international network resources.

### 1.7.7.4 Task 2 of NA4: Internal Cooperation (Consultation with Partners)

***Task 2 of NA4: Objectives***

The success of the GN3 project is closely bound to that of the European NREN partners. To effectively address the demands of the international research and education community, the project must meet the needs of each of its partner NRENs. Since each of the European NRENs is unique in terms of geography, financial status, technical development, national policy and culture, maximising their involvement and the benefit they receive from GN3 is an important and challenging activity.

***Task 2 of NA4: Work Plan***

This work is divided into three sub-Tasks:

- Effective organisation of the services offered to the European NREN community, including service information dissemination, consultation and account management of GÉANT services.
- Provision of a single-point of contact for support of NREN activities and requirements.
- NREN requirement gathering to feed essential capacity planning (SA1) and service demand (SA2) information into the project service activities.

A portfolio document and on-line resource will be created and maintained providing an up-to-date snapshot of the services offered by the GN3 project. This text and diagrammatic material associated with service dissemination will be fed into to NA2 for wider dissemination.

Regular visits will be made to NREN offices to strengthen relationships and to encourage inclusion and active participation in the project, and allow collection of NREN network requirements. The Task will work closely with procurement and operational functions to ensure both that technology and service changes are effectively communicated and to manage the provision of backbone and equipment upgrades.

### 1.7.7.5 Task 3 of NA4: Liaison with Projects and Initiatives

***Task 3 of NA4: Objectives***

It is the objective of this Task to liaise with target user groups, NRENs and users of the GN3 product portfolio with the aim of encouraging productive use of the network for new users and applications. Also, the Task will help both existing and new members of the target groups to get the best out of the network for their needs and the requirements of their applications. The Task will give special technical support to NRENs where appropriate to increase digital and geographic inclusion across the GN3 community.

***Task 3 of NA4: Work Plan***

This Task will interact with existing projects and user groups and the relevant associated NREN's to determine how the network, protocols, and hosts interact with the applications. It will participate in trials/proof of concept of new network applications with the relevant user groups to determine the network needs of the application and the effect of the application on the network.

The Task will include collaboration with Trans-European (e.g. appropriate infrastructures on the ESFRI roadmap) and international projects. It will help to keep abreast of technical research and developments, hence identifying new potential uses of the network.

Finally, the Task will support of information exchange between NRENs in evaluation of new network planning and technical issues, in collaboration with JRA1 and Task 2 - Internal Coordination with the aim to feed user and application needs into the technical development of GN3.

### 1.7.7.6 Task 4 of NA4: Liaison with and Contributions to Standards Bodies and Liaison with Industry

#### *Task 4 of NA4: Objectives*

It is the objective of the Task to act as a bi-directional conduit between the GN3 project and the standards organisations. In addition, the Task aims to track and evaluate technical and product developments of the relevant suppliers and manufacturers and exchange technical road-maps. This will include horizon scanning of emerging technology and evaluation of the potential impact on GN3 development.

#### *Task 4 of NA4: Work Plan*

It is intended to extend existing or enter into new relationships with standards bodies such as OGF IETF,IRTF, and bodies developing standards for global community use, and continue participation in European activities (such as FIRE) while strengthening collaboration with similar projects in Japan and the US. The intention will be to bring the results of the technical development work in the GN2 and GN3 projects to the global standardisation process that takes place in standards bodies by contributing, where appropriate, to RFC's and other draft standardisation instruments. It is difficult to be precise about the deliverables that may be generated by this Task. An annual report on progress and achievements is planned, together with deliverables documenting significant written submissions to standards bodies.

A second function is to organise meetings with key GN3 suppliers and manufacturers, to exchange road maps of product development and GN3 requirements and to test the operation and performance of new equipment, in collaboration with suitable JRA1 activities. Inter-operational testing will be done where it is appropriate to facilitate the interworking between NRENs using products from different manufacturers.

### 1.7.7.7 Task 5 of NA4: Assistance to the Development of Research and Education Networking in Less Advanced Regions

#### *Task 5 of NA4: Objectives*

There is a significant disparity between different countries and regions in Europe in the status and development of research and education networking. Wide differences, spanning multiple dimensions (technical, financial, and political) exist between countries in Europe. Narrowing this divide is of the utmost importance for achieving the European Union's political goal of equal opportunities for researchers throughout the European Research Area.

The objective is to contribute to diminishing this divide in the level of research and education networking facilities and services that exist between different countries and regions. The geographic scope of the actions is European and Mediterranean countries whose NRENs are less advanced.

#### *Task 5 of NA4: Work Plan*

Members of the TERENA Secretariat staff will carry out the work with contributions from staff members of other GN3 project participants, and possibly other experts in the European research and education networking community. A Development Support Advisory Panel composed of 4 to 6 senior representatives of NRENs and chaired by TERENA will assist them. The Panel will assist in the selection of focus countries and the priority setting for needs assessments. They will advise on the support actions to be undertaken, and they will act as a quality control panel for needs assessments reports and the individual support actions.

The work will include studies of the status of research and education networking at national and local level, resulting in confidential executive "country needs assessments" reports, as well as specific support actions to implement the recommendations laid down in those reports. Support actions make take the form of technical or managerial workshops, consultancy etc.

The Task targets primarily (national and local) research networking organisations in less advanced countries represented in the GN3 consortium and neighbouring countries.

### 1.7.7.8 Deliverables

| Deliverable Code | Title | Description | Delivery Date |
|---|---|---|---|
| DN4.1.1,1<br>….<br>DN4.1.1,4 | Feedback on Discussions with Global RE Organisations | Regular provision of feedback to partners related to discussions with global R&E organisations. | M6<br>M12<br>M24<br>M36 |
| DN4.2.2<br>DN4.2.3 | Case Study into the Use of International Connectivity | Development of content for a case study on the use of international connectivity. | M24<br>M48 |
| DN4.2.1 | GÉANT Service Portfolio | Creation of GÉANT service portfolio document and associated on-line resource for service-related information. | M12 |
| DN4.3.1 | Reference Site Documentation | Documentation of a reference site, a case study or a proof of concept demonstration | M18 |
| DN4.4.1,1<br>….<br>DN4.4.1,4 | Contribution to standards | Annual reports summarising contributions and achievements | M12<br>M24<br>M36<br>M48 |
| DN4.5.1,1<br>DN4.5.1,4 | Annual Reports on Country Needs Assessments and Development Support Actions | Annual reports on country needs' assessments and development support actions performed. | M12<br>M24<br>M36<br>M48 |

Table 1.12: NA4 Deliverables

### 1.7.7.9 Milestones

| Milestone Code | Title | Description | Delivery Date |
|---|---|---|---|
| MN4.2.1 | Agreements for Delivery of Point-to-Point Circuits | Agreements relating to the delivery of point-to-point circuits to other world regions. | M24 |
| MN4.2.2 | Single point of contact for NREN utilisation of GÉANT services | Establishment of a single point of contact for NREN utilisation of GÉANT services and consultation on international network requirements. | M6 |
| MN4.2.3,1<br>….<br>MN4.2.3,3 | Annual Service Review Workshop for NRENs | Joint organisation of and participation in an annual Service Review Workshop, for the purpose of inter-project dissemination on existing and future services (in collaboration with NA2, SA1 and SA2 ) | M12<br>M24<br>M36 |
| MN4.2.4 | Presentational material for New Users and Communities | Content for presentational material focused on enabling the target users to understand the service portfolio and network connectivity options ready to be used | M6 |
| MN4.3.1<br>MN4.3.2 | New User Communities and Application Areas | New user communities and application areas making use of GÉANT. | M18<br>M36 |
| MN4.4.X | Meetings, Working Groups and Standards | Participation in standards meetings and meetings with key manufactures and suppliers. | TBD |
| MN4.4.Y | Involvements in Standards | Involvement in the creation of new standards-related working group or research group, documents or draft standards | TBD |

| | | | |
|---|---|---|---|
| MN4.5.1 | Networking in less advanced regions | Selection, focus and priority setting for countries to be targeted together with an initial description of the workplan | M9 |

Table 1.13: NA4 Milestones

### 1.7.8 Summary Effort Table

Table below provides a summary of the staff effort in NAs. It indicates the number of person months over the whole duration of the planned work, for each work package by each participant. The work-package leader for each WP is identified by showing the relevant person-month figure **in bold**.

| Participant No | Paticipant short name | NA1 (Person months) | NA2 (Person months) | NA3 (Person months) | NA4 (Person months) | Total person month |
|---|---|---|---|---|---|---|
| 1 (Coordinator) | DANTE | **458** | **122** | 0 | **264** | 845 |
| 2 | TERENA | 22 | 40 | **121** | 24 | 206 |
| 3 | ACOnet | 0 | 0 | 0 | 0 | 0 |
| 4 | AMRES | 0 | 0 | 24 | 0 | 24 |
| 5 | ARNES | 0 | 0 | 0 | 0 | 0 |
| 6 | BELNET | 0 | 0 | 0 | 0 | 0 |
| 7 | BREN | 5 | 0 | 0 | 2 | 7 |
| 8 | CARNET | 0 | 0 | 0 | 0 | 0 |
| 9 | CESNET | 14 | 0 | 24 | 65 | 103 |
| 10 | CYNET | 0 | 0 | 0 | 0 | 0 |
| 11 | DFN | 0 | 0 | 0 | 0 | 0 |
| 12 | EENET | 0 | 0 | 0 | 0 | 0 |
| 13 | FCCN | 0 | 0 | 0 | 0 | 0 |
| 14 | GARR | 24 | 12 | 0 | 5 | 40 |
| 15 | GRNET | 0 | 0 | 0 | 0 | 0 |
| 16 | HEANET | 0 | 0 | 7 | 0 | 7 |
| 17 | IUCC | 5 | 0 | 0 | 5 | 10 |
| 18 | JANET | 0 | 0 | 0 | 24 | 24 |
| 19 | KTU-LITNET | 0 | 0 | 0 | 0 | 0 |
| 20 | MARNET | 5 | 0 | 0 | 0 | 5 |
| 21 | MREN | 5 | 0 | 0 | 19 | 24 |
| 22 | NIIFI | 5 | 5 | 5 | 0 | 14 |
| 23 | NORDUNET | 0 | 0 | 144 | 0 | 144 |
| 24 | PIONIER | 5 | 0 | 12 | 19 | 36 |
| 25 | REDIRIS | 5 | 0 | 0 | 0 | 5 |
| 26 | RENATER | 0 | 0 | 0 | 0 | 0 |
| 27 | RESTENA | 0 | 0 | 0 | 7 | 7 |
| 28 | RoEduNet | 5 | 0 | 0 | 0 | 5 |
| 29 | SANET | 0 | 0 | 0 | 0 | 0 |
| 30 | SIGMANET | 5 | 7 | 0 | 0 | 12 |
| 31 | SURFNET | 0 | 0 | 0 | 0 | 0 |
| 32 | SWITCH | 5 | 0 | 0 | 0 | 5 |
| 33 | ULAKBIM | 0 | 0 | 0 | 0 | 0 |
| 34 | UOM | 0 | 0 | 0 | 0 | 0 |
| | | 566 | 186 | 337 | 434 | 1522 |

Table 1.14: Summary Effort Table for Networking Activities (NAs)

Also see section 2.4 “Resources to be committed”.

### 1.7.9 Interdependencies of GN3 Networking Activities

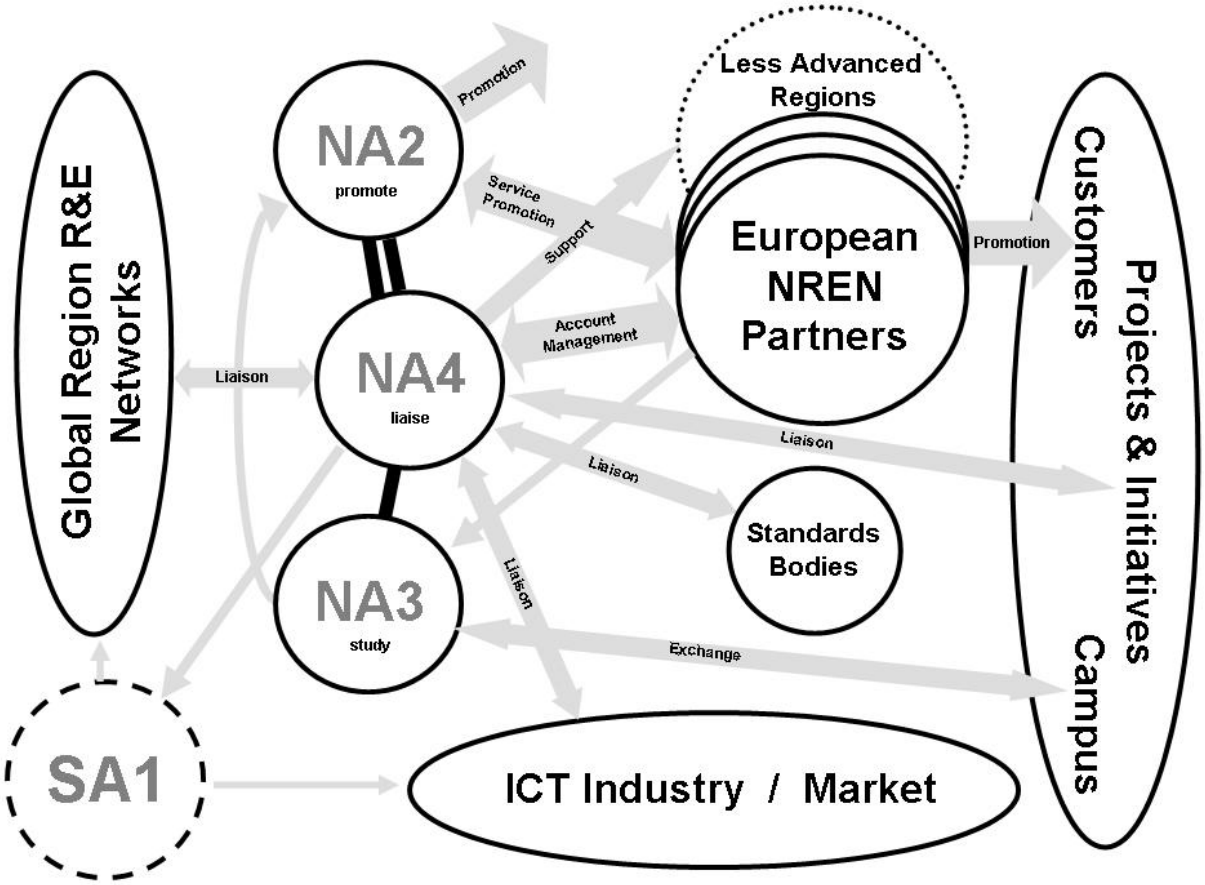


Figure 1.6: GN3 NAs and their interdependencies

### 1.7.10 Significant risks and associated contingency plans

The Networking Activities consist of NA1, which describes the overall management of the project, and NAs 2 to 4, which deal with more specific elements of dissemination. The analysis of risks and the approach to contingency plans differs between these two categories of NAs.

Regarding NA1, the principal risk is that the governance structure will not operate effectively primarily for two possible reasons:

1. Inadequate internal communications and information flow so that management decision making is not founded on good information.
2. Poor decision making structures with blurred lines of responsibility, accountability and authority.

The Management Structure proposed for GN3 has incorporated many lessons learned from GN2. In particular, improvements are being made in GN3 with respect to internal communications. Communications run via the Activity Leaders and the Project Office. Task Leaders also play an important role in this. The Project Management Team is tasked to create activities specifically aimed at ensuring a common awareness of the objectives and progress of the project. GN3 is considering the use of internal surveys as a way of understanding how successful this is, as well as continuing the practice of associating fulfilment questionnaires with events.

Regarding decision making structures, a significant improvement comes with the creation of the Project Management Team (consisting of the all activity leaders and the Project Managers). The co-ordination function

enabled as a result of the creation of this team will be important here. Regular meetings of this core team will not prevent problems occurring, but the creation of a common team of the activity leaders will assist in the early resolution of any cross-activity issues.

The other Networking Tasks are, to some reasonable extent, relatively straightforward dissemination activities associated with the project. There is the general risk of either duplication of work between NAs 2 to 4, or of items being missed, To avoid this a regular co-ordination among the NA activity leaders is envisaged.

To a large extent, the risks for the individual activities mirror the risks of the project. If the JRAs and SAs underachieve, there is less to disseminate in a convincing way. Specific risk items recognised in individual NAs are as follows:

- NA2 Joint Dissemination and Outreach. There are two recognisable risks. The first relates to Web-Based communications. It is possible that a less-than-optimum platform is chosen for the GN3 Web site. This risk will be minimised by seeking advice from NREN's who have recently upgraded their web-sites, and by analysing best practice in the commercial sector. The other element of NA2 that has potential risk associated with it is Focussed Market Out-Reach. The potential risk here is a lack of take up. This will be minimised as part of the overall management process in the Project Team.
- NA3: Status and Trends. None Recognised.
- NA4: Liaison and Support. As with the NAs in general, a particular risk is under achievement by the project as a whole, which would reflect into the NA4 activity. Specific risks relate to sporadic NREN take-up of new services, where it is planned to provide a barometer of service take-up to act as a stimulus to wider implementation. The standards liaison Task carries the risk of being unable to provide the level of resource to achieve success. This will be mitigated by very careful choice of where standardisation effort should be placed, and by initial calculation of potential resources and assurances of their availability before work is started.

## 1.8 Service Activities and associated work plan

### 1.8.1 Overall strategy of the work plan

In contrast with GN2, GN3 will place a much heavier emphasis on Service Activities (SAs). This is partly because GN3 is building on the JRAs of GN2 and developing them into a full service environment, and partly because the focus of innovation is moving away from technology deployment and towards implementing services based on advanced technology deployed in multiple independent domains. The focus on service also responds to the findings of the EARNEST study; a foresight study that predicts the future requirements of the NREN community for the next 5-10 years. EARNEST [http://www.terena.org/activities/earnest/] notes that:

"A cultural change is taking place with the emphasis moving from providing connectivity to providing network related services."

GN3 will recognise this cultural change by offering a unique portfolio of research services to GN3 partners.

Achieving this will require considerable innovation in the ability to provide services to end-users, independent of the underlying operational management domains involved. The basic IP service is the state–of-the-art today in providing operational network services that cross management domains. The development of a services portfolio that enables users to deploy a much richer portfolio of service capabilities will represent a considerable extension to the current position, and will deliver a wider and more efficient access to, and use of, European research infrastructures.

The SAs are divided into four groups of work:

- SA1 GÉANT Network Architecture, Design and Planning, Procuring, Building and Operating: This will integrate the results of technological developments into the current GÉANT infrastructure and review, operate and develop the existing architecture. Emphasis will also be given to extending the service portfolio to other world regions.
- SA2 Multi-Domain Network Service Operation: This will ensure that that the technological evolution of network services results in their operational enhancement from a user perspective, with the intention of improving accessibility and service robustness as well as dealing with the inter-domain processes necessary for seamless service operation.
- SA3 End User Services in a Federated Environment. As well as developing the enhanced portfolio of network services, GN3 will also develop multi-domain services targeted at end-users. The proposed service activity covers a range of work, from the provision of an AAI federation (as a general access and security

tool for use by other services) to the support of specific end-user services (including video conferencing and roaming). To achieve this it is necessary to engage NREN's in developing their national services and involving end-users.

- SA4 Software Governance: This activity is a result of the fact that software development will play a key role in many GN3 activities. Based on the experience gained in GN2, SA4 will provide a disciplined cross-project software development environment.

Shows the relationships between the SAs and the users they will service:

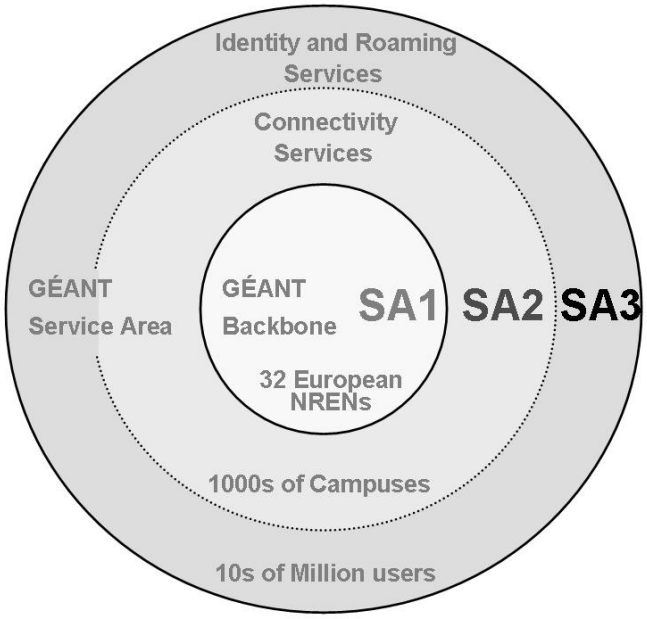


Figure 1.7: SAs and Target Users

A major objective of GN3 is the commitment to develop and implement a range of multi-domain services offering value added to end-users. The success of this objective is dependant on the take-up of such services across the GÉANT service area. It is recognised that the main criteria for success in respect of these service development activities will measured by service take-up. In advance of having services which are being rolled out, it is difficult to be definitive about what will constitute success in terms of geographic footprint. Based on the transition to service model of a pilot, interim and full service roll out, the co-ordination function within the Project Office will look to establish, monitor and report upon these success criteria particularly in terms of service take-up.

## 1.8.2 Timing of WPs/Activities and their components

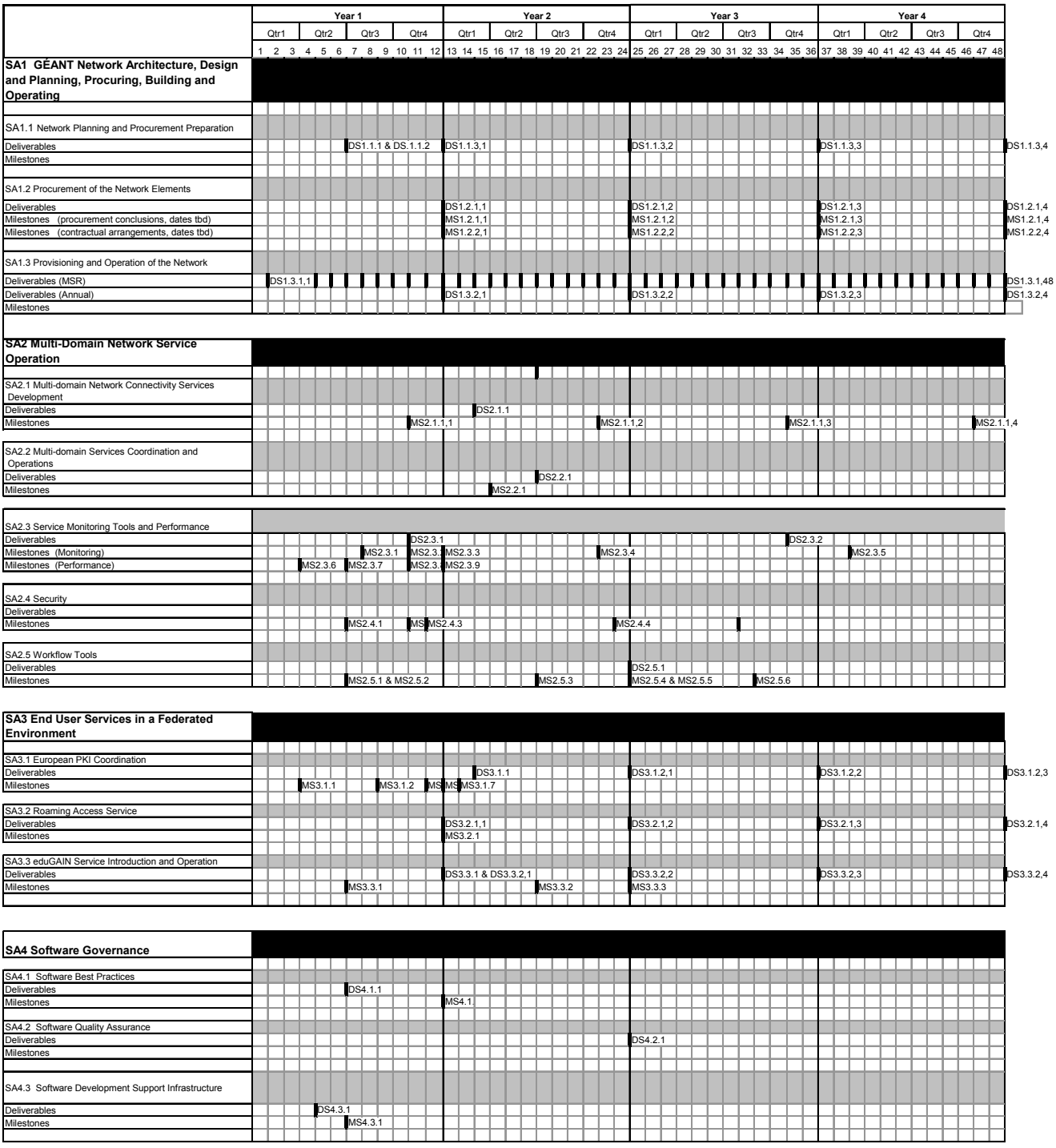


Table 1.15: SA Timings

### 1.8.3 Work package list

| Activity number | Activity Title | Type of activity[3] | Lead participant number[4] | Lead participant short name | Person months[5] | Start month[6] | End month[6] |
|---|---|---|---|---|---|---|---|
| SA1 | GÉANT Network Architecture Design, Procurement and Operation | SVC | 1 | DANTE | 953 | 1 | 48 |
| SA2 | Multi-domain Network Service Operation | SVC | 31 | SWITCH | 1831 | 1 | 48 |
| SA3 | End-user Services in a Federated Environment | SVC | 19 | JANET | 566 | 1 | 48 |
| SA4 | Software Governance | SVC | 1 | DANTE | 228 | 1 | 48 |
| | TOTAL | | | | 3578 | | |

Table 1.16: SA Work Packages

[3] Types of activities (EC classification):
RTD = Research and technological development; COORD = Co-ordination;
MGT = Management of the consortium; SVC = Service activities.
[4] Number of the participant leading the work in this work package (see List of Participants in the beginning).
[5] The total number of person-months allocated to each work package.
[6] Measured in months from the project start date (month 1).

### 1.8.4 Service Activity 1 (SA1) GÉANT Network Architecture Design and Planning, Procuring, Building and Operating

| WP Number | SA1 | | | | | Start date | | | |
|---|---|---|---|---|---|---|---|---|---|
| WP Title | | | | | | Activity Type | Service Activity | | |
| Participant name | DANTE | TERENA | ACOnet | AMRES | ARNES | BELNET | BREN | CARNET | CESNET |
| Participant number | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| Person months | 876 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 13 |
| | | | | | | | | | |
| Participant name | CYNET | DFN | EENET | FCCN | GARR | GRNET | HEANET | IUCC | JANET |
| Participant number | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
| Person months | 0 | 0 | 0 | 0 | 9 | 9 | 0 | 0 | 0 |
| | | | | | | | | | |
| Participant name | KTU-LITNET | MARNET | MREN | NIIFI | NORDUNET | PIONIER | REDIRIS | RENATER | RESTENA |
| Participant number | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 |
| Person months | 0 | 0 | 13 | 0 | 8 | 13 | 0 | 0 | 0 |
| | | | | | | | | | |
| Participant name | RoEduNet | SANET | SIGMANET | SURFNET | SWITCH | ULAKBIM | UOM | TOTAL | |
| Participant number | 28 | 29 | 30 | 31 | 32 | 33 | 34 | | |
| Person months | 13 | 0 | 0 | 0 | 0 | 0 | 0 | 953 | |

Table 1.17: SA1 Participants

#### 1.8.4.1 Objectives

GN2 has already implemented a hybrid network infrastructure on which GN3 can build. Nevertheless, there are changes to the historic assumptions about the architecture and design of the network that can be made in GN3. The technical review of advanced network technologies, to be carried out in JRA1, will highlight technical advances that will have a significant impact on the way the network evolves in GN3. Likewise, economic considerations about the costs of connectivity and switching and routing hardware will challenge existing assumptions about cost effective structures. The possibility of shared fibre acquisition and/or shared use between NREN and GN3 is a potential cost-saving approach, as is the possibility of joint-lighting of routes between the project and connectivity suppliers. It is therefore the first objective of this activity to conduct a thorough review of the GÉANT network architecture that will analyse these factors.

Preparatory work for this will commence before the project starts. This review will provide a planning structure for future network element implementation by considering:

- The results of investigations into technological developments.
- The availability of fibre infrastructure.
- The ongoing and emerging requirements of Research and Education networking customers.
- The results of detailed comparisons of total cost of ownership associated with the various options available.
- Other factors such as the geographic expansion of the footprint of the network as well as locations on the current GÉANT footprint where international connectivity costs are expensive due to lack of competition.
- The economic element of the Earnest study, which analysed costs on a geographic basis.

This analysis, which will be carried out at the start of the project, will feed into the strategy for procurement and implementation to be adopted in GN3. The objective will be to achieve optimum value for money solutions by:

- Carrying out the procurements according to best practice and EU procurement directives and

- Investigating new models for provisioning the network that will achieve the requirements set out in the procurement planning. This will include the investigation and development of possibilities to share fibre lines by GÉANT and NRENs by means of DWDM and shared lighting options with operators.

The existence of this highly performant, innovative and cost-effective network that meets the exceptional requirements of the research and education community and is provided at the most economic cost is a key element in the service activity of this project

The physical operational network connecting the Research and Education Community through the National Research and Education Networks (NRENS) will offer an initial set of services brought in from GN2 that will be developed and enhanced over the lifetime of the project, together with the introduction of new services.

Value for money, reliability, efficiency and fitness for purpose will benefit the users, exceed their expectations and provide the platform to improve and enhance research and education across the community. Vendors will also benefit by being challenged to develop and provide leading edge advanced services to meet the community's requirements.

### 1.8.4.2 Task 1: Network Planning and Procurement Preparation

#### *Task 1 SA1: Objectives*

The objectives of this task are to:

- Undertake a comprehensive review of all practicable GÉANT backbone architectures (at the network layer and below).
- Consider the results of investigations into the ongoing and emerging requirements of research and education networking customers and global networking partners (e.g. those emerging from NA4), and establish strategies to meet these requirements
- Investigate possible fibre-line availability (especially in GN3 countries outside the GÉANT2 fibre footprint). The efforts will continue from the GN2 project through the GN3 project term, with the main effort in Year 1.
- Consider the results of investigations into technological developments (e.g. those undertaken within JRA1).
- Consider the results of investigations into energy, space and travel savings (for example by means of remote maintenance) in network design and operation
- Provide a planning structure for future network element procurements.
- Provide input on the technical requirements of the services or equipment to be procured.

#### *Task 1 of SA1: Outline of Work Plan*

The network planning and procurement preparation task will focus on producing optimal designs for the lower layers (up to and including the IP/MPLS layer) of the cost-shared part of the GN3 network infrastructure (the "GÉANT" interconnect network) taking into account the following:

- The results of a thorough and far-reaching study of innovative backbone architectures, including options such as regional clustering of NRENs, dual NREN accesses, use of cross-border fibre and additional optical exchange points for long distance cables.
- Knowledge of existing and upcoming transmission infrastructures (including that available from commercial providers and from within the consortium partners own network resources).
- The expansion plans of the GÉANT consortium (e.g. providing access to new NREN partners).
- Network capacity forecasts based on ongoing investigations realised through the analysis of periodic customer forecast questionnaires (issued through NA4), and utilisation of the monitoring service to analyse and predict trends.
- The results of detailed comparisons of total (operational) cost of ownership (TCO) associated with the various options available.
- Input from JRA1 (on transmission/transport technology trends and topological optimisation studies).
- Liaison with the service architecture design activities within SA2/JRA2.
- Global connectivity planning and optimization with input from NA4.
- The results of studies of network and service resilience.

It should be noted that there is unlikely to be a fully "clean-slate" approach taken to the task of designing the GN3 network infrastructure. During the lifetime of GÉANT2, there has been a significant, strategic investment made in specific, long-term dark fibre leases and procurement of associated transmission equipment. The result of this, in the form of the set of 10Gbps wavelengths that have been commissioned over the GÉANT2 infrastructure to date, is shown in Figure 1.8

For the most part, the initial capital investment in these has now been fully depreciated but the infrastructure still retains some useful, further operational lifetime (up to 7 years for much of the dark fibre and probably 3-5 years for the DWDM equipment). This investment will be exploited as much as possible, taking into account the aspects listed above. The total cost of ownership will always be an important factor in determining whether to continue to use parts of the existing asset base or to invest in new infrastructure opportunities. However, this calculation will not only focus on TCO calculated over the project lifetime but also on aspects such as service performance and future, long-term strategic investment decisions (including those associated with maintaining technological advancement).

The work will be supported by the Backbone Architecture Supervisory Committee, which will act in an advisory role. This will be facilitated by meetings of this group, at which the task leader will be expected to attend and to present a summary of the latest planning results.

In addition, this task will issue periodic planning documents as project deliverables.

The outcome of the architecture planning and procurement preparation will be validated at a high level before being transferred to the procurement activity. Once validated in the NREN Policy Committee, the procurement goals will be passed on to the procurement team.

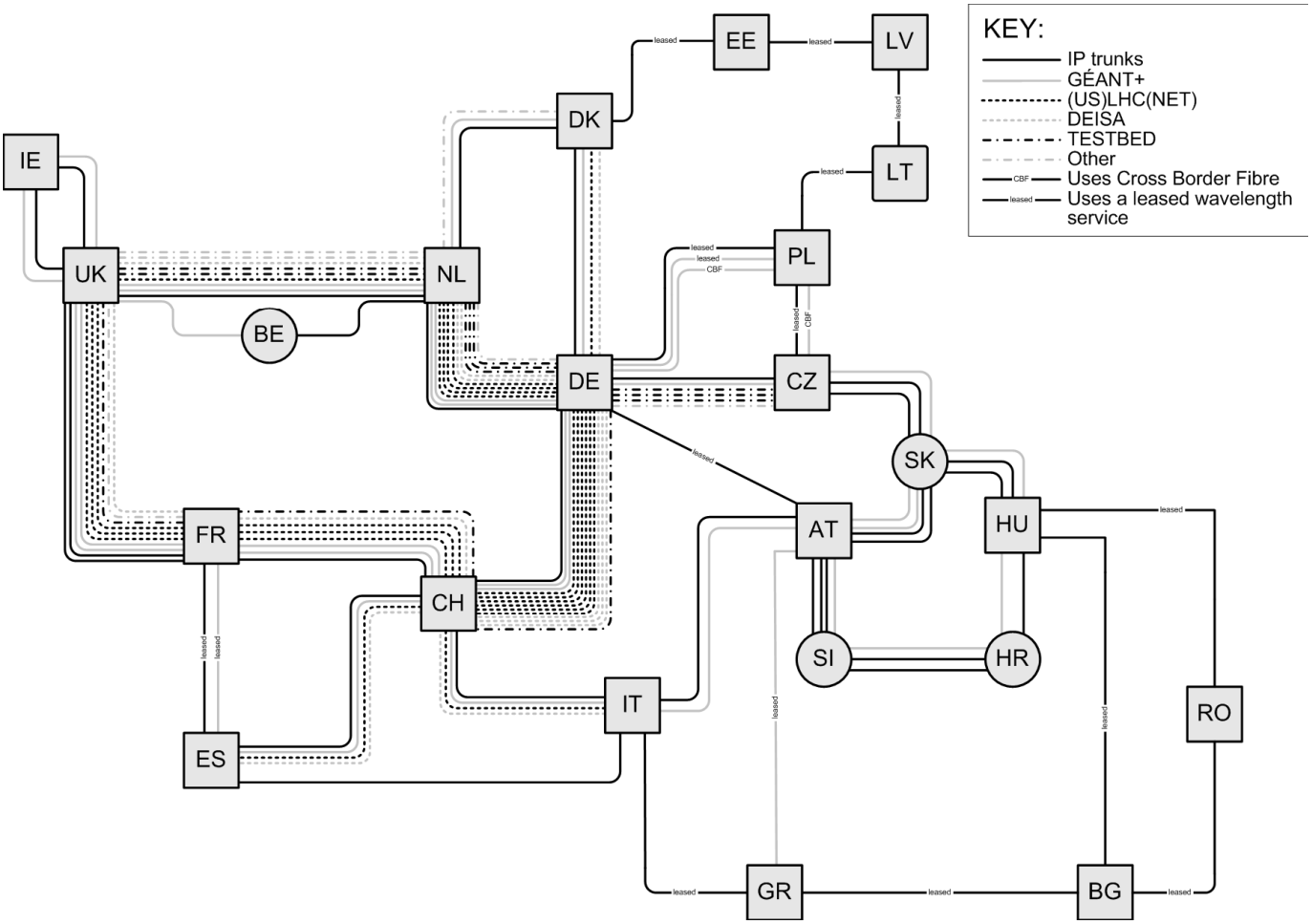


Figure 1.8: GÉANT2 10Gbps wavelength connectivity (Summer 2008)

### 1.8.4.3 Task 2 of SA1: Procurement of the network elements

***Task 2 of SA1: Objectives***

The Procurement task will follow the Network Procurement Preparation task. Its main objective is to achieve optimum value for money solutions identified in task 1 by carrying out the procurements according to best practice and EU procurement directives. This will be achieved by:

- Regularly re-tendering those parts of the infrastructure currently provided via short-term commitments.
- Tendering for new network equipment, as identified by the architectural and technology studies in task 1.
- Seeking further expansion of international lambda provisioning at lowest cost, whether by access to underlying fibre dedicated to the project, shared use of fibre/transmission equipment with commercial providers, or NREN infrastructures.
- Improving resilience aspects of the current network with the target that connectivity to each NREN should be by a minimum of dual diverse connections and where possible also with dual access points.

A procurement team, consisting of some NREN experts and DANTE staff, will prepare and conduct the procurement. Procurement results will be validated by the Project Board.

***Task 2 of SA1 Work Plan***

Taking the inputs from the Network Planning task, an annual procurement plan will be determined and the procurements then executed according to the plan using appropriate EC public procurement rules. Annual Reports on the outcome of the procurement will be issued as deliverables. Procurement outcomes will also be used as input to the Cost Sharing Steering Committee (CSSC) activities in NA1 to ensure that future contracted services match the NRENs' budgetary capabilities.

#### 1.8.4.4 Task 3 of SA1 Provisioning and Operation of the GÉANT Network

***Task 3 of SA1: Objectives***

This task will undertake the operational developments and service support functions that are needed in the state-of-the-art GÉANT pan-European backbone. It will be coupled with the Network Planning task, where technical developments are reviewed, and capacity expansion plans determined, to implement an operational capability that will provide a competitive and efficient service to the network users. It will address:

- The provisioning and maintenance requirements of new service types transiting the GÉANT backbone (and the enhancement of the existing ones).
- The related requirements arising from operating the underlying platform(s) upon which these services are transported.
- The ongoing refinement of the user experience.

The GÉANT Network Operations Centre (NOC) and the higher-level operations group within DANTE will continue to develop advanced, proactive approaches to the key functions of network operations. These include:

- Streamlined manual and semi-automated service provisioning processes.
- Enhanced in-service performance monitoring, pre-emptive fault management.
- Rapid fault detection with streamlined diagnostic and repair processes.
- Enhanced security incident detection and reporting, details of which being develop.
- Appropriate service accounting, service cessation processes, etc.
- Operational procedures for connectivity between GÉANT and research networks in other world regions.

***Task 3 of SA1: Work Plan***

The different operational areas will be covered as follows:

- **Service Design**: By liaising with NA4 and SA2 there will be an ongoing update of the services provided by the GÉANT backbone to reflect the customers' needs for new services or for upgrades to existing ones. The changes in the service portfolio will be followed by the inclusion of new Service Level Agreements (SLAs) targeted at managing the quality of new services provided. This area will include aspects such as the introduction and the operational support of 40Gbps IP accesses and backbone circuits.
- **Service Transition**: Definition of the support models and workflow management for the introduction in the GÉANT backbone of the new processes and tools defined by SA2. One of the main tasks for SA2 will be the definition of best practices for the support of multi-domain operational services. The adoption of these best practices by every domain involved in the provisioning of multi-domain services (the GÉANT backbone represents one such domain) will be addressed in this task. Appropriate resources will be dedicated to aspects such as the introduction of systems for the automated provisioning of service (e.g. AutoBAHN) and the interaction between the DANTE operational database and the I-SHARe component.
- **Service Operation**: Focusses on the maintenance and performance enhancement of the core network services already offered and expected to be offered by the GÉANT backbone. In addition to the basic IPv4 "best effort" service, through which GÉANT currently offers Internet Protocol (IP) connectivity to the NRENs, providing them access to the shared European IP backbone, these services include: IPv6,

multicast, Premium IP, layer-2 Virtual Private Networks (VPNs) and Circuit (Point-to-Point) services. The GÉANT Circuit service allows NRENs to request point-to-point circuits at speeds of between 155Mbps and 10Gbps across the backbone.

- **Network Operations:** Improvement of the integration of the Network Operations monitoring tools, Trouble Ticket System and the DANTE Configuration Items (CI) database together with better monitoring of security incidents will improve the overall service levels and availability management. During the GN3 project, it is expected that this database will be enhanced; for example to better reflect day-to-day operational processes. The database software will be made available to any NREN that could benefit from its deployment.

  Better integration of the database with the existing monitoring tools, together with the addition of passive monitoring tools, will provide a powerful planning, forecasting and trend analysis tool. This information will, in turn, feed back into the network planning task.

  Enhanced security monitoring systems using state-of-the-art techniques and tools will better detect security-related anomalies transiting the GÉANT network that affect NRENs and network users. The implementation of these tools will be coupled with the definition of the appropriate security procedures for detection and possibly mitigation of anomalies upon request of project partners. Both tools and procedures will be compatible with the multi domain security operational model for the connectivity service to be defined in SA2.

### 1.8.4.5 Deliverables

| Code | Title | Description | Delivery Date |
|---|---|---|---|
| DS1.1.1 | Report on the Backbone Architecture Study | Report on the initial results of the backbone architecture study setting out the options. | M6 |
| DS1.1.2 | Procurement Plan | Short term procurement plan for the geographic expansion and ongoing short-term upgrades to the backbone. | M6 |
| DS1.1.3,1<br>DS1.1.3,2<br>…<br>DS1.1.3,4 | Annual Report | Annual report containing an implementation plan for the longer term and addressing the outcome of the architectural studies. | M12<br>M24<br>…<br>M48 |
| DS1.2.1,1<br>DS1.2.1,2<br>…<br>DS1.2.1,4 | Annual Procurement Report | Annual report detailing the results of or updates on the progress of the major public procurements undertaken during the preceding year. | M12<br>M24<br>…<br>M48 |
| DS1.3.1,1<br>…<br>DS1.3.1,48 | Monthly Service Report | These deliverables will report on the technical status of the GÉANT network services on a monthly basis (they are also distributed to the NREN APMs). | M1-48 |
| DS1.3.2,1<br>…<br>DS1.3.2,4 | Annual Advanced Services Usage Report | This deliverable will report on the usage of the advanced services of GÉANT such as Layer-2 VPN and Circuit services. | M12<br>…<br>M48 |

### 1.8.4.6 Milestones

| Code | Title | Description | Delivery Date |
|---|---|---|---|
| MS1.1.1 | Report on the Backbone Architecture Study | The production of a report on the initial results of the backbone architecture study setting out the options. | M6 |
| MS1.2.1 | Procurement Conclusions | The conclusion of discrete procurement activities as recommended by Task 1 | tbd |

| | | | |
|---|---|---|---|
| MS1.2.2 | Updates of Ongoing Contractual Arrangements | These milestones will be associated with the ongoing process of ensuring best value for money by regularly updating ongoing contractual arrangements through annual revisions of extant contracts or full re-procurements. | tbd |

### 1.8.5 Service Activity 2 (SA2): Multi-Domain Network Service Operation

| WP Number | SA2 | | | | | Start date | | | |
|---|---|---|---|---|---|---|---|---|---|
| WP Title | | | | | | Activity Type | Service Activity | | |
| Participant name | DANTE | TERENA | ACOnet | AMRES | ARNES | BELNET | BREN | CARNET | CESNET |
| Participant number | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| Person months | 283 | 0 | 0 | 24 | 0 | 0 | 106 | 43 | 79 |
| | | | | | | | | | |
| Participant name | CYNET | DFN | EENET | FCCN | GARR | GRNET | HEANET | IUCC | JANET |
| Participant number | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
| Person months | 0 | 228 | 0 | 40 | 61 | 132 | 0 | 4 | 0 |
| | | | | | | | | | |
| Participant name | KTU-LITNET | MARNET | MREN | NIIFI | NORDUNET | PIONIER | REDIRIS | RENATER | RESTENA |
| Participant number | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 |
| Person months | 0 | 12 | 24 | 29 | 94 | 492 | 34 | 12 | 0 |
| | | | | | | | | | |
| Participant name | RoEduNet | SANET | SIGMANET | SURFNET | SWITCH | ULAKBIM | UOM | TOTAL | |
| Participant number | 28 | 29 | 30 | 31 | 32 | 33 | 34 | | |
| Person months | 12 | 0 | 24 | 0 | 88 | 12 | 0 | 1831 | |

Table 1.18: SA2 Participants

#### 1.8.5.1 SA 2: Objectives

SA2 will focus on meeting the operational expectations of the users of multi-domain services in a cost effective manner. Over the last few years, the GÉANT community has successfully provided high capacity, tailored and affordable network connectivity to researchers across Europe, largely due to the increased usage of dark fibre. Since dark fibre allows usage of various networking technologies, NRENs have been able to choose different national implementations based on their specific technical and budgetary constraints. Such a flexible and affordable approach has enabled the community to provide a wide range of services, but also imposes a number of operational issues in the multi-domain area. Sustainability of this wide range of services relies equally on the use of cutting edge networking technologies and harmonisation between the services definitions, and on the provision of high quality, operational support.

SA2 will enhance these services and extend them to a large number of end users, seeking to provide them seamlessly across the different management domains. The operational complexity of service provision is much increased due to this multi-domain, multi technology environment. End users' expectations are not limited to seamless network connectivity but extend to the availability of an efficient, user-friendly and integrated operational model across the portfolio of services provided by the GÉANT service area. The following areas of the operational model will be specifically targeted:

- **Service provisioning**: Quick and efficient provisioning of advanced services, using well-defined and, where possible, automated processes to ensure timely, efficient delivery for the user.

- **Service management**: Enhancing the coordination and communication flow between operational teams in different domains, maximising user satisfaction by ensuring service robustness with resilience and redundancy in mind, service level management.
- **Service security**: Addressing the security aspects of multi-domain services.
- **Service monitoring**: Advanced multi-domain monitoring for rapid fault detection and fault resolution, maximising the service availability for the users and supporting SLA management.

This activity will be carried out through five tasks.

- Task 1: Multi-domain Network Connectivity Services Development. This will concentrate on the design and deployment of a multi-domain service architecture and portfolio of services. A selection of the services to be evaluated for this portfolio include multi-domain provisioning of wavelength and sub-lambda circuits, and multi-point virtual networks built on these and other appropriate technologies.
- Task 2: Multi-domain Service Coordination & Operations. This will focus on the operational procedures for the successful deployment of multi-domain network connectivity services across the GÉANT service area. It will build on the work done by the E2ECU in managing complex multi-domain workflows.
- Task 3: Service Monitoring Tools and Performance. This Task addresses the specific challenge of providing the monitoring layer and tools designed for the multi-domain network connectivity services described in Task 1. These tools will provide a multi-domain monitoring service in support of the PERT activities piloted in GN2. The continuation of PERT activities will also be part of this task, including operation and enhancement of the existing PERT initiative.
- Task 4: Security. This operates in the context of multi-domain service provision, dealing with important security themes in terms of service integrity and protection of distributed resources. This task will define and promote procedures to ensure the security of multi-domain network connectivity services and tools across the GÉANT service area and provide relevant information resources to the wider NREN security community. It will also advise on security aspects of components produced for GÉANT services.
- Task 5 Workflow Tools. Task 5 will develop and maintain tools that help create domain independent workflows in support of the multi-domain services developed in Task 1. Multi domain services require a common understanding of the domain-specific network elements and resources that are employed in the creation and deployment of such services. They also require the adoption of a homogeneous layer of control and business logic functionality among all domains participating in the service provisioning. This task will build on GN2 initiatives that are defining a domain-independent taxonomy of network elements using common exchange formats as well as on GN2 pilot implementations of tools for the delivery of multi-domain network connectivity services.

All of these tasks interact to ensure effective delivery of multi-domain connectivity services.

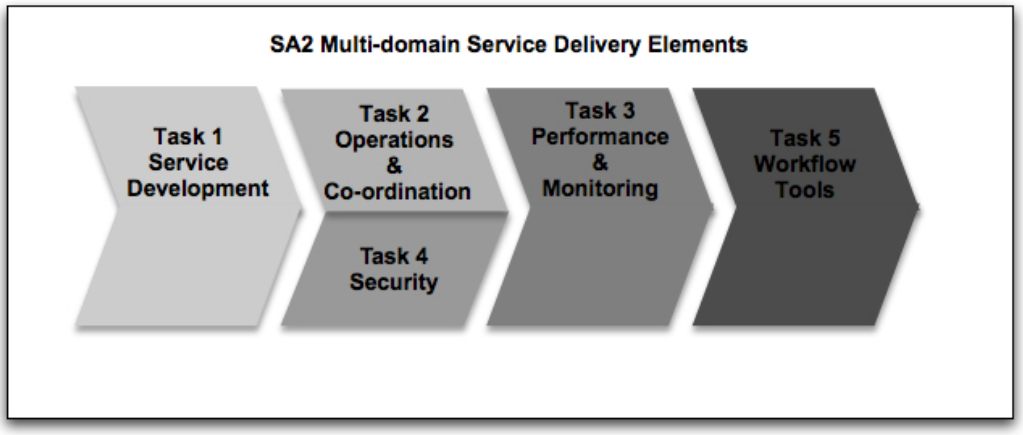


Figure 1.9: SA2 Multi-domain Service Delivery Elements

A more detailed description of the individual tasks follows.

### 1.8.5.2 Task 1 of SA2: Multi-domain network connectivity services development

***Objectives***

The goal of this task is to develop network provisioning methodologies and procedures for a multi-domain network transport provisioning service. Where possible and wished for by NREN service managers, these methodologies and procedures will be designed to be automated and/or managed.

The specific objectives of this task are to:

- Manage the requirement gathering, definition, architectural design and introduction support aspects of the life cycle management of the following service portfolio across the GÉANT service area:
  - Multi-domain provisioning of wavelengths.
  - Multi-domain provisioning of sub-lambda circuits.
  - QoS treatment of selected IP traffic flows and aggregates.
  - Multi-point virtual networks.
  - Optical Private Networks.
- Review the portfolio of multi-domain services and multi-domain services architecture.
- Establish a pan-European integrated procedure for accounting and service request across the GÉANT service area.
- Liaise with NREN service managers to coordinate and help with the deployment and extension of the services across the GÉANT service area.
- Liaise with SA1, JRA1, JRA2 and NA1 network architecture working groups to integrate network architectural changes derived from the projected service architecture.

***Outline of Work Plan***

The task will cover the following aspects of the life-cycle management of the service portfolio:

- Requirements gathering.
- Service architecture definition and continuous review.
- Service design.
- Service enhancements and tools change management control:
  - Integration of results from JRAs.
  - Close working relationship with the work-flow tools from Task 5 of SA2.
- Service deployment plan.
- Service introduction support in close relationship with NA4.
- Service level management.
- Service replacement/retirement.

The Task will include interaction with different elements of GN3. It will work with Task 2 to ensure that the service architecture and design fits in with the procedures and operational structure for all services developed. Operational feedback received will be used to enhance, further develop and correct the service architecture. This architecture will be reviewed every year against the performances of the services and user feedback.

The Task will work with Task 3 and Task 4 on defining and integrating monitoring, trouble-shooting and security with the services offered.

The task will work with Task 5 on providing specifications for new and existing tools to deliver multi-domain network connectivity services developed in GN2 and continued in Task 5, including AutoBAHN, AMPS, cNIS, I-SHARe, TTS harmonisation and standards for the harmonisation of NREN operational databases.

The Task will also work on integrating pan-European ordering and accounting procedures across all services for the users, in close relationship with the work done in NA4 and NA2.

Finally, the task will work in close relationship with SA1 to ensure services are aligned with the state-of-the-art network design envisaged for future network architectures, and will provide input and requirement into the network architecture which will need to be designed.

### 1.8.5.3 Task 2 of SA2: Services Coordination and Operations

***Services Coordination & Operations: Objectives***

This task will deal with the day-to-day operations involved with providing multi-domain connectivity services to the GÉANT community and international partners to ensure a stable service. This task receives input from the

services architecture planning in task 1, the monitoring tools development in task 3, the security aspects and considerations developed in task 4, and the work-flow and service tools developed by task 5. .

It is planned to receive commitments from GN3 NRENs for an agreed date for the incorporation of multi-domain connectivity service provisioning procedures and monitoring into their internal procedures by the end of the first 18 months. End-to-end and multipoint connectivity services will not be limited to Europe, Private circuits and networks will extend to other world regions Hence operational and monitoring procedures will be exchanged with relevant non-European parties with an aim to achieve optimal interoperability world-wide. This will be achieved in close cooperation with NA4 task 1.

***Work Plan***

Task 2 will revise and improve the multi-domain procedures and further disseminate information regarding multi-domain connectivity service monitoring to all involved parties, primarily the GN3 NRENs. The latter will be achieved by one-to-one contact with each party ensuring suitable feedback is received. The completed relevant procedures will be sent to all involved parties and feedback obtained from the majority.

Specific elements will be as follows:

- Develop the existing co-ordination functions set up to implement and monitor multi-domain connectivity services and coordinate information flow between the various involved domains. This will make use of the monitoring and workflow tools developed in Task 3 and Task 5.
- Improve awareness of the existence and purpose of this coordination effort amongst all parties involved.
- Define the operational procedures to be used by the various domain NOCs involved in the supply of multi-domain connectivity services across the GÉANT service area and relevant international partner NOCs.
- Expand procedures to use the tools developed by Task 5 of SA2 such as I-SHARe, AutoBAHN, and cNIS.
- Measure the availability of the network services and monitoring tools used to support them; feeding data back to Task 1 and Task 3 for analysis.
- Refine monitoring requirements to help enhance the existing and planned monitoring tools meet the needs of service operators.
- Increase tool usage for monitoring network services such as those developed in Task 3 of SA2 in support of the services defined in Task 1.
- Monitor the performance of the operational tools themselves and implement alerts being raised as a result of any faults within the tools.

#### 1.8.5.4 Task 3 of SA2 Service Monitoring Tools and Performance

***Objectives***

Task 3 has two themes; monitoring and performance. The work in these areas recognises that it is vital (from a user perspective) that the performance of services crossing multiple domains should be comparable to what they experience within their own operational domain. Under monitoring, this task will provide the monitoring layer and tools designed for the multi-domain network connectivity services as described in Task 1. Under performance, the continuation of collaborative federated PERT activities will be part of this work, including operation and enhancement of the centralised component of the PERT. Together, these areas will provide a multi-domain monitoring and performance service in support of multi-domain service management activities for the NRENs and key users of multi-domain services.

The specific objectives of Task 3 are to manage the requirement gathering, definition, architectural design, development and introduction support aspects of a monitoring service portfolio and to organise and support collaborative performance activities via the framework of a federated PERT.

***Outline of Work Plan***

The service monitoring part of SA2 Task 3 will:

- Provide functional specification of new tools or changes required for the monitoring of the network services, such as extensions to the MDM perfSONAR monitoring service required to support Task 2 of SA2 operational processes and Task 1 of SA2 service health.
- Develop specification of the perfSONAR MDM service to improve the operation of multi-domain services and to provide additional capability that will benefit the PERT.
- Implement the agreed tools or functionalities i.e. build, test and release them according to functional specification and standards provided by SA4.

- Provide a Monitoring Service Support team that will assist and support the NRENs in the deployment and in the operation of the multi-domain monitoring functionalities.
- Organise operational support to the service users by network service support roles and act as an escalation point for them.
- Carry out advanced software problem investigation, bug fixing and implementation of simple requests for enhancement.

The performance part of SA2 Task 3 will:

- Develop a central PERT team that will offer central services to the participating PERTs.
- Administer PERT accreditation according to the agreed policy developed in GN2 SA3 (DS3.12.4 'Policy for a Federated Performance Enhancement Response Team (PERT)')
- Organise PERT meetings for sharing information and experiences. This is the most crucial role of all for extending and re-enforcing the distributed community and will be done in conjunction with NA2.
- Manage the central PERT Knowledge Base and disseminate lessons learned from it.
- Regularly review the federated PERT policy in order to keep it up to date with new requirements and enhancements.

#### 1.8.5.5 Task 4 of SA2: Security

***Objectives***

This task will enhance the security aspects of the multi-domain services and their overall security when deployed in the GÉANT service area. The Task will provide a service to Tasks 1, 3, and 5 of this activity to ensure they develop security-aware and security-proof services. The task will also provide expertise to other GN3 activities as guided by the GN3 Security Coordinator. The final goal is a secure multi-domain service environment, delivered in co-operation with the wider GN3 security community. The activity will rely on the co-operation of the GN3 partners operational CERTs in defining and implementing appropriate security workflows for extending beyond a single domain.

In particular, for the multi-domain services of SA2 itself, a consultancy service will define guidelines for the secure deployment of the systems and workflows supporting such services. This service is available "on demand" to tasks and individual deployments where appropriate. A strong collaboration with the human networking activities and security research is a key element of this work plan. This will be harmonised following recommendations by the GN3 Security Coordinator and the NREN security community.

An increased level of agreed security workflows developed here will help all the NRENs to manage the security aspects of multi-domain services deployed over their own national domain by enabling them to handle multi-domain incidents, using the communication flows between CERTs, so that these multi-domain service incidents are tackled by those service partners who are positioned to protect the service most effectively, not just those currently affected by an attack. The specification of a security toolset with common and agreed functionalities to discover impacting security incidents and tools to share a common knowledge base for the benefit of all the CERTs are also needed to achieve the goal.

As a result of the security activity, end users will experience fewer service outages caused by targeted attacks to (or compromise of) the systems delivering multi-domain services, less network congestion in low bandwidth links at the periphery of the network caused by potential misuse of multi-domain transit, and less exposure of their end systems to the risks of being part of a multi-domain infrastructure.

***Work Plan***

Task 4 of SA2 will:

- Provide security expertise and enhancements for the development of multi-domain services over the time of the project i.e. operate a consultancy service and set the best-practice standard on how security should be embedded inside the services.
- Deploy an on-request Security Consultancy Service for GN3 components oriented to GN3 activities where there are security aspects involved (e.g. good security practices in coding design, in deploying systems to support network services).
- Define the agreed best-practice for multi-domain operational security requirements and for enabling tools and procedures.
- Define security processes for detection of and reaction to multi-domain security incidents by CERTs, including inter-domain communication procedures.

- Deploy support tools to share and store information about relevant multi-domain service related incidents and actions, building a common knowledge base for the benefit of all the security teams. These tools will be developed in other GN3 or NREN community activities, or acquired as appropriate
- Co-ordinate staged adoption of the agreed workflows for inter-NREN communications about multi-domain service security incidents, and of the common supporting tools.

### 1.8.5.6 Task 5 of SA2: Tools to support multi-domain workflows

***Objectives***

Several tools to support multi-domain workflows are under development in GN2 and their development will continue in GN3 by integration into the services developed in SA2. The current multi-domain service delivery tools include cNIS, AMPS, AutoBAHN and I-SHARe (with the latter being still at a conceptual phase).

Task 5 will:

- Continue development and maintenance of tools for multi-domain service delivery.
- Support the introduction of the tools among the GN3 partners.

These tools can be seen as layered tools that support and complement each other's functionality for the delivery of multi-domain services. For example cNIS (Common Network Information Service) is a supporting tool for AMPS (Advance Multi-domain Provisioning System) and AutoBAHN (Automated Bandwidth Allocation across Heterogeneous Networks), which in turn are supporting tools for the multi-domain services envisaged in task 1). Similarly I-SHARe is a system that supports multi-domain workflows for co-ordination of setup of new infrastructure or faults and maintenance management of multi-domain services (currently limited to manually provisioned multi-domain end-to-end circuits).

cNIS and I-SHARe will define which and how information should be extracted from a local information system and exchanged between network administrative domains, as well as providing reference implementations. cNIS provides information about network elements in each individual domain. It is envisaged that I-SHARe will support the exchange of trouble ticketing information among domains and the harmonisation of operational inter-domain procedures in GÉANT and NRENs.

These reference implementations will be deployed on GN3 and may be adopted by NRENs. The fundamental point, however, is that all NRENs exchange information in a commonly agreed interface, according to cNIS and I-SHARe specifications, whilst still using their own national information base which contains the information that needs to be exchanged.

Similar principles apply to AMPS and AutoBAHN at one layer above, as these are resource provisioning services utilising the underlying functionality of cNIS and I-SHARe specifications. In this case there is a strong call for NRENs to deploy the AutoBAHN system, or provide interfaces of their intra-domain dynamic circuit provisioning functionality towards AutoBAHN.

Tasks 1, 2, and 3 will rely on the use of the above tools to define, implement and operate multi-domain services and will provide requirements for their further development.

***Work Plan***

In general, for each of the tools, the following work plan applies:

- Requirements gathering and review from task 1 and NREN operations teams.
- Implementation of software development processes according to standards and tools provided by SA4.
- Proof of concept/validation phase involving a small number of partners in a very controlled setup.
- Development – software design, build, test, and release management in compliance with SA4 and functional specifications.
- Support of the tools including introduction support, advanced software problem investigation, bug fixing and implementation of simple requests for enhancement.

### 1.8.5.7 Deliverables

| Task | Title | Description | Delivery Date |
|---|---|---|---|
| DS2.1.1 | Multi-domain service architecture | High-level outline of planned multi-domain service architecture. | M14 |

| | | | |
|---|---|---|---|
| DS2.2.1 | Operations Deployment Commitments | GN3 Partner Multi-domain Service Procedure Deployment Commitments | M18 |
| DS2.3.1 | Monitoring service portfolio | Definition of a monitoring service portfolio. | M10 |
| DS2.3.2 | Multi-domain Service Performance Experiences | Lessons Learned during the Operation of a Federated PERT | M34 |
| DS2.5.1 | Workflow Tools Deployment Commitments | GN3 Partner Multi-domain Workflow Tools Deployment Commitments | M24 |

Table 1.19: SA2 Deliverables

#### 1.8.5.8 Milestones

| Task | Title | Description | Delivery Date |
|---|---|---|---|
| MS2.1.1,1 … ,4 | Service Portfolio Review | Review of portfolio of multi-domain service and multi-domain services architecture. | M10<br>M22<br>M34<br>M46 |
| MS2.2.1 | Multi-domain Operations Procedures | Operational procedures complete and feedback obtained from a majority of NREN Service Managers. | M15 |
| MS2.3.1 | Monitoring development delivery infrastructure | Implementation of development tools and processes for software build, test, problem management and release functions to comply with SA4 standards. | M7 |
| MS2.3.2 | Wavelength service monitoring tool | Delivery of wavelength service monitoring tool. | M10 |
| MS2.3.3 | Monitoring Service Desk operation procedure | Multi-domain monitoring Service Desk operation procedure defined, including wavelength monitoring. | M12 |
| MS2.3.4 | Delivery of monitoring tools for two network services. | Delivery of the monitoring tools for the monitoring of the two network services defined by task 1 priorities.. | M22 |
| MS2.3.5 | Delivery of monitoring tools for two additional network services | Delivery of the monitoring tools for the monitoring of the two network services defined by task 1 priorities,. | M38 |
| MS2.3.6 | Central PERT Services | Central PERT services fully functional. | M3 |
| MS2.3.7 | Backbone PERT support monitoring infrastructure | Specification of the backbone PERT support monitoring infrastructure (tools and GUIs). | M6 |
| MS2.3.8 | Campus PERT support monitoring infra | Specification of the campuses PERT support monitoring infrastructure (tools and GUIs). | M10 |
| MS2.3.9 | PERT Operation Rollout Plan | GN3 Partner PERT Certification Rollout Schedule | M12 |
| MS2.4.1 | Security Consultancy Service | Rollout of consultancy service | M6 |
| MS2.4.2 | Security teams operational requirements | Definition of security teams operational security requirements, tools and procedures agreed | M10 |

| | | | |
|---|---|---|---|
| MS2.4.3 | Security standards for multi-domain incident detection and reaction | Definition of processes for detection of and reaction to multi-domain security incidents agreed | M11 |
| MS2.4.4 | Deployment of support tools | Deployment of support tools to share and store information about relevant multi-domain service related incidents and actions | M23 |
| MS2.5.1 | Workflow tools development delivery infrastructure | Implementation of development tools and processes for software build, test, problem management and release functions to comply with SA4 standards. | M6 |
| MS2.5.2 | cNIS in 5 NRENs | Operational deployment of cNIS in 5 NRENs. | M6 |
| MS2.5.3 | i-SHARE in 5 NRENs | I-SHARe initial deployment in 5 NRENs. | M18 |
| MS2.5.4 | I-SHARe continued development | I-SHARe continued development based on new use cases for multi-domain services. | M24 |
| MS2.5.5 | Initial AutoBAHN rollout | Initial roll-out of AutoBAHN in 5 NRENs. | M24 |
| MS2.5.6 | Further cNIS and I-SHARe rollout | Further roll-out of cNIS and I-SHARe in NRENs. | M32 |

Table 1.20: SA2 Milestones

### 1.8.6 Service Activity 3 (SA3): End User Services in a Federated Environment

| WP Number | SA3 | | | | | Start date | | | |
|---|---|---|---|---|---|---|---|---|---|
| WP Title | | | | | | Activity Type | Service Activity | | |
| Participant name | DANTE | TERENA | ACOnet | AMRES | ARNES | BELNET | BREN | CARNET | CESNET |
| Participant number | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| Person months | 0 | 59 | 0 | 29 | 5 | 0 | 5 | 65 | 28 |
| | | | | | | | | | |
| Participant name | CYNET | DFN | EENET | FCCN | GARR | GRNET | HEANET | IUCC | JANET |
| Participant number | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
| Person months | 14 | 45 | 0 | 5 | 2 | 5 | 5 | 5 | 48 |
| | | | | | | | | | |
| Participant name | KTU-LITNET | MARNET | MREN | NIIFI | NORDUNET | PIONIER | REDIRIS | RENATER | RESTENA |
| Participant number | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 |
| Person months | 0 | 5 | 5 | 17 | 82 | 47 | 24 | 5 | 5 |
| | | | | | | | | | |
| Participant name | RoEduNet | SANET | SIGMANET | SURFNET | SWITCH | ULAKBIM | UOM | TOTAL | |
| Participant number | 28 | 29 | 30 | 31 | 32 | 33 | 34 | | |
| Person months | 5 | 0 | 0 | 36 | 13 | 5 | 0 | 566 | |

Table 1.21: SA3 Participants

#### 1.8.6.1 SA3: Objectives

The GN2 project developed two ways in which services were made available to NRENs' users on a pan-European basis; by building network connectivity services offering guaranteed availability and capacity; and by developing application-level services that provided added value to end-users.

This activity will develop and operate three services that will focus primarily on Authentication and Authorisation Infrastructure (AAI). This will enable the controlled management of access to networks, applications and content. Furthermore, these services will also be key enablers for other future services that are likely to increasingly require multi-domain AAI functionality.

The first of these services is eduroam. Based on the roaming service that was developed during GN2, eduroam is intended to provide ubiquitous network connectivity to end-users, a critical pre-requisite for providing networked resources to an increasingly mobile community. It is recognised that the development of multi-domain end-user application-level services is an important challenge and one where the European NREN community can enhance the ability of its users to co-operate with each another.

These services will have a specific benefit for the research community, but also a broader benefit from the high level of collaboration engendered within the NREN community. An integrated European approach to AAI will also facilitate the implementation or enhancement of existing and future network services (offering, for example, improvements in service integrity through better security, operational integration through improved collaborative tools, and resource management through richer authorisation, etc) while, looking further afield, improving the prospects for similar service enhancements working with other partners and similar organisations in other regions of the world

#### 1.8.6.2 SA3: Workplan

GN3 will use this environment of co-operation to develop a portfolio of services made available to end-users. While this activity will focus primarily on identifying and satisfying clearly defined use-cases, an important

secondary objective of the activity is the development of generic service capabilities that can be used by different end-user application-level services. This will enable the development of other application-level services, outside of the existing scope of GN3, operating on top of the services delivered by SA2 and SA3 respectively.

#### *Task List and Descriptions*

Within SA3, the following tasks are planned

- Task 1 of SA3: Co-ordination of European PKI infrastructures. The objective is to increase the use of PKI and to make it more accessible to end-users. This work builds on the experience of TERENA's TACAR PKI repository service, with a focus on developing and operating a new Policy Management Authority (PMA).
- Task 2 of SA3: Operation of the eduroam service. The objective is to provide a roaming network connectivity service, building on the work in GN2.
- Task 3 of SA3: Development and operation of the eduGAIN service. The object of eduGAIN is to provide a pan-European AAI, building on the work achieved in GN2. It is anticipated that eduGAIN will provide AAI services to many GN3 services, focusing initially on a core set of use-cases.

### 1.8.6.3 Task 1 of SA3: European PKI Co-ordination

#### *Task 1 of SA3: Objectives*

The objective of this task is to facilitate access to, and the use of, Public Key Infrastructure (PKI). Many services (from both GN2 and elsewhere) already make use of X.509 certificates issued by Certificate Authorities (CA) operating PKIs. It is anticipated that the demand for CA-issued certificates will increase in the coming years due to a growing requirement for securing communications. For example, it has been proposed that perfSONAR should use Secure Sockets Layer (SSL) connections; this would require the use of X.509 certificates.

To meet this demand, and to permit the use of existing national PKIs (in most cases operated by NRENs) for GN3 services, there exists a requirement for some coordination work and a limited central service.

This task will bring the following benefits:

- There will be no need to establish new service-specific PKIs, as GN2 services will be able to use existing PKIs (usually operated by NRENs) that meet their requirements.
- Users of GN3 services will be able to obtain all necessary certificates from a single CA (normally the one operated by their own NREN). A new centrally operated PKI will issue certificates to users whose NRENs do not operate a suitable CA.

This task will provide three main functions:

- A Policy Management Authority (PMA) that will define and maintain the set of criteria that must be met by participating PKIs, and accredits candidate PKIs on the basis of an evaluation of their policies these criteria.
- A repository to host the trust-anchors and the policies of accredited NREN PKIs.
- A default CA for users whose NRENs do not provide a national PKI service

#### *Task 1 of SA3: Outline of Work Plan*

The task will continue the work established by the existing TACAR (www.tacar.org) repository, which is already widely used by the global academic and research community. TACAR's functions will be enhanced to meet the requirements of GN3 services by:

- Establishing a Policy Management Authority (PMA) for European NRENs' PKIs and investigate the possibility of participation by other PKIs.
- Gathering information on the status of NRENs' existing PKIs.
- Gathering information on the status of GÉANT services' requirements.
- Defining minimum requirements for participating PKIs.
- Defining an accreditation process for participating PKIs.
- Defining new TACAR functions and procedures to support the PMA.
- Adapting TACAR to support the PMA requirements.

This task will also establish and operate a CA for users whose NRENs do not operate a PKI. This CA, the PMA and TACAR will operate throughout the lifetime of the project.

It is anticipated that the service specification will require regular updates during the lifetime of the GN3 project as new requirements emerge from existing or new services.

### 1.8.6.4 Task 2 of SA3: Roaming Access Services

#### *Task 2 of SA3: Objectives*

This task will further develop the eduroam service piloted in GN2. The eduroam service consists of a confederation of roaming federations operated by NRENs or National Roaming Operators (NRO). The confederation level services are provided by the eduroam Operational Team. Aside from the technology infrastructure (consisting primarily of a hierarchy of RADIUS servers), there are several other supporting elements (the confederation policy; a monitoring and diagnostics system; the eduroam confederation database; the eduroam website; and a trouble ticketing system) that must be maintained and enhanced in order to operate and improve the service and user's experience of it.

The objectives of this task are:

- To maintain the already established eduroam service.
- To enhance the eduroam service both in technical and organisational aspects.

Training and promotional activities are planned to improve the visibility and quality of the service. These activities will be established in cooperation with the training, dissemination and PR activities of the GN3 project.

#### *Task 2 of SA3: Work Plan*

The planned activities are grouped within three work items:

- Service management: This encompasses the management of the service and organisational activities performed by the Task Leader and the OT.
- Service maintenance: This encompasses the regular maintenance activities performed by the OT (both the technology infrastructure and all other supporting elements).
- Service enhancement: This encompasses the development of new requirements and the deployment of enhancements in conjunction with JRA3. It is anticipated that this will include:
  - Identifying new functionalities and use cases for eduroam.
  - Piloting prototypes of new technologies developed by JRA3 (such as RADSec) that might enhance the service.
  - Improving the service support elements (such as the monitoring and diagnostics system, the eduroam database, the eduroam website, and the trouble ticketing system).
  - Updating the eduroam policy, primarily to reflect changes in the technical infrastructure and the service support elements.
  - Co-operation with other similar services worldwide.

### 1.8.6.5 Task 3 of SA3: eduGAIN Service Introduction and Operation

#### *Task 3 of SA3 Objectives*

This Task builds on the GN2 work for the development of eduGAIN. eduGAIN defines and implements the framework to interconnect the various AAI federations in Europe and to enable controlled access to GÉANT and NREN services, and resources via identities asserted by those federations.

This Task will ensure a smooth transition of development efforts into operation of the eduGAIN developments, including interoperability with evolving standards and best-practices (such as SAML 2.0-based inter-federations in the global higher-education community). This task will also undertake any remaining development effort required to bring the technical infrastructure to a production quality, and to maintain it.

The work will follow standard service development life-cycle principles (based on ITIL) to define the eduGAIN service, its operational model (with specific emphasis on the service interactions with eduroam and perfSONAR and other GN3 services), the ongoing supporting infrastructure, service level management and user support, as well as a policy for eduGAIN.

An important element will be the support given to federations/NRENs to deploy and operate eduGAIN, and to service and resource providers to enable federated access.

A gradual introduction of the eduGAIN service is envisaged, initially with support for a few specific use cases and users. These use-cases will be identified, defined and evaluated by this task in collaboration with GN3 service providers and users.

***Task 3 of SA3 Workplan***

The objective of the eduGAIN service is to provide a generic AAI infrastructure that will support a diverse set of use-cases. This will be realised gradually through the incremental addition of supported use-cases, permitting a controlled development of the service as confidence in, and understanding of, the underlying technologies and policies grows. This will be achieved by:

- Identifying and defining the initial use-cases, in collaboration with GN3 service providers and users, that the service will support, and specifying their technical and policy requirements.
- Define the service model and policies required to support these use-cases.
- Improve and enhance the technical infrastructure to meet production standards.
- Develop a roll-out plan, starting from a small-scale pilot that builds to a production phase. This will necessitate participation from several federations/NRENs/GN3 services and the actual use of eduGAIN to access resources.
- Implement the operational structure and supporting tools.

There will be yearly deliverables reporting on the development of the service.

### 1.8.6.6 Deliverables

| Code | Title | Description | Delivery Date |
|---|---|---|---|
| DS3.3.1 | eduGAIN service definition and policy. | Initial definition of service model and a first draft of policy. | M12 |
| DS3.3.2,1<br>DS3.3.2,2<br>DS3.3.2,3<br>DS3.3.2,4 | eduGAIN service Annual Report | Annual report on the development of the service. | M12<br>M24<br>…<br>M48 |
| DS3.2.1,1<br>DS3.2.1,2<br>DS3.2.1,3<br>DS3.2.1,4 | Annual Report on the eduroam Service Operations and Enhancements | Report on the eduroam service operations and implementation of improvements in the eduroam technology and service support elements. | M12<br>M24<br>…<br>M48 |
| DS3.1.1 | Report on the Establishment and enhancement of the Policy Management Authority Repository. | Report on the establishment of the PMA, repository enhancements and catch-all PKI. | M14 |
| DS3.1.2,1<br>DS3.1.2,2<br>DS3.1.2,3 | Annual Report Of Identity Federation | Annual Report on the operations of the PMA, repository and catch-all PKI. | M24<br>M36<br>M48 |

Table 1.22: SA3 Deliverables

### 1.8.6.7 Milestones

| Code | Title | Description | Delivery Date |
|---|---|---|---|
| MS3.1.1 | PMA Establishment | Establish the PMA. | M3 |
| MS3.3.1 | eduGAIN use-case analysis | An analysis of the community's use-cases and requirements of the eduGAIN service. | M6 |
| MS3.1.2 | Status Report | Status report on NRENs' PKIs and GÉANT services requirements | M8 |
| MS3.1.3 | Accreditation Process | Specification of the accreditation process. | M11 |
| MS3.2.1 | Training Programme | eduroam training program establishment. | M12 |

| | | | |
|---|---|---|---|
| MS3.1.4 | Minimum Requirements | Minimum requirements for the participating PKIs. | M12 |
| MS3.1.5 | TACAR | TACAR ready to serve the PMA | M12 |
| MS3.1.6 | Support Co-ordination Service | Introduction of revised support co-ordination service based on GN2 experiences. | M12 |
| MS3.1.7 | Catch-all PKI | Catch-all PKI in operation. | M13 |
| MS3.3.2 | eduGAIN service Roll-out Plan | Roll-out plan developed. | M18 |
| MS3.3.3 | eduGAIN service Pilot Phase | Pilot phase with five NRENs. | M24 |

Table 1.23: SA3 Milestones

### 1.8.7 Service Activity 4 (SA4): Software Governance

| WP Number | SA4 | | | | | Start date | | | |
|---|---|---|---|---|---|---|---|---|---|
| WP Title | | | | | | Activity Type | Service Activity | | |
| Participant name | DANTE | TERENA | ACOnet | AMRES | ARNES | BELNET | BREN | CARNET | CESNET |
| Participant number | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| Person months | 20 | 0 | 0 | 31 | 0 | 0 | 8 | 14 | 0 |
| | | | | | | | | | |
| Participant name | CYNET | DFN | EENET | FCCN | GARR | GRNET | HEANET | IUCC | JANET |
| Participant number | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
| Person months | 0 | 0 | 0 | 0 | 0 | 24 | 0 | 0 | 0 |
| | | | | | | | | | |
| Participant name | KTU-LITNET | MARNET | MREN | NIIFI | NORDUNET | PIONIER | REDIRIS | RENATER | RESTENA |
| Participant number | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 |
| Person months | 0 | 0 | 0 | 0 | 0 | 125 | 5 | 0 | 0 |
| | | | | | | | | | |
| Participant name | RoEduNet | SANET | SIGMANET | SURFNET | SWITCH | ULAKBIM | UOM | TOTAL | |
| Participant number | 28 | 29 | 30 | 31 | 32 | 33 | 34 | | |
| Person months | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 228 | |

Table 1.24: SA4 Participants

#### 1.8.7.1 SA4 Objectives

Software based products and services will play a key role in many GN3 activities. Software development and maintenance will be a continuous effort throughout the project lifetime. The success of the GN3 services is directly linked to the success of the software developed to support these services.

The overall objective of this activity is software governance. This implies ensuring that the software development process is following defined guidelines in line with industry standards.

SA4 will define guidelines for software development methodology, standards and processes to ensure that the software produced by the project has a consistent architecture, is of high quality, is suitable for a production

environment, and is sustainable. It will monitor and audit the software development process in other activities to ensure that its guidelines are being followed. It will also operate a software development support infrastructure on behalf of other activities.

Policies relating to software (in particular IPR and software distribution) will be agreed by the consortium at large. SA4 will ensure that all project software development activities are carried out in accordance with the IPR policy. SA4 will use its expertise to recommend changes, if necessary, to the IPR policy. Where possible the development teams will reuse existing third party software. SA4 will ensure the compatibility (with respect to licensing) of any third party software packaged along with GN3 software.

It is important to note that SA4 will only issue best practice guidelines and audit the software development process. The actual software development and maintenance work will be carried out in other GN3 activities.

#### 1.8.7.2 Task 1 SA4: Software Best Practices

***Task 1 of SA4: Objectives***

The GN3 project will deliver various products and services based upon software development. Software development is not an exact science and the key to success is to follow a consistent development process in line with industry best practices.

The key objective of this task is to set the overall software architecture strategy and issue quality assurance guidelines on software development processes. This will provide guidance to the software development teams throughout the development lifecycle.

There are several software development methodologies and this task will recommend the most relevant methodologies for the project. It will define a set of software development processes for design, development, validation, testing, deployment, release and change management.

While all software development in GN3 will benefit from following the best practices guidelines; JRAs are expected to quickly prototype tools, and therefore may use the tools, methods, and architecture most appropriate for the task at hand. The policies and procedures of SA4 mostly apply to the SAs only. The SA4 policies will apply to JRA developments in those cases where JRAs use any software development environment for their proof of concept.

***Task 1 of SA4: Outline of Work Plan***

A software architecture advisory panel will be constituted initially to oversee this task. They will look into industry best practices for software development processes. A set of best practice documents recommending policies and procedures will be produced.

As a part of a continuous process improvement, these best practice documents and guidelines, as well as the tool set, will be assessed and updated as required.

#### 1.8.7.3 Task 2 of SA4: Software Quality Assurance (QA)

***Task 2 of SA4: Objectives***

This task will ensure that the guidelines issued by Task 1 of SA4 are followed by the software development teams within the project. It will work in collaboration with the software development teams in other activities, offering them assistance in understanding, interpreting and implementing the guidelines. It will periodically monitor and audit the software development process in other teams to ensure compliance.

The actual software development work will be done within the respective activities. This task will ensure that the correct QA processes like documentation, design, reviews, validation, testing, etc. are being followed.

***Task2 of SA4: Work Plan***

As this task is about quality assurance of work being carried out in other activities, its work plan depends upon the work plans of other activities. A QA team will be formed and be involved in the entire software development life cycle. It will review all the documentation produced as a part of the software development process and perform periodic audits of software development tasks in other activities.

In general this task provides the following functions:

- Assist other activities in software specification and architecture.
- Supervise other activities in the application of GN3 software best practices and use of standard tools and procedures.

- Assess compliance to the quality assurance guidelines.
- Perform software, configuration audits and issue audit reports.
- Escalate any QA issues to the project management.
- Provide feedback for continuous process improvement.
- If required, provide assistance when a project transitions from research activity to service activity

### 1.8.7.4 Task 3 of SA4: Software Development Support Infrastructure

***Task3 of SA4: Objectives***

GN3 is composed of various products and services for which software development will be required. There will be several distributed software project teams working in collaboration with each other. These teams will require a set of tools for their day-to-day work to follow the industry-standard software development process, collaborate effectively and improve productivity.

This key task is to specify, build and operate a software development support infrastructure for all software development teams within GN3. This includes code version control systems, configuration control and management systems, build management systems, continuous integration systems, packaging and release management systems, issue/bug tracking systems, etc. It will also create a collaboration environment for software developers from different teams to interact with each other (e.g. using mailing lists, discussion forums, developer portals, wiki pages etc.).

Such a development support infrastructure must be used by all other activities involved in software development. The software development teams in JRAs may not follow the SA4 best practice guidelines. However, they must use the common development infrastructure from SA4.

***Task3 of SA4: Work Plan***

This task will liaise with key software development partners in the community, as well as look into industry best practices for software development support infrastructures. It will recommend a tool set and procedures for a common development infrastructure. Once approved it will build and operate the software development support infrastructures. The infrastructure will be reviewed and updated as required on a yearly basis.

It will produce guidelines on the use of the development support infrastructure and provide assistance to software development teams from other activities.

### 1.8.7.5 Deliverables

| Code | Title | Description | Delivery Date |
|---|---|---|---|
| DS4.1.1 | Initial Best Practice Docs | Initial set of best practice documents namely the GN3 software architecture strategy, a software developer guide and a quality assurance guide. | M8 |
| DS4.2.1 | QA Audit Report | Report on the results of QA audits, software metrics, compliance issues and resolutions. | M21 |
| DS4.3.1 | Specification of software development infrastructure | Specification of required software development support infrastructure and tools. | M4 |

Table 1.25: SA4 Deliverables

### 1.8.7.6 Milestones

| Code | Title | Description | Delivery Date |
|---|---|---|---|
| MS4.1.1 | Guidelines and processes | Guidelines and processes for software packaging, configuration management, release management, deployment management, change management and problem management. | M14 |

| | | | |
|---|---|---|---|
| MS4.3.1 | SW Development Infrastructure in Place | The required SW Development Infrastructure for the project SA4 will be made available | M6 |

Table 1.26: SA4 Milestones

### 1.8.8 Summary Effort Table

Table 1.27 below provides a summary of the staff effort in the SAs. The Table indicates the number of person months over the whole duration of the planned work, for each work package by each participant. Work-package leader for each WP is identified by showing the relevant person-month figure **in bold**.

| Participant No | Paticipant short name | SA1 (Person months) | SA2 (Person months) | SA3 (Person months) | SA4 (Person months) | Total person month |
|---|---|---|---|---|---|---|
| 1 (Coordinator) | DANTE | **876** | 283 | 0 | **20** | 1180 |
| 2 | TERENA | 0 | 0 | 59 | 0 | 59 |
| 3 | ACOnet | 0 | 0 | 0 | 0 | 0 |
| 4 | AMRES | 0 | 24 | 29 | 31 | 84 |
| 5 | ARNES | 0 | 0 | 5 | 0 | 5 |
| 6 | BELNET | 0 | 0 | 0 | 0 | 0 |
| 7 | BREN | 0 | 106 | 5 | 8 | 119 |
| 8 | CARNET | 0 | 43 | 65 | 14 | 122 |
| 9 | CESNET | 13 | 79 | 28 | 0 | 120 |
| 10 | CYNET | 0 | 0 | 14 | 0 | 14 |
| 11 | DFN | 0 | 228 | 45 | 0 | 273 |
| 12 | EENET | 0 | 0 | 0 | 0 | 0 |
| 13 | FCCN | 0 | 40 | 5 | 0 | 44 |
| 14 | GARR | 9 | 61 | 2 | 0 | 72 |
| 15 | GRNET | 9 | 132 | 5 | 24 | 170 |
| 16 | HEANET | 0 | 0 | 5 | 0 | 5 |
| 17 | IUCC | 0 | 4 | 5 | 0 | 8 |
| 18 | JANET | 0 | 0 | **48** | 0 | 48 |
| 19 | KTU-LITNET | 0 | 0 | 0 | 0 | 0 |
| 20 | MARNET | 0 | 12 | 5 | 0 | 17 |
| 21 | MREN | 13 | 24 | 5 | 0 | 42 |
| 22 | NIIFI | 0 | 29 | 17 | 0 | 46 |
| 23 | NORDUNET | 8 | 94 | 82 | 0 | 183 |
| 24 | PIONIER | 13 | 492 | 47 | 125 | 676 |
| 25 | REDIRIS | 0 | 34 | 24 | 5 | 62 |
| 26 | RENATER | 0 | 12 | 5 | 0 | 17 |
| 27 | RESTENA | 0 | 0 | 5 | 0 | 5 |
| 28 | RoEduNet | 13 | 12 | 5 | 0 | 30 |
| 29 | SANET | 0 | 0 | 0 | 0 | 0 |
| 30 | SIGMANET | 0 | 24 | 0 | 0 | 24 |
| 31 | SURFNET | 0 | 0 | 36 | 0 | 36 |
| 32 | SWITCH | 0 | **88** | 13 | 0 | 101 |
| 33 | ULAKBIM | 0 | 12 | 5 | 0 | 17 |
| 34 | UOM | 0 | 0 | 0 | 0 | 0 |
| | | 953 | 1831 | 566 | 228 | 3578 |

Table 1.27: Summary Effort Table for Service Activities (SAs)

Also, see section 2.4 “Resources to be committed”.

### 1.8.9 Interdependencies of GN3 Service Activities

For interdependencies of all GN3 Activities, please see section 1.4 above.

### 1.8.10 Describe any significant risks, and associated contingency plans

Risks in the GN3 Service Activities can be summarised in the following points:

- Market conditions: Development of the GÉANT Network can be summarised by its geographic expansion, the deployment of state of the art telecommunications equipment to enable the development and deployment of the portfolio of services envisaged, the utilisation of NREN resources, and the ability to guarantee long sustainability whilst reducing total costs. All of these points are susceptible to market conditions; new and advanced technologies will only make it to market at affordable prices if there is sufficient market demand for vendors to develop them, while geographic expansion depends on the ability to obtain high capacity connectivity at affordable prices.
  These aspects can be a limiting factor in the success and long term sustainability of GÉANT, particularly in reducing the digital divide. To mitigate these issues, the GN3 project will conduct a thorough architecture study to look at alternative ways of ensuring network expansion (for example by exploring in more detail the opportunities for using NREN owned resources, e.g. cross-border and national fibre infrastructures). The study will also examine topology issues concerning locations of Points of Presence and their design, exploitation of existing NREN resources with the aim to increase flexibility and reduce costs. The project partners will engage in extensive discussions with equipment vendors to influence their technical roadmaps and encourage them to develop the advanced technologies the R&E community requires.
- Low take–up of services and reach out to end users: Success in the GN3 service activities will be partly determined by the number of NRENs taking up new services. These are in turn determined by the quality of the services being developed and interest shown in them by the NRENs. The risk of low take up of services is medium and its impact can be seen as high. Mitigation of these risks will rely on quality developments, dissemination and promotion of services. Developing quality services is mainly under the direct control of the project participants, whilst the interest within the NREN user base depends to a large extent on the dissemination of the service developments with the target user base. It will be important to involve representatives of the intended user base in the early stages of the development to ensure services meet user needs. Furthermore, there will be a co-ordinated activity within NA2 to promote the new GN3 services within the NRENs and their user base.
- Software (SW) quality and sustainability: The new services that are being developed in GN3 rely on a significant amount of SW that is developed by the partners in GN3 and previously in GN2. The GN3 project must ensure a sustainable SW development environment and that all SW produced adheres to industry best practices in order to ensure appropriate quality Structures and procedure must be put in place to guarantee long term SW maintenance. This is a relatively new challenge for the GN3 partners. SW development resources that are fragmented and, to a large extent, based on individual contributions exposes the consortium to un-coordinated SW development practices and significant long term support issues. SA4 has been established to ensure that quality control, fragmentation and support issues are addressed. The strategy will be to not accept SW development effort from individuals within a partner but rather from partners who dedicate teams of 3 or 4 interchangeable individuals and which are also committed to offering long term support for the developments.
- Possible risks arise from the wide variety of possible software tools and components, the creation of undocumented, non-maintainable code, the dependence on individual expert programmers, the dependency on imported IP, and so on. The Software Best Practice activity (SA4) will attempt to mitigate these risks with a systematic approach to software development and maintenance. However, SA4 itself carries risks that could affect its success:
  - There is a certain risk that the Software guidelines chosen will not be optimal. This risk is considered low as expertise will be collected from a wide spectrum of experienced developers in Europe.
  - There is a danger that auditing the software work of other project participants may not be a popular task and could be neglected or not be done with sufficient rigour. Assuring that this happens will be a task for the project managers.
  - Providing strict software policies serves the purpose of easing the transformation from proof of concept to production quality software. In GN2 this has been done in the final phase of Joint Research Activities in a transition to service (TTS) step. SA4 strives to make this step as small as possible. There is the risk that JRAs will stretch the proof concept phase and will end up with a larger that foreseen TTS problem. This is to be monitored by project management.

# 1.9 Joint Research Activities and associated work plan

## 1.9.1 Overall strategy of the work plan

The overall goal of the JRAs is to develop new services for the GÉANT and NREN infrastructures, and/or improve existing services. A very important part of this overall goal is to encourage a much wider (possibly universal) deployment of the services, other than basic connectivity. Initial planning for the research activities in the earlier GÈANT projects concentrated mostly on providing first-rate connectivity to the European R&D community. However, thanks to the experience gained during the course of the projects, there is now a better understanding of the relationship between SAs and the associated JRAs. This interrelation between SAs and JRAs is shown in Table 1.28 below.

For GN3, this better understanding means that the JRAs have been selected specifically to address either areas of the existing service that are known to be missing, or new services that have been specifically requested by the users (both of these have been derived from the survey of NREN requirements that took place in early 2008). These development areas are essential for the future use of the networks by researchers.

An additional goal is to ensure a strong relationship between JRA1, JRA2, SA1 and SA2. Together these activities contribute to the interconnection of backbone networks in a multi-domain, federated environment to provide multi-domain, federated network services, with the objective of providing seamless support to end users.

The three JRAs proposed for GN3 also serve as a focal point for European expertise, providing an overview of the project development. This overview will make the management of research in a Task easier. For example, it will be possible to change the direction of the research in a Task if and when required (for example, either terminate a Task early or start a new Task). To enable this to function, new management tools have been designed (for example, supervisory committees, which will advise activity leaders, Project Office, project managers and the Project Board on such matters). Also a strong co-ordination function, which will be exercised by the Project Office, will be able to identify any duplication of work or any missing elements in the technical programme, and suggest the appropriate action.

An important new component of the general development strategy is Software Governance (SA4). This Service Activity will play an important role in many GN3 activities. A group of software specialists will enforce the standards for software definition, quality monitoring, propose audit procedures, and so on. Although the software will be developed by the respective SAs and JRAs, the Software Governance group will ensure that the software produced has consistent architectures, uniform quality, and be both maintainable and reusable.

The Joint Research Activities planned for the GN3 project are:

- JRA1: Future Network.
- JRA2: Multi-domain Resources and Services.
- JRA3: Enabling Communities.

The relationships between the SAs and the relevant JRAs are shown in Table 1.28:

| | **Service Activity Task** | | **Respective research Activity Task** |
|---|---|---|---|
| SA1 Task 1 | Network Planning and Procurement Preparation | JRA1 Task1 | Core Network Technologies (state of the art IP technologies, PBT, Y-MPLS, equipment testing if feasible, operation of trial services) |
| | | JRA1 Task 2 | Photonic Switching/Multicasting, Experimental Photonic Facilities (state of the art in optical switching, hands-on evaluation/trial, analysis) |
| | | JRA1 Task 4 | Virtualisation (tools for virtualisation in single domain, formal definition of virtual resources, M-D virtualised resource sets) |
| | | JRA1 Task 5 | Advanced Network Control (BGP issues, secure BGP, Ethernet based circuit routing, inclusion of wireless networks, interaction with autonomic networks) |

| | **Service Activity Task** | | **Respective research Activity Task** |
|---|---|---|---|
| SA1 Task2 | Procurement | JRA1 Task3 | Federated Network Architectures (paper studies, software modelling, guidance for future GÈANT and NREN procurements) |
| SA2 Task1 | Multi – domain Network connectivity services development | JRA2 Task2 | Hybrid Network Provisioning (lookup service, authentication, automation of stitching, technology proxies, effective path finding) |
| SA2 Task2 | Services Coordination & Operations | JRA2 Task 1 | Control and management (information for multi-domain [M-D] service management, workflows for problem management, advanced signalling, management of M-D OPNs and VPNs, M-D workflows for new infrastructure provisioning) |
| SA2 Task3 | Service Monitoring Tools and performance | JRA2 Task3 | Monitoring (cross-layer monitoring, e2e monitoring techniques, monitoring of virtualised infrastructure, SLA monitoring, traffic pattern implications) |
| SA2 Task4 | Security | JRA2 Task4 | Security (anomaly detection, incident and security threats detection, mitigation actions) |
| SA3 Task1<br><br>SA3 Task3 | Coordination of European PKI infrastructures<br><br>Development and operation of eduGAIN, European AAI confederation | JRA3 Task 2 | Identity Federations (new ways for identity federations to interact; relationships Identity Providers (IdP) with one or more Service Provider (SPs); new identity architectures (OpenId) and new ways to implement protocols (simpleSAMLphp) - new opportunities to extend the usage of these models in several areas; non-Web-based applications) |
| SA3 Task2 | Operation of the eduroam confederation | JRA3 Task1 | Standardisation work on RadSec, implementation coordination, addition of authorisation and auditing elements, authenticated DHCP, diagnostics and monitoring facilities |

Table 1.28: SAs and respective JRAs

## 1.9.2 Timing of WPs/Activities and their components

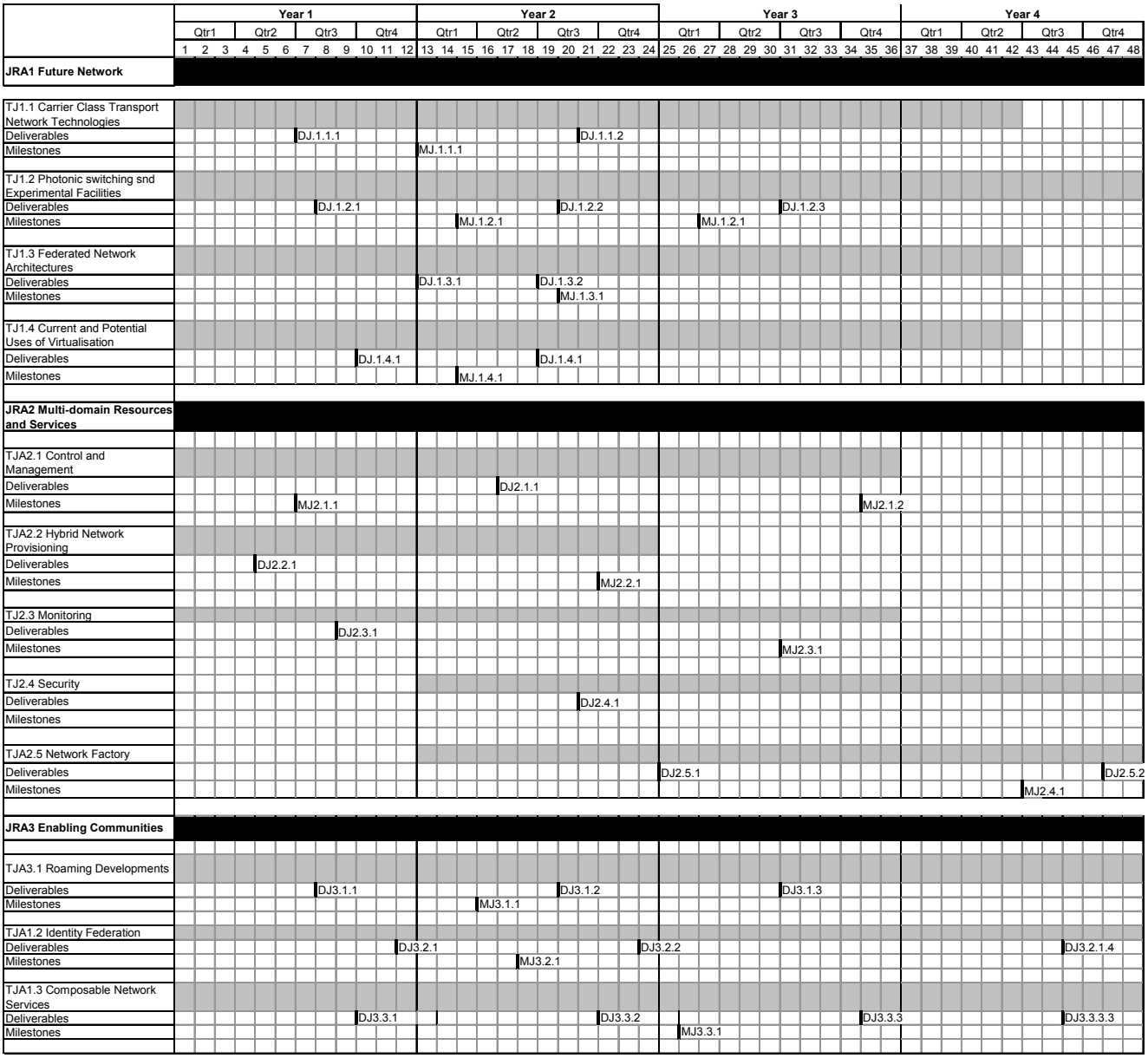


Table 1.29: GANTT Chart of JRAs and Tasks

### 1.9.3 Work package list

| Activity number | Activity Title | Type of activity[7] | Lead participant number[8] | Lead participant short name | Person months[9] | Start month[10] | End month[6] |
|---|---|---|---|---|---|---|---|
| JRA1 | Future Network | RTD | 23 | Nordunet | 240 | 1 | 48 |
| JRA2 | Multi-domain Resources and Services | RTD | 15 | GRNET | 719 | 1 | 48 |
| JRA3 | Enabling Communities | RTD | 2 | TERENA | 600 | 1 | 48 |
| | TOTAL | | | | 1559 | | |

Table 1.30: List of GN3 Joint Research Activities

### 1.9.4 Joint Research Activity 1: Future Network

| WP Number | JRA1 | | | | | Start date | | | |
|---|---|---|---|---|---|---|---|---|---|
| WP Title | Future Network | | | | | Activity Type | Joint Research Activity | | |
| Participant name | DANTE | TERENA | ACOnet | AMRES | ARNES | BELNET | BREN | CARNET | CESNET |
| Participant number | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| Person months | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 6 | 23 |
| | | | | | | | | | |
| Participant name | CYNET | DFN | EENET | FCCN | GARR | GRNET | HEANET | IUCC | JANET |
| Participant number | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
| Person months | 0 | 12 | 0 | 0 | 9 | 2 | 4 | 0 | 32 |
| | | | | | | | | | |
| Participant name | KTU-LITNET | MARNET | MREN | NIIFI | NORDUNET | PIONIER | REDIRIS | RENATER | RESTENA |
| Participant number | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 |
| Person months | 0 | 0 | 0 | 0 | 82 | 18 | 6 | 12 | 0 |
| | | | | | | | | | |
| Participant name | RoEduNet | SANET | SIGMANET | SURFNET | SWITCH | ULAKBIM | UOM | TOTAL | |
| Participant number | 28 | 29 | 30 | 31 | 32 | 33 | 34 | | |
| Person months | 7 | 0 | 0 | 22 | 0 | 0 | 0 | 240 | |

Table 1.31: JRA1 Participants

[7] Types of activities (EC classification):
RTD = Research and technological development; COORD = Co-ordination;
MGT = Management of the consortium; SVC = Service activities.
[8] Number of the participant leading the work in this work package (see List of Participants in the beginning).
[9] The total number of person-months allocated to each work package.
[10] Measured in months from the project start date (month 1).

#### 1.9.4.1 JRA1: Objectives

The overall objectives of JRA1 are to:

- Bring innovation to the basic infrastructure by investigating emerging technologies that enhance the network infrastructure and the corresponding portfolio of services offered by GÉANT and NRENs. Such technologies include:
  - Carrier Class Transport technologies, such as Provider Backbone Transport (PBT) and Transport Multiprotocol Packet Label Switching (T-MPLS).
  - Photonic equipment based on the state of art Photonic Switching.
- Examine and envisage new architectural paradigms applicable to backbone networks with the objective of optimising the use of resources deployed. Such studies will include:
  - Control plane and management.
  - Virtualisation services.
  - Protocol layering and scaling.

The expected results of JRA1 are to produce a set of reports that will be used a reference documents for GÉANT and NRENs when designing their next generation networks and services. In addition, it is expected that this work will influence the technical roadmaps of equipment vendors based on requirements from the GN3 community and the findings of this work.

#### 1.9.4.2 JRA1: Work Plan

Four key areas have been identifies as strategically important for the GÉANT and NREN community to invest effort for designing their network of the future:

- Carrier Class Transport Network Technologies.
- Photonic Switching and experimental Photonic Facilities.
- Federated Network Architectures.
- Current and Future uses of Virtualisation.

Each of these areas of work will consist firstly of a state of the art study followed by a definition and implementation of a test plan followed by the production of a report which will be used as a reference document for GÉANT and NRENs to use for the specification of their next generation networks.

##### *Task List and Descriptions*

JRA1 consists of the following Tasks:

- Task 1: Carrier Class Transport Network Technologies, which will examine the technical and operational aspects related to emerging carrier Class Transport Network Technologies (such as PBT and T-MPLS).
- Task 2: Photonic Switching and experimental Photonic Facilities, which will examine advances and issues related to photonic networking with emphasis on capacities (100+Gbps), interoperability, control and management and OAM&P.
- Task 3: Federated Network Architectures, which will focus primarily on the per-domain aspects in order to optimise the implementation and operation of multi-domain services as well as the corresponding management tools and workflows;
- Task 4: Current and Future uses of Virtualisation, which will focus on opportunities for offering services based on virtualisation techniques at L1, L2 and L3 and how virtualisation services from GÉANT and NRENs can be aggregated.

#### 1.9.4.3 Task 1: Carrier Class Transport Network Technologies

##### *Task 1 of JRA1: Objectives*

This work will research the exploitation of the hybrid infrastructure by emerging connection-oriented transport technologies such as Carrier Class PBT and T-MPLS in order to support point-to-point, point-to-multipoint and VPN services.

The fundamental functionalities that will be assessed in the study and testing include:

- Scalability.
- Traffic shaping and policing capabilities.
- Support for multicast.
- OAM&P functionalities like protection switching and restoration, efficient fault localization and multi-operator service offering.

- Layer 2 QoS.
- Layer 2 routing and their monitoring and management capabilities:

The expected results of the work are the:

- Production of reference papers for GÉANT and NREN's future transport network technologies.
- Inclusion into equipment vendors technical roadmaps of the requirements of GÉANT and NRENs resulting from the testing and evaluation.

***Task 1 of JRA1: Outline of Work Plan***

The work plan will consist of:

- State of the art study of Carrier Class transport technologies (such as PBT, T-MPLS). This will include the study of relevant standards.
- Definition of a test plan including:
  - Elements to be tested.
  - Role of project partners, equipment vendors.
  - Time plan.
- Logistics of testing including:
  - Sourcing of test support equipment (traffic generators etc).
  - Sourcing of equipment to be tested.
  - Location of tests (GÉANT and NREN facilities, vendor facilities, other).
- Analyse results and produce reports.

This work plan will be enhanced according to the results of previous phases depending upon the availability of resources.

#### 1.9.4.4 Task 2: Photonic Switching and Experimental Photonic Facilities

***Task 2 of JRA1: Objectives***

The objectives of this Task are to investigate five key areas:

- **Photonic technologies** focusing on emerging ROADM technologies such as Wavelength Blocker (WB), Wavelength Selective Switches (WSS), Small Switch Array (SSA) and also on Photonic Integrated Circuit (PIC) based solutions.
- **Photonic Interoperability**: at present there is still no real interoperability among different vendors in the optical (between adjacent transponders) domain due to the fact that each vendor uses different optical modulations schemes, impairment compensations techniques etc. In the combined GÉANT and NREN environment addressing these interoperability issues is of fundamental importance if the advantages offered by photonic technologies are to be exploited in a multi-domain, multi-technology environment.
- **Transmission capacity and granularity**: this area will investigate issues related to higher capacities per wavelength (i.e. 100Gbps), wavelength count, multicast and compensation techniques.
- **Control and management plane**: this will deal with all the details related to the Control and Management Plane interfaces and implementations for protocols such as GMPLS, ASON and TL1.
- **Operation, Administration, maintenance and Provisioning (OAM&P**): this will conduct a study and analysis including testing of the functions considered more important to future photonic Layer management including fault detection, localisation and restoration, path provisioning, automatic quality assurance of the optical path.

The expected results of the work are:

- Production of reference papers for GÉANT and NREN's future photonic network architectures.
- Inclusion into equipment vendors technical roadmaps of the requirements of GÉANT and NRENs resulting from the testing and evaluation.

***Task 2 of JRA1: Work Plan***

The work plan will consist of:

- State of the art study of identified technologies. This will include the study of relevant standards.
- Definition of a test plan including:
  - Elements to be tested.
  - Role of project partners, equipment vendors.
  - Time plan.

- Logistics of testing including:
  - Sourcing of test support equipment (traffic generators etc).
  - Sourcing of equipment to be tested.
  - Location of tests (GÉANT and NREN facilities, vendor facilities, other).
- Analyse results and produce reports.

This work plan will be enhanced according to the results of previous phases depending upon the availability of resources.

#### 1.9.4.5 Task 3: Federated Network Architectures

***Task 3 of JRA1: Objectives***

A key challenge for European NRENs is to optimise the use of network resources and to find practical ways to stitch together services from equipment originating in multiple domains, while maintaining a high quality of service. Other challenges include the ability to provision services quickly, whilst keeping operations costs low. Such federated networks pose challenges to L1, L2 and L3 network architectures, control planes, management systems, etc as well as their administrative and organisational set up.

The work will study alternative network architectures and investigate how effectively they can support the various multi-domain network and services that are planned to be ubiquitously supported by the GN3 community, thereby arriving at a set of recommendations for the architectural design optimum of both single- and multi-domain network infrastructures and services.

This work will not be limited to technical aspects. It will also examine organisational and administrative aspects of new architectural paradigms. It will build on cross-border fibre and multi-domain coordination efforts started in GN2 as well as network stitching work done in PHOSPORUS and elsewhere.

It is expected that new architectures will require the development of new tools and methods as well as an innovative and effective organisational environment for the operations and administration of a multi-domain infrastructure.

In addition there will be the specification of a test case, based on the report findings, to create a sample multi-domain architecture involving a limited number of NREN's interconnected via cross board fibres.

***Task 3 of JRA1: Work Plan***

- Conduct a state-of-the-art paper study in order to describe different GÉANT, NREN and third party network architectures. Produce a report dealing with:
  - Network architectures:
    - Capacities and separation/sharing of nodes and links.
    - Layering of protocols and technologies.
    - Dimensioning and scaling of functionalities.
    - Service offering.
    - Requirement for a generic modelling and planning tool.
  - Operational and administrative aspects:
    - Planning, scheduling and provisioning.
    - Operation and maintenance.
    - Service assurance and service performance.
    - Cost issues.
    - Workflow and process tools.
  - Local influences e.g. geography, liberalisation of markets, etc.
  - Operational and administrative organisational structure

The following sub tasks will be conducted according to the results of previous phases and depending upon resources:

- Definition of a test case in cooperation with JRA2 addressing:
  - The involvement from GÉANT, NREN and vendors.
  - Development of tools and applications for the test case.
  - Sourcing of equipment
- Conduct testing.
- Analyse results and findings. Produce a report and paper possible for publication.

### 1.9.4.6 Task 4: Current and Potential uses of Virtualisation

***Task 4 of JRA1: Objectives***

Virtualisation is a classic technology in computer systems and networking. In recent years virtualisation has be employed in many areas, ranging from full virtualisation of computer servers to virtual private networks. With hardware support, virtualisation can be done with little overhead, and the benefits are better utilization of hardware resources, reduced complexity of management, and increased flexibility and resiliency of the architecture. The combination of computer systems and networks with embedded virtualisation capabilities creates new scenarios; Task 4 will carefully evaluate their consequences and investigate how to exploit the potential.

Virtualisation can be addressed in many ways, and can be applied to various network layers:

- Virtualisation of node resources within the network, i.e. virtualisation of L1, L2 and L3 devices, thereby creating multiservice virtual nodes.
- Virtualisation seen from the operation and support systems (virtualisation of servers).
- Multi-domain Aggregation of virtualised services and elements, thereby creating a single virtual network spanning multiple physical and control domains.

This work will start analyzing the current and possible use of virtualisation in a single-domain environment, e.g., virtualisation of node and transport service resources, and the possibility of creating virtual sets of resources, including computational elements.

Following this, the architecture of a single virtual domain based on virtual resources from a multi-domain service will be examined. The advantages of such architecture from a network, operations, and user perspective will be investigated.

The findings will be used to specify the requirements of a single virtual domain prototype followed by a hands-on test case.

The work will include a business analysis addressing strategic, tactical, operational and risk issues.

***Task 4 of JRA1: Work Plan***

The work plan will consist of three phases, where phase three will be started according to the results of previous phases if there is spare manpower available or if JRA1 receives additional manpower:

- Analysis, Framework and Definition of Virtualisation Services: in this phase the findings of related initiatives such as FEDERICA, PHOSPHORUS, MANTICORE will be taken into account. It will examine network virtualisation issues at L1, L2 and L3.
- Prototyping: in this phase the requirements for a prototype of a single virtual domain will be specified.
- Definition and implementation of a test case: based on phase 2, this phase will define all technical, organisational and logistics aspects for conducting the test case. It will implement the test case.

### 1.9.4.7 Deliverables

| Code | Title | Description | Deliver y Date |
|---|---|---|---|
| DJ.1.1.1 | Transport Network Technologies - Study | Initial report on state of the art hybrid connection-oriented transport technologies such as Carrier Class PBT and T-MPLS with regards to classification of each technological approach, listing of transport functionalities , addressing the status of the interoperability in order define requirement from the research and education community including evaluation whether new standardisation developments should be tested. | M6 |
| DJ.1.1.2 | Transport Network Technologies – Study and testing | Final report paper based on the same scope as outlined in DJ.1.1.1. In addition founded by test results. This report will act as basis for GÉANT and NREN's strategically future transport network architectures. | M20 |
| DJ.1.2.1 | State of the Art Photonic | Initial report outlining the state of the art with regard to photonic switching solutions, address photonic | M7 |

| | | | |
|---|---|---|---|
| | Switching Technologies | interoperability in order define requirement from the research and education community, study different control and management plane protocols and outline the functions considered important to OAM&P with regards to future photonic layer management. | |
| DJ.1.2.2 | State of the art Photonic Switching Technologies – Study and testing | Mid stage report on testing state of the art photonic technology, interoperability, transmission capacity and granularity with focus on 100G+ solutions, control and management plane protocols in coordination with JRA2, OAM&P with regards to photonic layer management. Including update of DJ.1.2.1 | M19 |
| DJ.1.2.3 | State of the art Photonic Switching Technologies – Final Study and testing | Final report paper based on the same scope as outlined in DJ.1.2.1 and DJ1.2.2. In addition founded by test results. This report will act as basis for GÉANT and NREN's strategically future photonic network architectures | M30 |
| DJ1.3.1 | Architecture considerations for federated backbone networks – Study | Initial report outlining various models of architectural options available for a multi-domain backbone network, operational and administratively aspects including local influences like geography and liberalisation of markets. It will outline the best operational and administratively structure and optionally form the basis of a specification requirement for a test case in cooperation with JRA2 | M12 |
| DJ1.3.2 | Architecture considerations for federated backbone networks including – Study and optionally test case studies | Final report based on the same scope as outlined in DJ.1.3.1. The report will act as guidance for important design decisions that will be made in relation to future GÉANT and NREN network procurements. Optionally founded by test case results | M18 |
| DJ1.4.1 | Virtualisation Services and Framework – Study | This task will produce an initial report describing the result and findings from analyzing the current and possible use of virtualisation in a single-domain environment e.g. virtualisation of node and transport service resources and the possibility of creating virtual sets of resources, including computational elements. In addition conduct a risk analysis of the virtualisation services in relation to the NREN community. Optionally a specification requirement for a prototype of virtualisation services | M9 |
| DJ1.4.2 | Virtualisation Services and Framework – Study and optionally test case studies | Final report based on the same scope as outlined in DJ.1.4.1. In addition founded by test case results. The report will act as guidance with regards to virtualisation service in the GN3 community. | M18 |

Table 1.32: JRA1 Deliverables

## Milestones

| Code | Title | Description | Deliver y Date |
|---|---|---|---|
| MJ1.1.1 | Testing | testing system architecture, deployment and test trial services ready | M12 |
| MJ1.2.1 | Test phase one | Initial test phase based on the study and analyse | M14 |
| MJ1.2.2 | Test phase two | Second test phase including final report | M26 |
| MJ1.3.1 | Study and Requirement specification | Requirement specification for a multi-domain architecture forming a federated network. Optionally:<br>• Development of tools and application including logistical planning<br>• Test case based on the specification requirement, developed tools and applications and co-operation with JRA2 | M19 |
| MJ1.4.1 | Tool development and logistical planning | Specification requirement for a prototype of virtualisation services. Optionally:<br>• Development of tools and application including logistical planning<br>• Test case based on the specification requirement, developed tools and applications and co-operation with JRA2 | M14 |

Table 1.33: JRA1 Milestones

### 1.9.5 Joint Research Activity 2 (JRA2): Multi-domain Resources and Services

| WP Number | JRA2 | | | | | Start date | | | |
|---|---|---|---|---|---|---|---|---|---|
| WP Title | Multi-Domain Resources and Services | | | | | Activity Type | Joint Research Activity | | |
| Participant name | DANTE | TERENA | ACOnet | AMRES | ARNES | BELNET | BREN | CARNET | CESNET |
| Participant number | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| Person months | 0 | 0 | 0 | 29 | 0 | 0 | 27 | 0 | 54 |
| | | | | | | | | | |
| Participant name | CYNET | DFN | EENET | FCCN | GARR | GRNET | HEANET | IUCC | JANET |
| Participant number | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
| Person months | 14 | 18 | 0 | 0 | 25 | 121 | 5 | 4 | 10 |
| | | | | | | | | | |
| Participant name | KTU-LITNET | MARNET | MREN | NIIFI | NORDUNET | PIONIER | REDIRIS | RENATER | RESTENA |
| Participant number | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 |
| Person months | 0 | 14 | 27 | 0 | 60 | 111 | 54 | 16 | 0 |
| | | | | | | | | | |
| Participant name | RoEduNet | SANET | SIGMANET | SURFNET | SWITCH | ULAKBIM | UOM | TOTAL | |
| Participant number | 28 | 29 | 30 | 31 | 32 | 33 | 34 | | |
| Person months | 29 | 0 | 0 | 67 | 0 | 31 | 0 | 715 | |

Table 1.34: JRA2 Participants

#### 1.9.5.1 JRA2: Objectives

This activity will address the issues of control, management and service provisioning in the multi-domain environment of GÉANT and the European NRENs. These issues have been recognised from GN2 project experiences, user requirements and recent evolutions in the community of Research and Education networks (e.g. new transport technologies and virtualisation techniques). The activity will define the framework for coordinated management and control of the multi-domain infrastructure. The framework will then serve as the basis for the operation of multi-domain services, some of which have already emerged as a result of activities in GN2. For these services a number of open issues and new aspects not already addressed in GN2 or other groups of the global R&E networking community will be tackled. Useful results and successful pilots emerging from this activity will lead to production-level developments in SAs.

#### 1.9.5.2 JRA2: Work Plan

The work will be conducted in general over a period of 3 years (except in one case where it is 2 years) and will cover five themes, as outlined in the following sections.

***Task List and Descriptions***

JRA2 consists of the following Tasks:

- Task 1: Control and Management. Duration 3 years. Its main objective is to investigate a common, cross-activity framework for the harmonisation and integration of the control and management functions required in a multi-domain environment. The goal is to enable resources reachability, allow for information sharing, and provide the means for coordinated management and control of the infrastructure and incidents across domains in a harmonised way. It is also intended to specify control and management functions that will

serve as the basic toolset for the orchestration of advanced multi-domain services in the other Tasks of JRA2 (circuit provisioning, monitoring, federated security, network factory).

- Task 2: Hybrid Network Provisioning. Duration 2 years. It is intended to deliver an enhanced version of the AutoBAHN prototype, which is used for dynamic circuit provisioning over different technologies in a multi-domain environment
- Task 3: Requirements. Duration 3 years. This will investigate new demands, derive requirements, and elaborate new concepts for network monitoring to foster the provisioning and operation of the multi-domain services portfolio.
- Task 4: Security. Duration 3 years. This Task will focus on research into advanced methods for incident and security threat detection, both refining the developed tools in GN2 JRA2 (based on traffic analysis and statistical recognition), and creating a knowledge base information system to help security teams (and eventually automated tools) to raise alarms where necessary. The research will include solutions whose deployment is both foreseen inside the NREN domains and in the inter-domain environment, embedded in the multi-domain management processes as defined in Task 1.
- Task 5: Network Factory. Duration 3 years. This Task will plan, configure and provide the basic framework for the evolution to an infrastructure independent of the production environment to perform tests. The study should tackle the multi-domain environment to understand how a "network factory" service can be implemented between different domains and for this purpose the Task will adopt the results of Task 1. Additionally, demonstrations should be performed with the participation of end users, working together on their requirements. The provisioning of a multi-domain network factory as a service is the ultimate goal of this Task.

#### 1.9.5.3 Task1 of JRA2: Control and Management

***Task 1 of JRA2: Objectives***

The main objective of this Task is to investigate a common, cross-activity framework for the harmonisation and integration of the control and management functions required in a multi-domain environment. The goal is to enable resource reachability, allow for information sharing and provide the means for coordinated management and control of the infrastructure and incidents across domains in a harmonised way.

On top of this basic functionality, provisioned services in a multi-domain environment require an integrated approach to agreement on procedures, well defined and consistent sharing of service-specific fundamental information, and fixed policies for information disclosure. Task 1 of JRA2 aims to meet these requirements.

While only visible to the NOCs (and not to the user community), the control and management functions specified as part of this Task will serve as the basic toolset for the orchestration of advanced, visible (to the end-users) multi-domain services in the other Tasks of JRA2 (circuit provisioning, monitoring, federated security, network factory). Emphasis will be placed on a seamless view of information exchanges, data formats, message signalling, and information storage at the inter-domain level.

Task JRA2.1 will eventually feed its recommendations, results and prototypes into SA2.

***Task 1 of JRA2: Outline of Work Plan***

The work plan of Task 1 of JRA2 includes the analysis and specification of the schemas and workflows required for multi-domain control and management of networking infrastructures, and more specifically functions such as:

- Multi-domain workflows for resource representation (addressing scalability, interoperability issues).
- Harmonisation of information sharing for multi-domain service management (addressing scalability and information updating).
- Globally adopted workflows for neighbour discovery and inter-domain link management.
- Multi-domain workflows for problem management (for inter-domain links).
- Multi-domain advanced signalling (G2MPLS, NSIS).
- Multi-domain workflows for monitoring, accounting.
- Management of multi-domain virtual private networks (OPNs-VPNs) and multi-domain overlay networks.
- Multi-domain workflows for new infrastructure provisioning.

Results achieved in the first half of the project will lead to prototypes within Task 1 of JRA2, or detailed specifications for the development of utilities/tools required to achieve the functionality required in the areas above in SA2. In general this work will apply to technologies and services provided at all layers (L1, L2, L3) where applicable and will differ in their detail accordingly. In most cases the work is expected to focus on L1

and L2 techniques and services, whilst L3 issues will be dealt with mainly for the item on management of multi-domain virtual private networks.

#### 1.9.5.4 Task 2 of JRA2: Hybrid Network Provisioning

***Task 2 of JRA2: Objectives***

This Task is a follow-up research activity to the GN2 JRA3 activity, delivering a prototype for dynamic circuit provisioning over different technologies in a multi-domain environment (known as AutoBAHN). The objective of the Task is to focus on enhancing the AutoBAHN prototype with functionality, extending it to other layers and technologies for dynamic circuit provisioning and improving existing modules (e.g. path-finding computations) or revising its functions where necessary to make them easier to manage and maintain. This will facilitate their take-up in an eventual transition to service phase. As dynamic circuit provisioning is a particularly "hot topic" in Research and Education networking, the Task will take into consideration architectures, frameworks and systems aiming at equivalent functionality, such as the IaaS framework[11] or the DCN of Internet2. Additionally the developments in this Task need to be compatible with the multi-domain control and management framework defined in Task 1 of JRA2. In this way the AutoBAHN system will evolve in terms of functionality, and will mature so as to be integrated in the multi-domain services portfolio of GN3, as offered by SA2.

***Task 2 of JRA2: Work Plan***

Work in this Task will include:

- Design and development of a lookup service for Interdomain Manager systems and service delivery end-points that enable clients to identify the locations and gain access to the AutoBAHN system.
- Introduction of authentication and accounting.
- Further automation of technology stitching techniques (e.g. inter-domain link discovery and parameter negotiation).
- Addressing last-mile configuration issues and applications, bridging the gap between the circuit delivery point and the actual end-user location wherever such gaps exist.
- Prototyping of per-network domain technology proxies for emerging transport technologies (GMPLS, Carrier Ethernet, OTN, dynamic lambda provisioning).
- Further development pathfinding techniques, including crankbacks (a scheme whereby setup failure information is returned from the point of failure to allow new setup attempts to be made avoiding the blocked resources).

#### 1.9.5.5 Task 3 of JRA2: Monitoring

***Task 3 of JRA2: Objectives***

Experience in GN2 (both operational and within research activities JRA1, JRA3 and JRA4) exposed several challenges to network monitoring that have been tackled partially, but could not be solved during the lifetime of GN2. These challenges originate not only from the fast-paced progress of network technologies, but also from the specific organisational structures encountered in the multi-national co-operation of the European NRENs and GÉANT. Additionally, the spectrum of multi-domain network services has been extended beyond pure IP-based services. Finally, demanding applications under wide scale deployment (streaming media, multicast TV, videoconferencing, HD streaming at Gbps) impose new requirements on the assessment of end to end quality of network services. It is the objective of the monitoring Task of the JRA2 research activity in GN3 to investigate new demands, derive requirements, and elaborate new concepts for network monitoring to foster the provisioning and operation of the GN3 multi-domain services portfolio.

Issues that will be addressed include:

- Cross-layer monitoring: Experience has shown that it is not always sufficient to monitor at a single network layer (e.g. only IP). For investigation of network outages, underlying layers must also be taken into account (for example, Ethernet or SDH/SONET on Layer 2 and optical/electrical status information on Layer 1).
- Monitoring as a means of multi-domain infrastructure management: Tight integration of monitoring techniques into overall management processes (such as fault management) is the basis for sustainable multi-domain operations. Approaches like event correlation, and impact and root cause analysis, close the gap between traditional monitoring techniques and effective multi-domain management. The existing approaches and research topics that are applicable within GN3 will be investigated in conjunction with the overall approach of Task 1 of JRA2 for integrated management functions in the multi-domain environment.

[11] http://www.iaasframework.com/

- End-to-end monitoring techniques: These have tremendous importance for the operation of multi-domain services with tight requirements regarding, for example, bandwidth, delay or other Quality of Service (QoS) parameters. Along with true end-to-end measurements, the aggregation of monitoring data from multiple domains involved in provisioning is required.
- Seamless monitoring across organisational boundaries: The exchange of monitoring information between administrative domains is constrained by several aspects, such as privacy and security considerations, especially if campus networks also participate in monitoring. Policies and procedures for sharing monitoring data must be elaborated in conjunction with the workflows for multi-domain management investigated in Task 1 of JRA2
- Monitoring of virtualised network infrastructures: Virtualisation of infrastructures increases the flexibility and adaptability of modern networks. Virtualisation techniques range from VPNs on different network layers, through virtual routers or firewalls, to Overlay and P2P networks. To leverage the operation of virtual networks on a pan-European scale, appropriate monitoring strategies and architectures must be conceived. These will target first the virtualisation techniques used in network operations (SA2) and later the new virtualisation techniques being investigated in JRA1.
- Service Level Agreement (SLA) monitoring: to ensure that the GN3 network provides the required level of service to user traffic in terms of data transport parameters (e.g. packet loss, jitter, etc.),
- Traffic pattern analysis and traffic classification at high link speeds: Increasing link speeds in core networks is putting more and more strain on traffic pattern analysis and traffic classification. New paradigms using hardware and software are necessary to monitor these traffic volumes will be investigated.

#### *Task 3 of JRA2: Work Plan*

The work will focus on:

- Alarms: Provide a concept defining when alarms should be raised by whom and how they should be handled and further investigated in the multi-domain environment. Use the correlation of network monitoring information for the interpretation of the current situation. For the correlation, acquire knowledge about the typical impact of events like link failures or rerouting.
- Service lookup: Consider efficiency aspects in the design of the service lookup, in particular in the summarisation of the content of services (e.g. provide a service utilisation archive by compiling summarised utilisation information for the monitored interfaces).
- Netflow monitoring: Investigate how flows should be monitored what information should be made available and how the information should be made available.
- Service generalisation: Provide a proxy concept that masks differences in the individual measurement configurations (Transformation Service).
- Passive monitoring: Integration of passive measurement tools into the perfSONAR monitoring framework as a means to measure performance parameters of flows for assessing end to end quality of network services.
- Traffic burstiness: Investigate how to quantify traffic burstiness in order to assess its effects on perceivable network characteristics, such as delay and jitter.
- Intelligent traceroute: Investigate how to implement an intelligent traceroute-like tool that will provide performance information about the components of a network path to assist in locating performance limiting points.

The conceptual work must consider the deployment that is planned for the monitoring software. In addition to the target user groups considered so far (see below), the monitoring system should be suited for university campus and research facility environments. This requires an easy-to-deploy and easy-to-maintain solution. Scalability and policy aspects require that monitoring infrastructure is based on distributed components so that a transition of such infrastructure towards distributed operation can be supported.

For the standardisation of GN2-developed perfSONAR protocols and schemas, active participation in the OGF is planned (previously done indirectly via Internet2).

### 1.9.5.6 Task 4 of JRA2: Security

#### *Task 4 of JRA2: Objectives*

Security activities within the NREN community have in recent times developed a valuable set of tools, procedures and countermeasures to handle evolving threats and mitigate their effects on the network, its component, services, and ultimately its end-users. However, most of the existing consolidated methods comprise reactive actions, and many of these actions still rely on manual handling of sometimes complex procedures.

There is a need to exploit both better and more adaptable monitoring tools to enable early detection of problems, including better handling of complex traffic data analysis, and to lessen the manual intervention time required by counteractions. Research into the use of monitoring tools (in conjunction with Task 3 of JRA2) and information exchange formats (in conjunction with Task 1 of JRA2) is the overall goal of this Task. The main topic of advanced security research will focus on new, innovative and advanced methods for incident and security threat detection (in addition to those used already by NRENs). This will both refine the developed tools in GN2 JRA2 (based on traffic analysis and statistical recognition), and create a knowledge-base information system to help security teams (and eventually automated tools) to switch on alarms where something wrong is happening on the network, both at backbone level or at local level. The security research will include solutions whose deployment is both foreseen inside the NREN domains and in the inter-domain environment, embedded in the multi-domain management processes as defined in Task 1 of JRA2. Research will of necessity include validation of solutions inside the IPv6 environment.

#### *Task 4 of JRA2: Work Plan*

Research activities focus mainly on new advanced anomaly detection techniques, tools and attack mitigation actions which, when validated, should turn into tools and procedures adopted by security teams belonging to the multi-domain environment and relying on security services for their daily operations. In particular, the Task will focus on analysis and specification of:

- Anomaly detection based on correlation of flow data, traffic data, routing data (nfsen, NetReflex, traffic monitoring data) and security probe data.
- Support for mitigation tools, by semi-automated efficient transmission of information about sources of problems (botnet controller/members locations, origins of most frequent attacks).
- Enhanced functionality inside network devices (router, switches, etc.) to support anomaly detection and mitigation actions, defined in collaboration with the device's developers.

### 1.9.5.7 Task 5 of JRA2: Network Factory

#### *Task 5 of JRA2: Objectives*

The hybrid infrastructure at the base of the GÉANT network is capable of creating logical and physical infrastructures that can be considered independent of the production infrastructure, but that share physical elements among them. The underlying infrastructure can be considered as a network (or infrastructure) factory.

Apart from network resources (circuits and network equipment), these infrastructures can also contain other resources such as computing equipment (which is also capable of virtualisation).

The goals of the Task are:

- To plan, configure and provide the basic framework for the evolution to an infrastructure independent of the production environment to perform tests. The infrastructure should be conceived to be permanent. From the start the study should tackle the multi-domain environment in an attempt to understand how a "network factory" service can be implemented between different domains. For this purpose, the Task will adopt the results of TJRA1.4 on virtualisation of resources in a single-domain, and those of Task 1 of JRA2 on multi-domain management and operations.
- To perform demonstrations with the participation of end users, working together on their requirements. Initial users should be part of the potential target groups for this Task, especially those in the fields of health sciences, art and humanities and those testing emergency scenarios (e.g. earthquakes).

The provisioning of a multi-domain network factory as a service would be the ultimate goal, and therefore the Task will maintain links with JRA3 to deliver the network factory as a tool to the user community.

#### *Task 5 of JRA2: Work Plan*

The Task will be organised in yearly lifecycles, each of which will deliver the documentation of the current network factory footprint as well as its usage report.

Initially the work will produce architectural documents defining network engineering to be applied to existing resources. The network factory will be created mainly using resources from the GÉANT backbone, probably enriched by resources from participating NRENs. The architecture will likely leverage the experience from the FEDERICA project with which collaboration is foreseen during the first months.

The actual building of the infrastructure must be a joint effort with SA1, using tools and services provided by SA2 and the resulting capabilities should be aligned with the results and services defined for JRA3.1 and JRA3.2.

An initial set of end users will be chosen to perform testing and to tailor the infrastructure to their needs, with the specific requirement of involving non-traditional user groups (e.g. from the arts and humanities or the health science sectors). The Task will investigate their requirements and map them.

The search for new users should be agreed with NA4. Each test should produce a report and aim at increasing the understanding of the "network factory" concept.

### 1.9.5.8 Deliverables

| Code | Title | Description | Delivery Date |
|---|---|---|---|
| DJ2.1.1 | Information schemas and workflows for multi-domain control and management functions | This deliverable will produce the specification of the information schemas and workflows, which will allow for information sharing and provide the means for coordinated management and control of the infrastructure and incidents across domains in a harmonised way. Emphasis will be placed on a seamless view of information exchanges, data formats, message signalling, and information storage at the inter-domain level. | M16 |
| DJ2.2.1 | Specification of enhancements and developments for the AutoBAHN system | The deliverable will produce a specification for delivering an enhanced prototype of AutoBAHN, which is used for dynamic circuit provisioning over different technologies in a multi-domain environment. The objective of the Task is to focus on enhancing the AutoBAHN prototype's functionality, extending it to other layers and technologies for dynamic circuit provisioning and improving the existing modules (e.g. pathfinding computations) or revising their functions where necessary. | M4 |
| DJ2.3.1 | Specification of advanced features for a multi-domain monitoring infrastructure | The deliverable will produce a specification for delivering an enhanced prototype of GN2-developed perfSONAR and additional monitoring functionality for multi-domain operations and services | M08 |
| DJ2.4.1 | Specification of advanced methods for incident and security threats' detection and mitigation in a multi-domain environment | This deliverable will produce a specification of advanced methods for incident and security threat detection, with solutions to be deployed both within the NRENs and in the inter-domain environment, embedded in the multi-domain management processes. | M20 |
| DJ2.5.1 | Network factory footprint | Task 5 will initially produce a deliverable documenting the coverage of the Network Factory and the technologies used to realise it | M24 |
| DJ2.5.2 | Updated network factory footprint and usage report | Towards the end of its duration, Task 5 will produce an update deliverable for the Network Factory footprint, together with a report on its usage by user groups and applications | M46 |

Table 1.35:JRA2 Deliverables

#### 1.9.5.9 Milestones

| Code | Title | Description | Delivery Date |
|---|---|---|---|
| MJ2.1.1 | Definition of a multi-domain control and management architecture | The milestone concerns the definition of the basic architecture for the harmonisation and integration of the control and management functions required in a multi-domain environment | M06 |
| MJ2.1.2 | Delivery of a common platform for multi-domain control and management | The milestone concerns the delivery of pilot implementation and documentation of a common platform for multi-domain operations together with an integrated approach to agreement on procedures, well-defined and consistent sharing of service-specific fundamental information and fixed policies for information disclosure. | M34 |
| MJ2.2.1 | Delivery of an advanced release of AutoBAHN | This milestone concerns the delivery of an enhanced and updated release of AutoBAHN, with additional features that will be ready for migration to its service-level release. | M21 |
| MJ2.3.1 | Delivery of advanced features for a multi-domain monitoring infrastructure | The milestone concerns the delivery of pilots and research results in different areas of multi-technology, multi-domain monitoring, as emerging from Task 3 | M30 |
| MJ2.4.1 | Advanced methods for incident and security threats' detection and mitigation in a multi-domain environment | The milestone concerns the delivery of advanced methods and pilots for the detection and mitigation of security threats, as emerging from Task 4 | M42 |

Table 1.36: JRA2 Milestones

### 1.9.6 Joint Research Activity 3 (JRA3): Enabling Communities

| WP Number | JRA3 | | | | | Start date | | | |
|---|---|---|---|---|---|---|---|---|---|
| WP Title | Enabling Communities | | | | | Activity Type | Joint Research Activity | | |
| Participant name | DANTE | TERENA | ACOnet | AMRES | ARNES | BELNET | BREN | CARNET | CESNET |
| Participant number | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| Person months | 0 | 36 | 0 | 0 | 5 | 0 | 5 | 34 | 19 |
| | | | | | | | | | |
| Participant name | CYNET | DFN | EENET | FCCN | GARR | GRNET | HEANET | IUCC | JANET |
| Participant number | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
| Person months | 0 | 74 | 0 | 0 | 0 | 50 | 0 | 0 | 10 |
| | | | | | | | | | |
| Participant name | KTU-LITNET | MARNET | MREN | NIIFI | NORDUNET | PIONIER | REDIRIS | RENATER | RESTENA |
| Participant number | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 |
| Person months | 0 | 0 | 0 | 10 | 82 | 82 | 82 | 10 | 24 |
| | | | | | | | | | |
| Participant name | RoEduNet | SANET | SIGMANET | SURFNET | SWITCH | ULAKBIM | UOM | TOTAL | |
| Participant number | 28 | 29 | 30 | 31 | 32 | 33 | 34 | | |
| Person months | 0 | 0 | 0 | 70 | 10 | 0 | 0 | 600 | |

Table 1.37: JRA3 Participants

#### 1.9.6.1 JRA3: Objectives

This activity will concentrate on research and development of services (mainly software based), to better support direct end-to-end collaboration in a multidomain and multilayer environment. The confederated approach to services has been initiated in GÉANT2 and it will be extended and generalised in almost all activities throughout the lifetime of the GN3 project.

The competitive edge of research and education networks is defined by their ability to offer services beyond those available in the market. A key paradigm in this innovation process is seamless collaboration, going beyond the current model of a community of collaborating network operators (the NRENs), into an open cloud of services that users can freely compose not only to access network resources, but also to define these resources and allow others to share them, thereby building collaborating communities.

These services have to ensure a seamless authentication and authorisation across multiple domains, possibly through an identity harmonisation. Also new possible services are appearing for the end-user, e.g. federation of general purpose repositories and storage facilities and collaborative tools. They introduce simple and effective access to the network and to the resources available through the network to allow users to select and compose services.

The main objectives of this activity are:

- To enable (federated) access to infrastructures and services for end-users.
- To frame new ways in which existing services and infrastructures (located in different domains and operating in different layers) can be composed, offered and accessed by the end-user in a federated environment.
- To increase the number of services that can be accessed using such a federated infrastructure.
- To reach out other well-established communities, such as Grids and libraries consortia, and to allow them to use the federated framework initiated in GN2 and to be further developed in GN3.

A close collaboration with standards bodies and other related communities (IETF, IEEE for wireless technologies) and with similar initiatives beyond Europe (like those carried out by Internet2) will be actively sought.

### 1.9.6.2 JRA3: Work Plan

The strategy is to research on key security areas and to develop protocols to develop a framework to create modular services for access to network resources or other resources accessible through the network.

Each Task will initially collect the specific state of the art information and requirements from as wide a range as possible of potential users, with special focus on existing communities, and establish liaisons with them. Early prototyping based on realistic use cases, is considered essential.

The collection of requirements will be used by each Task to elaborate an evolutionary cycle that be summarised as follows:

- Identify services to be implemented in the evolutionary cycle. This will vary depending on the Task. In the case of the Task JRA3.1 a new service could be the integration of SSO with eduroam.
- In the case of Task JRA3.2 this could mean the implementation of an attribute authority service. In the case of JRA3.3 the use cases collection might lead to the first specifications for the API or to composable services diagnostic tools.

The services will be designed to integrate with existing services.

#### *Task List and Descriptions*

The Tasks for the JRA3 activity are the following:

- **JRA3.1 Roaming developments**. The Task will focus mainly on federated network access. New protocols (RadSec, authenticated DHCP) will be explored and used to secure the existing and future infrastructure.
- **JRA3.2 Identity Federations**. The Task will research new ways for different identity federations to coexist and interact. The classical approach for inter-operation of federations is based on the assumption that users trust their own Identity Provider (IdP), which will be entitled to establish relationships with one or more Service Provider (SPs). New identity architectures (such as OpenId) and new ways to implement protocols (like simpleSAMLphp) offer new opportunities to extend the usage of these models in several areas. The federated framework will also be extended to encompass non-Web-based applications.
- **JRA3.3 Composable network services**. The third Task aims to define a new framework to enable users to create and request services for resources (HD videoconference, physical space to store data for a certain period, etc) on demand in an easy and manageable way.

### 1.9.6.3 Task 1 of JRA3: Roaming developments

#### *Task 1 of JRA3: Objectives*

The current implementation of the roaming service in the NRENs environment is based on the eduroam service [http://www.eduroam.org]. In GN2, its confederation level is operated by a dedicated service activity, with the aim of providing network access at roaming spots (the so-called “Service Providers”) with the credentials of the own home organisation (the “Identity Provider”).

The current eduroam infrastructure has some limitations, which only allow for network access and limit eduroam in terms of security and scalability in the long term (when the number of eduroam users will increase significantly) and efficiency.

The Task’s objective is to develop the eduroam architecture to overcome current limitations.

#### *Task 1 of JRA3: Outline of Work Plan*

This Task will work to:

- Standardise RadSec within the IETF. This work will focus on the preparation of a RadSec RFC that will be submitted to the IETF for approval. RadSec combines TCP protocol with TLS protocol allowing for a more secure and stable underlying infrastructure. The ultimate goal is to migrate all national eduroam RADIUS servers to RadSec.
- Provide application-layer access to home organisation’s resources. This will be achieved integrating Single Sign-On solutions with the current network access technologies. The benefit for the users will be that once they have authenticated via eduroam, they will also gain access to other applications without the need of yet another authentication.

- Addition of authorisation and auditing elements to the current roaming infrastructure. Currently eduroam does not allow for fine-grained authorisation.
- Extend eduroam to cover wired access.
- Provide a mechanism to implement authenticated DHCP to assign IP addresses on the production network only to devices of users who have properly authenticated.

#### 1.9.6.4 Task 2 of JRA3: Identity Federations

***Task 2 of JRA3: Objectives***

This Task will research new ways in which different federations operating in the research and education community coexist and interact among each other and also with other federations that are being established in other sectors (for instance eGovernment).

The classical approach for inter-operation of federations is based on the assumption that users trust their own Identity Provider (IdP), which establish relationships with one or more Service Provider (SPs). This model is not the only possible one, as emerging use cases highlight. Federations can also inter-operate following other models, such as peering, creating confederations, levering etc. All these new models require the development of ad-hoc technologies to support different authentication methods, different authorisation and different levels of assurances. A key factor in all this will be how metadata will be exchanged in such a dynamic environment and how security and trust are preserved.

New identity architectures (such as OpenId) and new ways to implement protocols (like simpleSAMLphp) offer new opportunities to extend the usage of these models in several areas.

This Task will also investigate how these new features can be developed and used in federation-based GN3 network services.

***Task 2 of JRA3: Work Plan***

The initial effort of the Task will be in the following topics:

- Definition of new SAML profiles to aid Single Sign On (SSO);
- Implementation of Single Log Out (SLO): Currently there is no specific protocol to allow a user who has logged in multiple applications to quit all of them or some of them at once. SAML2.0 offers a new protocol to make this possible.
- De-provisioning of services, which consists in defining methods to inform Service Providers (SP) about the invalidation of an electronic Identity initiated at the Identity Provider (IdP). This has become an important issue even for single federations. This issue has serious implications to security.
- Virtual Organizations (VO) support, following a model based on authorisation via VO-controlled attribute authorities. This includes usage of distributed Attribute Authorities.

#### 1.9.6.5 Task 3 of JRA3: Composable Services

***Task 3 of JRA3: Objectives***

This Task aims to provide a framework to enable users to use “primitive” network and application-level services provided by the GN3 service portfolio to create composite, added-value end-user services. An example is that of combining HD videoconferencing with federated authentication and bandwidth allocation services, as provided by the GN3 service portfolio, to create a composite premium videoconferencing service for one or more group of end-users.

***Task 3 of JRA3: Work Plan***

The work will be carried out in close collaboration with user groups to identify and prototype use cases. In the first year the Task will focus on the collection of use cases to scope more clearly the requirements and which areas to address first. The initial group of users to draft the use cases will include those involved in virtual pan-European data centre and storage facilities, digital libraries, general-purpose repositories and those involved in VoIP and video-streaming.

Following the initial phase of analysis and requirement gathering, the a framework will be developed, also taking into account the results of the Service Architecture developed in SA2.

Work towards this new paradigm has been initiated e.g. by the Enterprise Service Bus[12] (ESB), which offers a service-oriented way for building integrated enterprise systems out of heterogeneous and highly distributed components. This Task will expand the ESB model to produce the basic framework for a Multi-Domain ESB (MDESB) as the foundation of future advanced network services for the European research and academic community.

This kind of approach is also acknowledged by the industry, which is addressing related issues through initiatives like IPsphere (http://www.ipsphereforum.org/).

The ultimate goal of this Task is to create a network APIs that will allow users seamless access to the network and application-level services of the GN3 portfolio for the instantiation of composable network services.

### 1.9.6.6 Deliverables

| Code | Title | Description | Delivery Date |
|---|---|---|---|
| DJ3.1.1 | RadSec standardisation and definition of eduroam extensions | Specification of the standardization work on RadSec and definition of eduroam extensions. | M7 |
| DJ3.1.2,1<br>DJ3.1.2.2 | Roaming developments | Deliverable covering a full development cycle for new eduroam service elements, including:<br>• eduroam new software release.<br>• Standardisation Activity Report (on the work carried out on RadSec, IEEE802.1X etc). | M19,<br>M30 |
| DJ3.2.1.1<br>DJ3.2.1.2 | Identity Federations | Deliverable covering a full development cycle for the issues identified in the Task description above, namely:<br>• Interconnection of federations within the academic community and beyond;<br>• Pilot service specification for new SAML2.0 profiles,<br>• SLO<br>• VO support.<br>• The software will be enhanced to also include reports from its utilisation in other JRAs/SAs. | M11,<br>M23 |
| DJ3.3.1 | Composable Network Services use cases | Description of the state of the art in the architectures to compose services. Requirements and use case definition. | M9 |
| DJ3.3.2 | Composable Network Services Framework and General Architecture | Specification framework and architecture for composite services. | M21 |
| DJ3.3.3 | Composable Network Services developments | Yearly deliverable reporting on the upgrades and development on the research on the architecture of composable Network Services: | M34 |

[12] For more details see: http://en.wikipedia.org/wiki/Enterprise_service_bus

| | | | |
|---|---|---|---|
| | | • Basic building blocks for constructing services.<br>• Directory service, able to provide data on the components.<br>• General framework that can be used to build particular diagnostics for each service. | |

Table 1.38: JRA3 Deliverables

#### 1.9.6.7 Milestones

| Code | Title | Description | Delivery Date |
|---|---|---|---|
| MJ3.1.1 | New eduroam software release | Release of new eduroam software | M15 |
| MJ3.2.1 | Identity federation laboratory | Identity federation laboratory estabilished, as an environment to test new software elements without effecting the production services | M17 |
| MJ3.3.1 | Prototype for composable network services | Prototype for composable network services | M25 |

Table 1.39: JRA3 Milestones

### 1.9.7 Summary Effort Table

Table 1.40 below provides a summary of the staff effort in the JRAs. The table indicates the number of person months over the whole duration of the planned work, for each work package by each participant. The work-package leader for each WP is identified by showing the relevant person-month figure **in bold**.

| Participant No | Paticipant short name | JRA1 (Person months) | JRA2 (Person months) | JRA3 (Person months) | Total person month |
|---|---|---|---|---|---|
| 1 (Coordinator) | DANTE | 6 | 0 | 0 | 6 |
| 2 | TERENA | 0 | 0 | **36** | 36 |
| 3 | ACOnet | 0 | 0 | 0 | 0 |
| 4 | AMRES | 0 | 29 | 0 | 29 |
| 5 | ARNES | 0 | 0 | 5 | 5 |
| 6 | BELNET | 0 | 0 | 0 | 0 |
| 7 | BREN | 0 | 27 | 5 | 32 |
| 8 | CARNET | 6 | 0 | 34 | 40 |
| 9 | CESNET | 23 | 54 | 19 | 96 |
| 10 | CYNET | 0 | 14 | 0 | 14 |
| 11 | DFN | 12 | 18 | 74 | 104 |
| 12 | EENET | 0 | 0 | 0 | 0 |
| 13 | FCCN | 0 | 0 | 0 | 0 |
| 14 | GARR | 9 | 25 | 0 | 34 |
| 15 | GRNET | 2 | **121** | 50 | 173 |
| 16 | HEANET | 4 | 5 | 0 | 8 |
| 17 | IUCC | 0 | 4 | 0 | 4 |
| 18 | JANET | 32 | 10 | 10 | 51 |
| 19 | KTU-LITNET | 0 | 0 | 0 | 0 |
| 20 | MARNET | 0 | 14 | 0 | 14 |
| 21 | MREN | 0 | 27 | 0 | 27 |
| 22 | NIIFI | 0 | 0 | 10 | 10 |
| 23 | NORDUNET | **82** | 60 | 82 | 224 |
| 24 | PIONIER | 18 | 111 | 82 | 210 |
| 25 | REDIRIS | 6 | 54 | 82 | 142 |
| 26 | RENATER | 12 | 16 | 10 | 37 |
| 27 | RESTENA | 0 | 0 | 24 | 24 |
| 28 | RoEduNet | 7 | 29 | 0 | 36 |
| 29 | SANET | 0 | 0 | 0 | 0 |
| 30 | SIGMANET | 0 | 0 | 0 | 0 |
| 31 | SURFNET | 22 | 67 | 70 | 158 |
| 32 | SWITCH | 0 | 0 | 10 | 10 |
| 33 | ULAKBIM | 0 | 31 | 0 | 31 |
| 34 | UOM | 0 | 0 | 0 | 0 |
| | | 240 | 715 | 600 | 1555 |

Table 1.40: Summary Effort Table for Joint Research Activities (JRAs)

### 1.9.8 Interdependencies of GN3 Joint Research Activities

For interdependencies of all GN3 Activities, please see section 1.4 above.

### 1.9.9 Describe any significant risks, and associated contingency plans

As described in various sections of this proposal, the planning of the JRAs is linked to either the services that are already running and need improvement, or to the development of new services that are requested by the R&D community. It is expected that not all research activities will bring to an implementable service; this is not considered a risk, but rather a normal behaviour of research. Nonetheless the risk of failure is minimised through the initial choice of research topics and frequent evaluations.

An inherent risk of such a complex project is that of insufficient communications and harmonisation between the various activities. This will be minimised through the definition and role of the Project Office, by the SA4 activity securing software coherence, and by the periodic meetings and videoconferences of the Activity and Task leaders.

Risks involved in the implementation and evolution of the services are varied. They can be either internal to the project (for example, originating from less than optimal performance of a group), or external (for example, due to the lack of progress of an anticipated standard, or failure to secure advanced equipment required for experimentation, or changes in the requirements). Constant monitoring of the progress and feedback loops with users will minimise these risks.

Specific risks for individual Tasks are:

- JRA1 Tasks 1: Core networking Technologies. The risk is not on testing and evaluation of the new technologies, but rather in a wrong choice of the technology to implement in a service. This risk is minimised by carefully following the technology evolution in the market and avoiding the deployment in the production environment of technologies until more than one vendor is available.
- JRA1 Task 2: Photonic technologies, switching–experimental facilities. The risk is that the vendors will not implement needed functionalities in hardware to allow optimum management, or will not allow lab testing. The risk will be minimised by avoiding complex architectures and approaching more than one vendor
- JRA1 Task 3: Federated network architectures. This consists initially of paper studies and software modelling, and therefore should not be subject to any serious risks.
- JRA1 Task 4: Virtualisation. Most of the present solutions in the virtualisation field are offered in the single domain, even in a single administrative realm. Research work has been performed in some European projects (FEDERICA), and the answers are still to be obtained. The Task itself will perform a risk analysis of strategic, tactical and operational issues for the virtualisation services for the NREN business cases. A serious concern is the question of scalability of virtualisation in a global multi–domain environment. No contingency plan is provided at present, as not enough information is available.
- JRA1 Task 5: Advanced network control. A part of the proposed work (BGP issues and Ethernet based routing) is known and presents no initial risk, while the consequences of routing with wireless–based networks and interaction with the autonomic networks are more far reaching (although of interest, particularly to NRENs and campus networks). Interaction with the autonomic networks in particular depends on the results from some of the existing research projects, such as the EC financed ANA.
- JRA2 Tasks 1 and 2: Control and management and Hybrid network provisioning. These are continuing the research ongoing in some of the GN2 Tasks, and experience indicates a low risk profile.
- JRA2 Task 3: Monitoring. This is also a continuation of a similar GN2 Task. The international success of the GN2 monitoring services provides a very good chance for excellent performance in the development area. Additional effort will be needed for migration to the services.
- JRA2 Task 4: Security. Development of the tools for anomaly detection involves some risks of hitting some dead ends, but these must be accepted due to the importance of the results.
- JRA2 Task 5: Network Factory. This is a very innovative Task. As such, it involves risk but is worth pursuing since it will enable a way for cost–effective establishment of multidomain environments to perform tests.
- JRA3 Task 1: Access control. Part of the effort of this task will involve work to standardise and promote new technologies (for instance RadSec). Although the task has a very clear picture of the required further steps in the developments, risks might still arise. One possible risk might be that despite the fact that new technologies are accepted by the standardisation bodies, their take up in practise might remain quite low or slow (due for instance to legacy equipment, budget issues, etc).
- JRA3 Task 2: Identity Federations: The task aims to develop an identity management framework (and a testbed as well) to serve and support other GN services. A possible risk related to this is to low usage of such a framework in other JRAs and/or SAs. To minimise such a chance JRA3 will closely liaise since the very beginning with existing and potential GN3 services.
- JRA3 Task 3: Composable network services. The study of the requirements for the seamless interoperation and integration (including network APIs) of services when accessing network resources by distributed applications is quite is a new concept. The generalization of such goal may lead to very complex architectures. The risk is minimized by focusing initially on well defined use cases and applications development the prototype for user requirements. The extension of the Enterprise Service Bus to the multi–domain environment has a big potential, but it entails some risks which can be minimized with an early evaluation of the technology for its applicability and usefulness.

#### 1.9.9.1 Conclusion

The risks in Research Activities are inherent, and to be expected. Not all activities will bring a successful implementation to the production environment.

The GN3 project has two broad types of research activities:

- Those that develop and innovate in a known area, already explored in part in GN2, for which most of the serious risks have been already avoided.
- Those which are very innovative, with some depending on the results of independent groups or projects. The success of these activities will involve much more risk. For these activities, management will identify upcoming problems in good time and provide rectifying actions if required.

## 1.10 Table 1.3F: Connectivity Services Cost Table

| Participant number | Participant short name | Cost (€) |
|---|---|---|
| 1 | DANTE | 115,875.884 |
| | TOTAL | 115,875.884 |

Table 1.3F: Connectivity Services Cost Table

All connectivity services costs have been allocated to a central budget held by DANTE, although during the project and following the results of the Network Architecture study in SA1 (see section 1.8.4), it is possible that some budget reallocation between the Partners will be required. Further details of the costs are itemised in section 2.4 “Resources to be committed”.

# 2 Section 2: Implementation

## 2.1 Management structure and procedures

The GN3 project Management structure will build on the lessons learned from GN2. A significant innovation is the creation of the Project Management Team, which will bring together all the Activity Leaders and the Project Managers in a single grouping supported by the Project Office. This formalises and rationalises certain informal structures that were developed in GN2. In particular, the centralisation in the Project Office of cross activity project Tasks will lead to a more efficient and consistent operation of the project.

Likewise, the explicit involvement of all Activity leaders as part of the project team will improve internal communications and lead to swifter and more effective resolution of cross activity issues, as well as transition issues between JRA and SA activities. It is envisaged that the project team will have regular monthly meetings. Most of these will be virtual meetings but face-to-face meetings will be held in conjunction with other events where appropriate. It is expected that the administration of the project team will be lightweight with team meetings recording decisions and action lists.

A third lesson learned from GN2 is the importance of more general internal project communications, so that all active participants have a better general appreciation of the overall objectives of the project and the way these objectives interact with one another to achieve the overall project goals. To this end both the project management conventions and the project symposium will be designed to enhance internal communications.

It is recognised that the teams involved in the various activities will be distributed across a number of participating organisations. The project will develop working methods to create a virtual organisation to ensure that the teams are managed to ensure their commitment to the project

Other planned changes, based on the experience of GN2 are:

- To limit the duration of JRA Tasks to 12-18 months and to ensure that new JRA Tasks are explicitly justified by a “business case “ approach to Task scoping which will identify in advance expected benefits, resources required and criteria for success.
- To plan the allocation of resources to Tasks more critically to ensure that work is carried out by individuals who make significant individual manpower contributions and that established teams of people with appropriate resourcing carry out appropriate, individual Tasks. This will eliminate potential inefficiencies that can be caused by a fragmentation of effort.

## 2.2 Individual participants

Due to its length and for better readability and ease of use, this section has been moved to Appendix A below.

## 2.3 Consortium as a whole

The consortium will be developed to meet the requirements of the call, namely:

"the further deployment and evolution of pan-European high-capacity and high performance communication network (GÉANT) in close articulation with the National Research and Education Networks (NREN's) building upon the current world leadership and addressing the ever growing requirements of advancing scientific communities."

It will be built on the current consortium of NREN's that is successfully managing the GN2 project. It will take over the assets and experience and skills of this consortium, which were in turn based on the inheritance of GÉANT. The governance structures of the consortium will evolve to meet the specific needs of GN3. In particular, enhanced activities addressing implementation of services and strengthening the communications between the project and users are envisaged.

In GN2 the consortium created an executive board (GN2 Executive Committee) to better manage and oversee the day-to day issues of the project. This innovation will be retained and the governance structures further developed in GN3 by the creation of a dedicated Project Office and by the use of additional ad-hoc supervisory committees, including, where appropriate expertise from outside the project. A fuller description of the management approach is contained in section 1.3.

As well as the NREN membership, the European organisations of the NRENs play an important role in the overall delivery of the project. DANTE has many successful years experience as project co-ordinator of such projects, fulfilling a role that it has played in all the co-operative NREN networking projects since TEN-34 in 1996. Over a twelve-year period, DANTE has demonstrated the managerial, financial and project management and liaison skills to act as the co-ordinator. Its sister organisation, TERENA, offers a forum to collaborate, innovate and share knowledge in order to foster developments of technology, infrastructure and services to be used by the research and education community. TERENA supports the collaboration of network engineers and managers from all over Europe and beyond, thereby mobilising the expertise and experience of hundreds of professionals in the research and education networking area and industry.

DANTE is currently a company limited by shares where the shareholders are a major sub-set of the NRENs involved in submitting the GN3 proposal. It is planned to convert DANTE into a Company Limited by Guarantee (CLG). The need to become a shareholder of DANTE has been an inhibiting factor for some NRENs to become a member. In contrast, a CLG is a much simpler structure from a membership point of view. This will make it much easier for non shareholding NRENs to become members; shareholding NREN's would have their shares acquired by DANTE and all the NRENs would become guarantors of the new company. By making this structural transition, issues of asset-ownership, risk management and governance would be streamlined. Discussions are well underway regarding restructuring; it is not intended to complete this before the GN3 proposal is negotiated but it would be proposed as an early activity in GN3.

The Consortium consists of 31 National Research and Education Networks, NORDUnet (representing Forskningsnet/Denmark, FUNET/Finland, SUNET/Sweden, UNINETT/Norway and RHnet/Iceland), TERENA and DANTE as the Coordinator, as well as four associate partners (BASNET/Belarus, RENAM/Moldova, JSCC/Russian Federation and URAN/Ukraine. A map of Consortium partners is provided in Figure 2.1. Further information about associate partners is provided in Appendix A.


Figure 2.1: Map of Consortium Partners

### 2.3.1 Associate Partners

While not listed formally as beneficiaries in the GN3 project the following NRENs will nevertheless play an active part in the Consortium as associate partners (in alphabetical order):

- BASNET (Belarus)
- RENAM (Moldova)
- JSCC (Russian Federation)
- URAN (Ukraine)

The details of their proposed engagement will be defined in special Cooperation Agreements to be signed with the GÉANT Consortium. The process of drafting and signature of the Cooperation Agreements for the four respective NRENs above is under way at the time of the submission of this proposal. The associate partners will participate in project meetings and play an active part in its activities.

JSCC is at present a partner in the GN2 (GÉANT2) project and is currently fully connected to the GÉANT network. It is expected to further develop these existing connectivity arrangements during the project.

It is also expected that the remaining three NRENs will receive GÉANT services at appropriate GÉANT Points of Presence to be determined by the Consortium. Related connectivity and access costs will have to be distributed between the Consortium and the respective NRENs on a case-by-case basis, as approved by the NREN Policy Committee.

More information about each of the associate partners is provided in Appendix A.

### 2.3.2 Sub-contracting

Sub-contracting is proposed to be used in the following activities:

| Activity | Task | Description | Partner |
|---|---|---|---|
| NA1 | n/a | Room hire | TERENA |
| | n/a | Project Symposium | TERENA |
| | n/a | Training (course logistics) | TERENA |
| | n/a | Technical writing and training contractors | DANTE |
| | n/a | Audit fees | All partners |
| NA2 | 6 | GN3 workshops at TNC | TERENA |
| | 3, 4 | Design/artwork and creative services | DANTE |
| | 3 | GN3 website | DANTE |
| | 4 | Media production | DANTE |
| | 5 | Press coverage and analysis | DANTE |
| | 6 | External events | DANTE |
| NA3 | 1 | Compendium print costs | TERENA |
| | 3 | Foresight contractors | TERENA |
| | 3 | Meeting room hire | TERENA |
| | 4 | Translation costs | TERENA |
| | 3, 4 | Printing | TERENA |
| | 5 | Environmental consultants | TERENA |
| NA4 | 5 | Meeting room hire | TERENA |
| SA1 | 3 | Connectivity and network equipment | DANTE |
| SA2 | 3,5 | Software design, development and maintenance | DANTE, DFN |
| SA4 | 3 | Software design, development and maintenance | DANTE, DFN |
| JRA2 | 4 | Security research, testbeds (NoAH) | DFN |

Table 2.1: Subcontracting Costs in GN3

In all cases, sub-contracting was chosen because the required specific professional expertise and/or experience is both outside the core capabilities required for the project (as provided by the project partners) and as such could not be found within the GÉANT Consortium itself. In addition, through the use of sub-contractors and third parties, the Consortium is able to benefit from the expertise of a large number of Universities, Institutes and other research and education organisations across Europe.

### 2.3.3 Other Countries

None of the project participants requesting EU funding are based outside of the EU Member states, Associated Countries and the list of International Cooperation Partner Countries (ICPCs).

### 2.3.4 Additional Partners

There are no as-yet-unidentified participants in the project.

## 2.4 Resources to be committed

This section describes the resources necessary to be deployed in achieving the Project's objectives, the levels of EC and partner contribution, and notes other resources that complement the EC contribution.

The overall budget figures are as follows:

**Total Cost = € 181,446,353**

**EC Contribution requested = € 93,000,000 (51 % of the total cost)**

The total costs and amount of EC contribution requested are illustrated in table 2.3 at the end of this section.

A summary of the costs by activity and main category item is shown below:

| | Manpower | equipment | Network costs | travel | other subcontracting | TOTAL | EC funding requested | average funding rate per activity |
|---|---|---|---|---|---|---|---|---|
| SA1 | 9,195,530 | 17,648,494 | 98,227,389 | 109,430 | 0 | 125,180,843 | 58,398,942 | 47% |
| SA2 | 15,444,334 | | | 457,740 | 0 | 15,902,074 | 9,819,457 | 62% |
| SA3 | 4,917,629 | | | 141,588 | 0 | 5,059,217 | 3,994,343 | 79% |
| SA4 | 1,729,160 | | | 57,000 | 0 | 1,786,160 | 1,187,838 | 67% |
| JRA1 | 2,339,021 | | | 59,906 | 0 | 2,398,928 | 1,746,371 | 73% |
| JRA2 | 5,937,263 | | | 178,800 | 0 | 6,116,063 | 4,253,890 | 70% |
| JRA3 | 5,583,067 | | | 150,000 | 0 | 5,733,067 | 4,160,571 | 73% |
| NA1 | 5,343,535 | | | 667,000 | 1,266,000 | 7,276,535 | 3,467,097 | 48% |
| NA2 | 1,927,280 | | | 77,300 | 1,110,000 | 3,114,580 | 1,616,560 | 52% |
| NA3 | 3,876,518 | | | 140,250 | 655,000 | 4,671,768 | 3,243,942 | 69% |
| NA4 | 4,006,317 | | | 180,800 | 20,000 | 4,207,117 | 1,110,990 | 26% |
| Total | 60,299,655 | 17,648,494 | 98,227,389 | 2,219,814 | 3,051,000 | 181,446,353 | 93,000,000 | |
| EC funding requested | 30,090,660 | 8,824,247 | 49,113,695 | 1,920,398 | 3,051,000 | 93,000,000 | | |
| average funding rate per cost category | 50% | 50% | 50% | 87% | 100% | 51% | | |

Figure 2.2: Distribution of and Contribution to Costs by Category

€ 115,875,884 of the total cost is for the subcontracted GÉANT network plus equipment. € 3,051,000 is for other subcontracting/specific costs. The remaining € 60,299,653 is for personnel costs and € 2,219,814 for travel (including overheads, where appropriate, according to the funding model).

The total available EC funding of 93 M€ was not considered as a limiting factor in the preparation of this proposal. Rather than reduce the scope of the activities, lower levels of EC reimbursement have been agreed in order to match the indicative funding budget. Therefore the actual EC contributions requested have been calculated using the EC guidance, with the following exceptions where EC contributions are lower than the maximum allowable levels:

In accordance with the reimbursement rates in FP7, the EC contribution is normally calculated on the basis that:

- NA1 (MGT) is reimbursed at 100%.
- NA2, NA3 and NA4 (COORD) are reimbursed at 100% (but the Indirect Costs are limited to 7%)
- All SAs (Other) are reimbursed at 100%, except for connectivity, which is reimbursed at 50%.
- All JRAs (RTD) are reimbursed at 50% for large non-public organisations, and at 75% for non-profit public bodies, secondary and higher education establishments, and research organisations SMEs.

In the preparation of this proposal, the following agreements have been used:

1. Indirect Cost (overhead) has been applied only to the personnel costs for partners. Other costs (such as travel and equipment) are only reimbursed at the actual direct cost level without an overhead allowance being included.
2. Service Activity costs (excluding the connectivity costs, which are anyway capped at 50%) are reimbursed at 75% rather than the maximum 100% allowed.
3. DANTE's person-month figures are included in the proposal and are to be fully recorded and reported. However, in order to maximise the utilisation of the limited EC funds, the manpower effort of the Coordinator, DANTE, is also being fully funded by the Partners and not claimed to the EC.

The overall % age of requested EC funding of the project of only 51% therefore demonstrates a strong reinforcement of the investment and commitment of the partners into the overall project.

### 2.4.1 The Relative Expenditures in Each of the Activity Types (NA, SA, JRA)

The distribution of costs detailed above can be summarised as follows. Further explanations of the most significant costs and resources are detailed in the rest of this section.

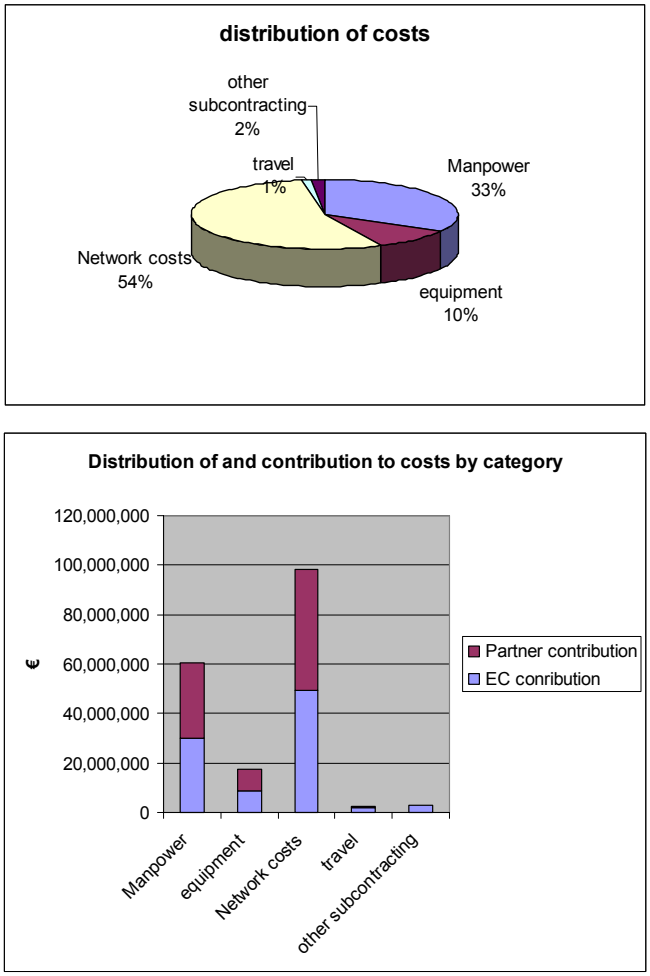


Figure 2.2: Distribution of Costs by Activity type

64% of the total budget is allocated to the physical provisioning of the network. If the manpower resource that is directly allocated to its operation in SA1 is added, the percentage reaches approximately 68%. Overall, manpower resources account for approximately one third of the total projected costs, while the remaining 3% relates to other subcontracting and travel costs.Network and equipment costs

The most significant area of costs is in the GÉANT network. The breakdown below shows a projection of ongoing costs for the network during the lifetime of the project. In reaching this projection of recurring costs it should be noted there is a significant prior investment in the physical network assets that are being brought into the project at the start. This is vital for the continued operation of the network and to allow sufficient time to prepare and deploy the network advances that are planned in the project. Hence, a very conservative estimate of the value of the existing physical asset base being contributed into the project by the partners is 16M€.

In order to establish the likely financial scale of the network, the budget has been based on the current and projected future costs of the network. However, it is also assumed that the budgetary effect of incorporating or combining any national infrastructures as part of the overall costs of the network and improving the overall resilience of the network (to be examined as part of the network planning review in Year 1) will be achievable within this overall budget target.

| | 2009/2010 year 1 | 2010/2011 year 2 | 2011/2012 year 3 | 2012/2013 year 4 | Total |
|---|---|---|---|---|---|
| projected GEANT network costs | k€ | k€ | k€ | k€ | k€ |
| dark fibre lease costs | 1,593 | 1,593 | 7,593 | 7,593 | 18,372 |
| leased circuits | 15,439 | 17,239 | 11,239 | 11,239 | 55,156 |
| Outsourced network operations | 350 | 368 | 386 | 405 | 1,509 |
| Equipment (depreciation and maintenance) | 7,548 | 6,663 | 8,683 | 7,953 | 30,847 |
| Equipment housing ( rent,power,a/c) | 1,200 | 1,380 | 1,587 | 1,825 | 5,992 |
| other contingency costs | 1,000 | 1,000 | 1,000 | 1,000 | 4,000 |
| Total | 27,130 | 28,243 | 30,488 | 30,015 | 115,876 |

Table 2.2: Projected GÉANT Network Costs

The forecast is based on the following main assumptions. These assumptions are consistent with a continuation of the network being resourced in a similar way to today, which may not be the case if the architectural study concludes on different preferred long-term solutions:

- The network expands to include the connection costs of three new partner countries (Serbia, FYROM and Montenegro) by the end of Year 1, bringing the total of connected countries within the GÉANT network budget to 33.
- By the start of Year 3 the number of countries connected either by fibre or other alternative cost-effective solutions for point-to-point services increases to 24 from 16 at the start of the project.
- Also by the start of Year 3, a new transmission platform is introduced into the network where ongoing economies and flexibility service provisioning can be shown.
- The router platform that was procured and installed just before the start of GN3 is expected to operate throughout the GN3 project.

Other increases in costs of transmission, switch and router interface costs during the project are based on the estimate of lambda growth shown in the table below. These growth estimates may be regarded as conservative. However, due to the small incremental costs of deploying lambdas across the fibre infrastructure, total projected costs will not be significantly affected by substantial variations from this growth forecast.

| | year 0 | year 1 | year 2 | year 3 | year 4 |
|---|---|---|---|---|---|
| lambda usage on fibre network | | | | | |
| GEANT IP backbone | 40 | 45 | 50 | 63 | 68 |
| GEANT PLUS backbone | 40 | 45 | 50 | 63 | 68 |
| lambda circuits | 40 | 60 | 70 | 80 | 90 |
| | 120 | 150 | 170 | 206 | 226 |

Table 2.3: Estimate of Lambda Growth in GÉANT

The contingency sum for unforeseen costs has been set at a reduced level of approximately 3.5% of overall costs, as this is the level at which unforeseeable costs have historically appeared over the last 5 years of running the network. Although each of the above assumptions has a probability of not being valid, the risk will be minimised by the contingency fund. The sustainability of the production environment is not a risk in any case. For the implementation of new features and services, a slower deployment plan is foreseen in case of insufficient funding, which will not undermine the proposed research and development plan.

### 2.4.2 Travel Costs

Travel costs have been minimised (1% of the total project costs) through the anticipated use of conference calls (ideally videoconferencing), and the exploitation of meeting in conjunction with other events where several of the partners will already be participating. A travel allowance for all partners to attend the regular consortium meetings is included to ensure all beneficiaries are able to contribute to the overall strategy and policies set and to fulfil the obligations of the project.

### 2.4.3 Other Specific/Subcontracted Costs

These are mainly in the NAs and, excluding the NA1 costs detailed below, represent a total of €1,785,000 in costs. Projected subcontracted costs of €1,110,000 for NA2 are projected to cover external events such as GN3 launch and workshops at the TERENA networking conference, support and development of the new GN3 website, press coverage and creation and distribution of media. The €655,000 in NA3 is projected for consultancy costs in the Foresight and Environmental studies translation of the Campus Best Practice reports and printing costs for the all of the above reports, plus the Compendium.

### 2.4.4 Consortium Management Proportion of Total Project Cost

The consortium management is carried out in NA1 and at €7,276,535 represents about 4% of the total project costs. These costs include subcontractor costs of €1,266,000, €667,000 in travel and €5,343,535 cost of human resources from the Coordinator and other consortium partners. Subcontractor costs include €900,000 for contractors providing support in technical writing for the production of deliverables, operations manuals and instructions booklets plus training programmes for the introduction and operation of new services across the network and €204,000 for audit fee costs for the 18 partners that are expected to exceed the threshold for audit certification on their cost claims.

In terms of EC Contribution, €3,467,097 (48% of costs) is requested which is approximately 4% of the total contribution requested

### 2.4.5 Human resources

The allocation of Human resources to the NAs, SAs and JRAs is shown in Figure 2.3:

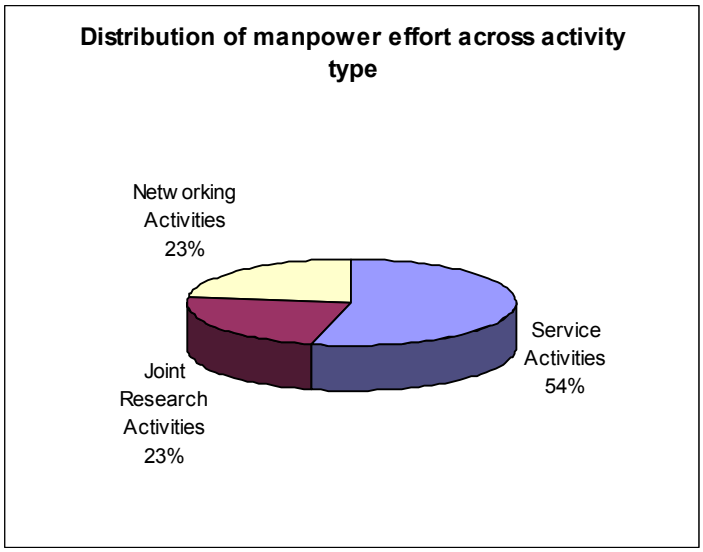


Figure 2.3: Distribution of Manpower Effort Across Activity Type

This demonstrates that the largest percentage (54%) and majority of the effort is allocated to the SAs, for continuing and developing the network and its associated services, while 23% each is allocated to the JRAs and NAs. Figure 2.4 below provides further detail on the split of effort per Activity:

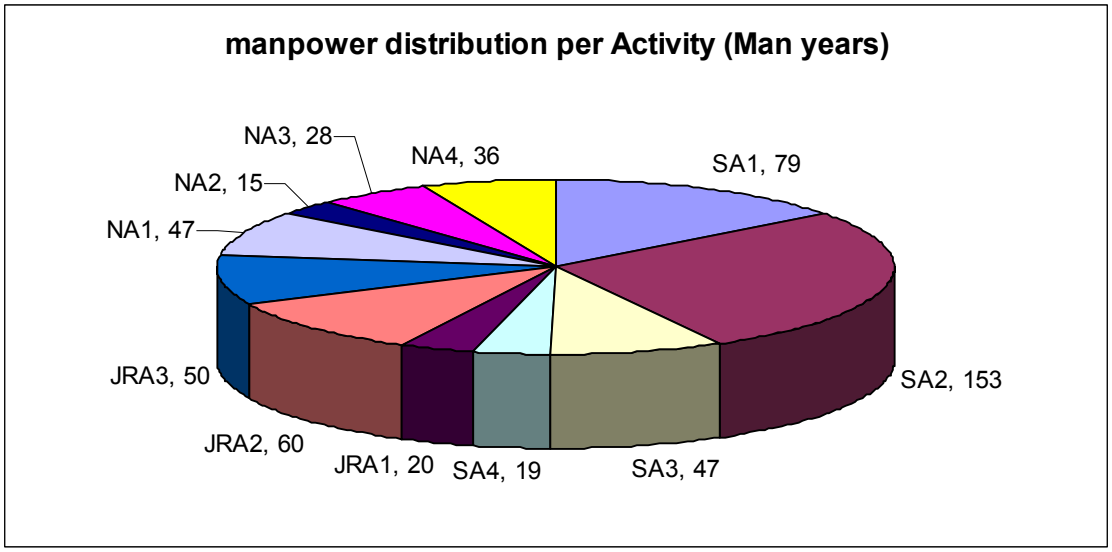


Figure 2.4: Manpower Distribution per Activity

As shown in the overall Manpower effort per partner table below, Manpower effort is reasonably well distributed across the partners. For all the NREN partners there are also very significant levels of resource required in providing the National network connectivity, and these are not represented in the table. On an annualised basis the total budgets of the NREN partners are in the region of €500M and therefore, indirectly, provide a substantial amount of additional unfunded resource that will be part of, and contribute to, the overall success of the project. There are specific individual partners where a substantial part of their manpower capacity is dedicated to the project. DANTE was the prime contracting party and coordinator for the GN2 project. In GN3, the 169 man years of effort shown above can be roughly calculated as around 41 FTEs per year contributing to the projects various activities especially related to project management and operations. There are approximately 19 person months per year being held unallocated for the Supervisory committees and for other tasks where allocations can only be made once the specific skill sets have been identified. Taking into account the 9 FTEs being added to the organisation for the running of the new in-sourced Network Operations Centre, there are therefore a further 32 FTE of DANTE allocated across the project (mostly in Operational Service and Other Networking Activities). This is at the same level as currently being allocated to the GN2 project. This and other partners' contributions can also be seen detailed per activity in the table below, and are also described in more detail in Appendix A.

Looking at the detailed manpower effort proposed by the partners, one may get a mistaken impression that the proposal consists of two "classes" of partners in the GN3 Project:

- Those which have offered substantial manpower toward the execution of the Project. There are six partners with more than 300 person months of effort (in addition to DANTE in his role as coordinator and the network operator, typically in the Service and even more so in the Joint Research Activities.
- Those which are not offering manpower at all, or some small number of person months, and are thus receiving much less in terms of EC support.

The reason for this is a wide diversity of the formal status and organisational arrangement of the NRENs participating in the GN3 Project. Some of them have been able, in the course of time, to find means to secure stable financing of the national networks, either from the respective governments, or through long-term agreements with the users (universities, institutes, libraries, etc.) for contributions covering the costs of the national network operations. They are, as a rule, investing considerable effort into developments in new services and technology.

The other group is either struggling to secure means for the operation of the national R&E network, or have modest funds for development work. Some of the NRENs, although they have stable financing, have limited resources for work outside of their environment, and cannot contribute manpower to the common projects.

The second partners could be considered, at first sight, to be underprivileged members of the Project. However, this is not the case:

- The partners heavily participating in the research work in the project have to secure up to 50 % of the finances from their own resources.
- The funds received by them cannot be controlled by the partner, but have to be applied to the common goal. Therefore they are contributing by providing additional funds and resources to the Community at large.
- The GÈANT network, the backbone and higher-level services as they are now, and even more in the direction they are evolving, represent the main reason for the existence of the past and future GÉANT Projects. In this most important part, the small partners and those less active in R&D are fully profiting, on a par with all NRENs, by the use of this world-class network and associated services.

It is very clear that any and all partners have absolutely solid reasons to participate in the GN3 project, and each of them is receiving equal treatment by the rest of the community.

TOTAL MANPOWER EFFORT IN MANYEARS

| | Total | DANTE | TERENA | ACONET | AMRES | ARNES | BELNET | BREN | CARNet | CESNET | CYNET | DFN | EENET | FCCN | GARR | GRNET | HEAnet | IUCC | JANET | KTU | MARnet | MREN | NIIFI | NORDUnet | PIONIER | Red.es | RENATER | RESTENA | RoEduNet | SANET | Sigmanet | SURFNET | SWITCH | ULAKBIM | UoM |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **SA1** | **79.4** | 73.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.8 | 0.8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.1 | 0.0 | 0.7 | 1.1 | 0.0 | 0.0 | 0.0 | 1.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| **SA2** | **152.6** | 23.6 | 0.0 | 0.0 | 2.0 | 0.0 | 0.0 | 8.8 | 3.6 | 6.6 | 0.0 | 19.0 | 0.0 | 3.3 | 5.1 | 11.0 | 0.0 | 0.3 | 0.0 | 0.0 | 1.0 | 2.0 | 2.4 | 7.8 | 41.0 | 2.8 | 1.0 | 0.0 | 1.0 | 0.0 | 2.0 | 0.0 | 7.3 | 1.0 | 0.0 |
| **SA3** | **47.2** | 0.0 | 4.9 | 0.0 | 2.4 | 0.4 | 0.0 | 0.4 | 5.4 | 2.4 | 1.2 | 3.8 | 0.0 | 0.4 | 0.2 | 0.4 | 0.4 | 0.4 | 4.0 | 0.0 | 0.4 | 0.4 | 1.4 | 6.8 | 3.9 | 2.0 | 0.4 | 0.4 | 0.4 | 0.0 | 0.0 | 3.0 | 1.1 | 0.4 | 0.0 |
| **SA4** | **19.0** | 1.7 | 0.0 | 0.0 | 2.6 | 0.0 | 0.0 | 0.7 | 1.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 2.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 10.4 | 0.4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| **SA Total** | **298.2** | **98.3** | **4.9** | **0.0** | **7.0** | **0.4** | **0.0** | **9.9** | **10.2** | **10.0** | **1.2** | **22.8** | **0.0** | **3.7** | **6.0** | **14.2** | **0.4** | **0.7** | **4.0** | **0.0** | **1.4** | **3.5** | **3.8** | **15.3** | **56.4** | **5.2** | **1.4** | **0.4** | **2.5** | **0.0** | **2.0** | **3.0** | **8.4** | **1.4** | **0.0** |
| **JRA1** | **20.0** | 0.5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.5 | 1.9 | 0.0 | 1.0 | 0.0 | 0.0 | 0.7 | 0.2 | 0.3 | 0.0 | 2.6 | 0.0 | 0.0 | 0.0 | 0.0 | 6.9 | 1.5 | 0.5 | 1.0 | 0.0 | 0.6 | 0.0 | 0.0 | 1.8 | 0.0 | 0.0 | 0.0 |
| **JRA2** | **59.6** | 0.0 | 0.0 | 0.0 | 2.4 | 0.0 | 0.0 | 2.3 | 0.0 | 4.5 | 1.2 | 1.5 | 0.0 | 0.0 | 2.1 | 10.1 | 0.4 | 0.3 | 0.8 | 0.0 | 1.2 | 2.3 | 0.0 | 5.0 | 9.3 | 4.5 | 1.4 | 0.0 | 2.4 | 0.0 | 0.0 | 5.6 | 0.0 | 2.6 | 0.0 |
| **JRA3** | **50.0** | 0.0 | 3.0 | 0.0 | 0.0 | 0.4 | 0.0 | 0.4 | 2.8 | 1.6 | 0.0 | 6.2 | 0.0 | 0.0 | 0.0 | 4.2 | 0.0 | 0.0 | 0.8 | 0.0 | 0.0 | 0.0 | 0.8 | 6.8 | 6.8 | 6.8 | 0.8 | 2.0 | 0.0 | 0.0 | 0.0 | 5.8 | 0.8 | 0.0 | 0.0 |
| **JRA Total** | **129.6** | **0.5** | **3.0** | **0.0** | **2.4** | **0.4** | **0.0** | **2.7** | **3.3** | **8.0** | **1.2** | **8.7** | **0.0** | **0.0** | **2.8** | **14.4** | **0.7** | **0.3** | **4.2** | **0.0** | **1.2** | **2.3** | **0.8** | **18.7** | **17.5** | **11.8** | **3.1** | **2.0** | **3.0** | **0.0** | **0.0** | **13.2** | **0.8** | **2.6** | **0.0** |
| **NA1** | **47.2** | 38.2 | 1.8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.4 | 0.0 | 1.2 | 0.0 | 0.0 | 0.0 | 0.0 | 2.0 | 0.0 | 0.0 | 0.4 | 0.0 | 0.0 | 0.4 | 0.4 | 0.4 | 0.0 | 0.4 | 0.4 | 0.0 | 0.0 | 0.4 | 0.0 | 0.4 | 0.0 | 0.4 | 0.0 | 0.0 |
| **NA2** | **15.5** | 10.2 | 3.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.6 | 0.0 | 0.0 | 0.0 | 0.0 |
| **NA3** | **28.1** | 0.0 | 10.1 | 0.0 | 2.0 | 0.0 | 0.0 | 0.0 | 0.0 | 2.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.4 | 12.0 | 1.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| **NA4** | **36.2** | 22.0 | 2.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.2 | 0.0 | 5.4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.4 | 0.0 | 0.0 | 0.4 | 2.0 | 0.0 | 0.0 | 1.6 | 0.0 | 0.0 | 1.6 | 0.0 | 0.0 | 0.6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| **NA Total** | **126.9** | **70.4** | **17.2** | **0.0** | **2.0** | **0.0** | **0.0** | **0.6** | **0.0** | **8.6** | **0.0** | **0.0** | **0.0** | **0.0** | **3.4** | **0.0** | **0.6** | **0.8** | **2.0** | **0.0** | **0.4** | **2.0** | **1.2** | **12.0** | **3.0** | **0.4** | **0.0** | **0.6** | **0.4** | **0.0** | **1.0** | **0.0** | **0.4** | **0.0** | **0.0** |
| **Total** | **554.6** | **169.2** | **25.1** | **0.0** | **11.4** | **0.8** | **0.0** | **13.1** | **13.5** | **26.6** | **2.4** | **31.4** | **0.0** | **3.7** | **12.2** | **28.6** | **1.7** | **1.8** | **10.2** | **0.0** | **3.0** | **7.7** | **5.8** | **45.9** | **76.9** | **17.4** | **4.5** | **3.0** | **5.8** | **0.0** | **3.0** | **16.2** | **9.6** | **4.0** | **0.0** |

**Per Partner effort in person months**

| | TOTAL | DANTE | TERENA | ACONET | AMRES | ARNES | BELNET | BREN | CARNet | CESNET | CYNET | DFN | EENET | FCCN | GARR | GRNET | HEAnet | IUCC | JANET | KTU | MARnet | MREN | NIIFI | NORDUnet | PIONIER | Red.es | RENATER | RESTENA | RoEduNet | SANET | Sigmanet | SURFNET | SWITCH | ULAKBIM | UoM |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SA1 | 953 | 876 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 13 | 0 | 0 | 0 | 0 | 9 | 9 | 0 | 0 | 0 | 0 | 0 | 13 | 0 | 8 | 13 | 0 | 0 | 0 | 13 | 0 | 0 | 0 | 0 | 0 | 0 |
| SA2 | 1831 | 283 | 0 | 0 | 24 | 0 | 0 | 106 | 43 | 79 | 0 | 228 | 0 | 40 | 61 | 132 | 0 | 4 | 0 | 0 | 12 | 24 | 29 | 94 | 492 | 34 | 12 | 0 | 12 | 0 | 24 | 0 | 88 | 12 | 0 |
| SA3 | 566 | 0 | 59 | 0 | 29 | 5 | 0 | 5 | 65 | 28 | 14 | 45 | 0 | 5 | 2 | 5 | 5 | 5 | 48 | 0 | 5 | 5 | 17 | 82 | 47 | 24 | 5 | 5 | 5 | 0 | 0 | 36 | 13 | 5 | 0 |
| SA4 | 228 | 20 | 0 | 0 | 31 | 0 | 0 | 8 | 14 | 0 | 0 | 0 | 0 | 0 | 0 | 24 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 125 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **SA Total** | **3578** | **1180** | **59** | **0** | **84** | **5** | **0** | **119** | **122** | **120** | **14** | **273** | **0** | **44** | **72** | **170** | **5** | **8** | **48** | **0** | **17** | **42** | **46** | **183** | **676** | **62** | **17** | **5** | **30** | **0** | **24** | **36** | **101** | **17** | **0** |
| JRA1 | 240 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 6 | 23 | 0 | 12 | 0 | 0 | 9 | 2 | 4 | 0 | 32 | 0 | 0 | 0 | 0 | 82 | 18 | 6 | 12 | 0 | 7 | 0 | 0 | 22 | 0 | 0 | 0 |
| JRA2 | 715 | 0 | 0 | 0 | 29 | 0 | 0 | 27 | 0 | 54 | 14 | 18 | 0 | 0 | 25 | 121 | 5 | 4 | 10 | 0 | 14 | 27 | 0 | 60 | 111 | 54 | 16 | 0 | 29 | 0 | 0 | 67 | 0 | 31 | 0 |
| JRA3 | 600 | 0 | 36 | 0 | 0 | 5 | 0 | 5 | 34 | 19 | 0 | 74 | 0 | 0 | 0 | 50 | 0 | 0 | 10 | 0 | 0 | 0 | 10 | 82 | 82 | 82 | 10 | 24 | 0 | 0 | 0 | 70 | 10 | 0 | 0 |
| **JRA Total** | **1555** | **6** | **36** | **0** | **29** | **5** | **0** | **32** | **40** | **96** | **14** | **104** | **0** | **0** | **34** | **173** | **8** | **4** | **51** | **0** | **14** | **27** | **10** | **224** | **210** | **142** | **37** | **24** | **36** | **0** | **0** | **158** | **10** | **31** | **0** |
| NA1 | 566 | 458 | 22 | 0 | 0 | 0 | 0 | 5 | 0 | 14 | 0 | 0 | 0 | 0 | 24 | 0 | 0 | 5 | 0 | 0 | 5 | 5 | 5 | 0 | 5 | 5 | 0 | 0 | 5 | 0 | 5 | 0 | 5 | 0 | 0 |
| NA2 | 186 | 122 | 40 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7 | 0 | 0 | 0 | 0 |
| NA3 | 337 | 0 | 121 | 0 | 24 | 0 | 0 | 0 | 0 | 24 | 0 | 0 | 0 | 0 | 0 | 0 | 7 | 0 | 0 | 0 | 0 | 0 | 5 | 144 | 12 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NA4 | 434 | 264 | 24 | 0 | 0 | 0 | 0 | 2 | 0 | 65 | 0 | 0 | 0 | 0 | 5 | 0 | 0 | 5 | 24 | 0 | 0 | 19 | 0 | 0 | 19 | 0 | 0 | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **NA Total** | **1522** | **845** | **206** | **0** | **24** | **0** | **0** | **7** | **0** | **103** | **0** | **0** | **0** | **0** | **40** | **0** | **7** | **10** | **24** | **0** | **5** | **24** | **14** | **144** | **36** | **5** | **0** | **7** | **5** | **0** | **12** | **0** | **5** | **0** | **0** |
| **Total** | **6655** | **2031** | **301** | **0** | **137** | **10** | **0** | **157** | **162** | **319** | **29** | **377** | **0** | **44** | **147** | **343** | **20** | **22** | **123** | **0** | **36** | **93** | **70** | **551** | **923** | **209** | **54** | **36** | **70** | **0** | **36** | **194** | **115** | **47** | **0** |

**Projected Costs**

| | TOTAL | DANTE | TERENA | ACONET | AMRES | ARNES | BELNET | BREN | CARNet | CESNET | CYNET | DFN | EENET | FCCN | GARR | GRNET | HEAnet | IUCC | JANET | KTU | MARnet | MREN | NIIFI | NORDUnet | PIONIER | Red.es | RENATER | RESTENA | RoEduNet | SANET | Sigmanet | SURFNET | SWITCH | ULAKBIM | UoM |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Manpower** | 60299655 | 20028087 | 4088366 | 0 | 506160 | 54400 | 0 | 1155863 | 902210 | 2829804 | 115200 | 2766192 | 0 | 270000 | 1134222 | 3700080 | 223821 | 207360 | 900689 | 0 | 120960 | 93260 | 487200 | 6613645 | 7232674 | 1394720 | 613973 | 216000 | 94582 | 0 | 259200 | 2538364 | 1468224 | 284400 | 0 |
| **Equipment** | 17648494 | 17648494 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Network costs** | 98227389 | 98227389 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Travel** | 2219814 | 440708 | 121850 | 16000 | 54200 | 18400 | 16000 | 55650 | 56602 | 110588 | 23200 | 110302 | 16000 | 27100 | 55426 | 101650 | 22300 | 22200 | 50705 | 16000 | 25000 | 42330 | 35000 | 177784 | 251834 | 68302 | 29544 | 26200 | 33472 | 16000 | 26200 | 64618 | 44800 | 27850 | 16000 |
| **Other specific/ subcontracting** | 3051000 | 1935000 | 936000 | 0 | 12000 | 0 | 0 | 12000 | 12000 | 12000 | 0 | 12000 | 0 | 0 | 12000 | 12000 | 0 | 0 | 12000 | 0 | 0 | 0 | 0 | 12000 | 12000 | 12000 | 12000 | 0 | 0 | 0 | 0 | 12000 | 12000 | 0 | 0 |
| **Total** | 181446353 | 138279678 | 5146216 | 16000 | 572360 | 72800 | 16000 | 1223513 | 970812 | 2952391 | 138400 | 2888494 | 16000 | 297100 | 1201648 | 3813730 | 246121 | 229560 | 963394 | 16000 | 145960 | 135590 | 534200 | 6803430 | 7496508 | 1475022 | 655517 | 242200 | 128054 | 16000 | 285400 | 2614981 | 1525024 | 312250 | 16000 |

**EC contribution to costs**

| | TOTAL | DANTE | TERENA | ACONET | AMRES | ARNES | BELNET | BREN | CARNet | CESNET | CYNET | DFN | EENET | FCCN | GARR | GRNET | HEAnet | IUCC | JANET | KTU | MARnet | MREN | NIIFI | NORDUnet | PIONIER | Red.es | RENATER | RESTENA | RoEduNet | SANET | Sigmanet | SURFNET | SWITCH | ULAKBIM | UoM |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Manpower** | 30090660 | 619465 | 2881433 | 0 | 392200 | 40800 | 0 | 874567 | 676657 | 2090300 | 86400 | 2074644 | 0 | 202500 | 892394 | 2308500 | 161447 | 163296 | 661217 | 0 | 94752 | 73896 | 374760 | 4819835 | 5414038 | 1054040 | 460479 | 168120 | 72560 | 0 | 198828 | 1903772 | 1116462 | 213300 | 0 |
| **Equipment** | 8824247 | 8824247 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Network costs** | 49113695 | 49113695 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Travel** | 1920398 | 398781 | 115925 | 16000 | 47150 | 17800 | 16000 | 46238 | 46452 | 97091 | 21400 | 86727 | 16000 | 24325 | 48770 | 69438 | 21475 | 21450 | 44529 | 16000 | 23050 | 38048 | 31550 | 152338 | 196425 | 55527 | 26158 | 24400 | 29404 | 16000 | 24700 | 52463 | 37900 | 24888 | 16000 |
| **Other specific/ subcontracting** | 3051000 | 1935000 | 936000 | 0 | 12000 | 0 | 0 | 12000 | 12000 | 12000 | 0 | 12000 | 0 | 0 | 12000 | 12000 | 0 | 0 | 12000 | 0 | 0 | 0 | 0 | 12000 | 12000 | 12000 | 12000 | 0 | 0 | 0 | 0 | 12000 | 12000 | 0 | 0 |
| **Total** | 93000000 | 60891187 | 3933358 | 16000 | 451350 | 58600 | 16000 | 932804 | 735108 | 2199391 | 107800 | 2173371 | 16000 | 226825 | 953163 | 2389938 | 182922 | 184746 | 717746 | 16000 | 117802 | 111944 | 418310 | 4984173 | 5622463 | 1121567 | 498637 | 192520 | 101964 | 16000 | 223528 | 1968235 | 1166362 | 238188 | 16000 |

**Consortium contribution to costs**

| | TOTAL | DANTE | TERENA | ACONET | AMRES | ARNES | BELNET | BREN | CARNet | CESNET | CYNET | DFN | EENET | FCCN | GARR | GRNET | HEAnet | IUCC | JANET | KTU | MARnet | MREN | NIIFI | NORDUnet | PIONIER | Red.es | RENATER | RESTENA | RoEduNet | SANET | Sigmanet | SURFNET | SWITCH | ULAKBIM | UoM |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Manpower** | 30208995 | 19408622 | 1206934 | 0 | 113960 | 13600 | 0 | 281296 | 225553 | 739504 | 28800 | 691548 | 0 | 67501 | 241828 | 1391580 | 62374 | 44064 | 239472 | 0 | 26208 | 19364 | 112440 | 1793811 | 1818636 | 340680 | 153494 | 47880 | 22021 | 0 | 60372 | 634592 | 351762 | 71100 | 0 |
| **Equipment** | 8824247 | 8824247 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Network costs** | 49113695 | 49113695 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Travel** | 299416 | 41927 | 5925 | 0 | 7050 | 600 | 0 | 9413 | 10151 | 13497 | 1800 | 23576 | 0 | 2775 | 6657 | 32213 | 825 | 750 | 6176 | 0 | 1950 | 4283 | 3450 | 25446 | 55408 | 12776 | 3386 | 1800 | 4068 | 0 | 1500 | 12154 | 6900 | 2963 | 0 |
| **Other specific/ subcontracting** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Total** | 88446353 | 77388491 | 1212859 | 0 | 121010 | 14200 | 0 | 290708 | 235704 | 753001 | 30600 | 715124 | 0 | 70276 | 248485 | 1423793 | 63199 | 44814 | 245649 | 0 | 28158 | 23646 | 115890 | 1819257 | 1874044 | 353456 | 156880 | 49680 | 26089 | 0 | 61872 | 646746 | 358662 | 74063 | 0 |

Table 2.4: GN3 Costs and EC Funding per Partner

# 3 Section 3: Impact

There is no doubt of the value of a fully integrated, specialised communication backbone infrastructure, devoted to support and facilitate the development of the European Research Area. The GN3 project will leverage this value, building upon over 20 years of experience in the NREN community that has resulted in the current world leadership of the federated infrastructure.

The GN3 project is a key initiative (both at the technical and organisational level) in continuing the development of a rich networking environment, uniquely suited to the research community needs. This impact is fundamental, as the research communities and data are more and more geographically dispersed. No matter where they are, a researcher should have access to the same rich set of supporting services from the network, possibly including include a seamless access to data.

The current three-tier model (European Backbone, NREN backbones, campus or regional access) has proven to be the most responsive to the fast-changing needs of researchers, and also the best to promote new research technologies (for example, real-time synchronisation of radio telescopes).

GN3 will maintain the cohesion provided by the basic IP connectivity (GÈANT), as well as extend the network of additional high-speed links (GÈANT2 + service) and facilitate dedicated support of end-user services. It will ensure a further level of collaboration between researchers in Europe and beyond, and provide a more efficient stage for all scientists working on the present global problems by attempting to reduce the digital divide, and increasing available resources. The activity has the potential to foster completely new paradigms of collaborative methods, both in Europe and globally.

The GN3 network will offer an increasing number of unprecedented new services through the course of the project, resulting from innovative development programmes. These services will not only enable flexible use of the infrastructure, but will provide a configurable open space for research on networking, supporting all forms of e-science.

## 3.1 Collaborative arrangements and long-term sustainability

A major impact of the GN3 project is the constant promotion and fostering of the close collaboration of networking management and developments between the NRENs and researchers, both in Europe and globally. The NRENs have permanent collaborations in place inside and beyond the European projects, and have demonstrated the capability to maintain and evolve these collaborations through the legal entities of TERENA and DANTE.

The GN3 environment is best suited to the exchange of expertise, best practise and also promotes personal networking across Europe.

The multi-domain nature of the European NREN environment has proven to be an opportunity to develop and offer high quality services to researchers. The continuation of such effort to build a European e-Infrastructure on top of the growing NREN base is a key effort in GN3, and the impact of the developed technologies will extend beyond the research community.

The GN3 project will also provide a platform for fostering and organising collaboration with non-European NRENs. Such collaboration is essential, as agreements become necessary in the development of the new services and architectures. The GN3 project will provide Europe with a single voice (equivalent to Internet2, and similar regional infrastructure organisations in Asia, Africa and South America).

Regardless of any future financing arrangements, a GÈANT–like infrastructure will have to be maintained to serve the R&E community in Europe and worldwide.

## 3.2 Expected impacts from Service activities

The GN3 project has the essential task of continuing to provide a high quality production infrastructure by combining its core network and education network backbones, to which most of the European researchers are connected. Advancing and maintaining such an advanced production infrastructure has an unnoticed but profound impact on day-to-day research and new developments. This hybrid infrastructure is also mandatory as a platform for new developments in e-Science.

It is important to note that, even more now than ever, GN3 stands for the whole “chain” (from the end-user through the campus network, NREN, core backbone, to and finally to the user (or services) at the other end). This statement is strongly supported by a number of GN3 activities involving end–user services.

The main advantage for the major part of the extremely large body of GÈANT users in Europe (and globally) is the state-of-the-art, reliable Internet network, with a high level of over-provisioning. The latter is particularly true in those areas covered by dark fibre. Contrary to a possible interpretation that the over-provision of the capacity may not be justified economically, the fact is that the present and future hybrid (circuits and packets based) network architecture of GÈANT, rooted in dark fibre (required to make available a multitude of additional services, like dedicated high capacity point-to-point connections, etc.) provides the basis for an efficient, reliable and redundant high capacity IP network at a low marginal cost. Also the trend for scientific network traffic shows a bursty nature in the range of Gigabits per second, which demands even larger capacities.

In view of the above premise, one of the most important GN3 Service activities will be SA1 “GÈANT Network Architecture Design, Procurement as Operations”. This activity includes an initial planning activity, involving the study of innovative backbone architectures, which will allow a swift transition from the present network architecture to the GN3 network infrastructures. Taking into account the technologies and service definitions, SA1 will design and operate a high performance, hybrid, ubiquitous network, which will meet all the challenging requirements of the research and educational community at an optimal cost.

The total cost of ownership will decrease by exploiting the use of Cross Border Fibres, owned by the NRENs and incorporated into the GN3 network. Establishment of an in-house NOC, operated by a separate unit of DANTE, will decrease reaction times and further strengthen the coordination between the GÉANT NOC and the NOCs operated by the NRENs.

A huge step toward reducing the digital divide in Europe will be the extension of the “dark fibre cloud” to countries that until now have been connected with leased links, and the addition of three new countries to the community with direct connection of their networks into the GÉANT backbone. The main goal of this activity is, of course, to provide world-class services at acceptable costs.

SA2 “Multi – Domain Network Service Operation” will create delivery and setup of operational services support throughout the GN3 area, of which multi–domain provisioning of wavelengths (based on the AutoBAHN activity) and automatic provisioning of sub-lambda circuits will be essential for those user projects demanding short term, high capacity links. The monitoring tool suite (further development of the highly praised PerfSONAR multi–domain monitoring system) will be used to supervise these services. An important future step is to move from the tools mainly used by GÈANT or NREN NOCs to those suitable for use by advanced end users. This will be instrumental for a better understanding by end users of the issues taking place in multi–domain service provision. Information provided in this way will be important for handling performance and security issues.

SA3 “End User Services in a Federated Environment” further develops and deploys services involving end users themselves. These services generally provide identification, authentication and authorisation. They will be based on the present eduroam service and on the further development of the eduGAIN service. Experience in running the TACAR PKI repository will be used to deploy the coordination of a Europe-wide PKI infrastructure. Research into new capabilities and services, which will be carried out, will benefit from communication between Networking, Service and Joint Networking activities. This activity clearly illustrates the focal point of the whole GN3 Project: To judge the value of the network by its use by end-users and their organisations.

## 3.3 Expected impacts listed in the work programme

Although one may expect most of the visible impact of GN3 to be from the SAs, work performed in the JRAs will contribute indirectly by feeding their results to the SAs. On the other hand, a portion of the work done in the NAs will directly influence the pace and extent of dissemination and proper use of the multi–domain and end user services.

The management structure foreseen for GN3 and executed within NA1 will, to a great extent, engage interested NRENs in the technical planning activities through the Supervisory committee mechanism. This will lead to a wider understanding of the NREN management and staff of the issues involved, and of the results of the development of advanced services developed by the technical activities.

Task 2 of NA2 will further supplement these results by the “Partner Services Promotion”, an activity to facilitate dissemination of the information of new opportunities of the NRENs. It will contribute to faster dissemination of services at the local and national level by offering NRENs the tools, materials and assistance they need to conduct dissemination activity in their countries. The NA4 Task “Internal Cooperation (Consultation with

Partners)" will serve the same goal. A number of additional actions in other GÉANT network activity areas will also contribute to this (events, Web sites, conferences, etc).

And finally, the impact of the NA4 ("Liaison and Support") will have an appreciable effect on less-experienced NRENs or those with difficulties securing adequate resources, with Task 5 "Assistance to the Development of Research and Education Networking in Less Advanced Regions" also contributing to the acceptance of new services. In global terms, Task 1 "International Cooperation (Outside the GÉANT Service Area)" and TASK 3 "Liaison with Projects and Initiatives" will continue with, and surpass, the present influence of the European R&E networking on the global development.

Therefore, it is envisaged that the GN3 project will have a greater impact than past projects. It will provide increasing technical excellence and a shining example of cooperative activity in a complex environment. The independence of the NRENs will be preserved, yet still GN3 will provide a seamless integration of multi–domain services.

### 3.3.1 Impacts on the NREN community

The GN3 project is a very closely interlaced activity between NRENs, the consortium, and the coordinator operating the Project, all with the common goal to provide European researchers with a world-class communication infrastructure. The technically most advanced NRENs will be able (and are willing) to make available their expertise for the common objective, while those not so advanced will be given every opportunity to catch up.

Also, the project will provide the following added values:

- Optimisation of cost and expertise.
- Indirect impact on the campus and regional networks.
- Exposure of personnel to an international environment.
- Harmonisation of political directions.
- Possibility to have a "mass" effect.

### 3.3.2 The European dimension

The GN3 project involves 34 countries, with more to join. It is difficult to imagine any project having more of a pan-European character. Its mission is to serve all partners and researchers, regardless of where they live and work. The GÉANT networks, both in the past and in the future, give the term "European Research Area" its true meaning.

The GN3 project will also facilitate the extension of research networking and research to non-European countries, and impact the technical liaison with non-Europeans research network infrastructures.

## 3.4 Dissemination and IPR management

### 3.4.1 Dissemination and exploitation

The project will address several distinct audiences in terms of dissemination and exploitation of project results. A major objective of GN3 is the development and implementation of an enhanced portfolio of services to be made available to end-users in a consistent manner than enable services crossing multiple management domains to have generated similar positive user experiences. This will reinforce the provision of end-to-end connectivity and services (user -to-user) at the European level. To succeed, this objective will require the active involvement of participating NRENs.

As the development resources allocated are more strongly focussed on service activities there will be a natural emphasis on the introduction of new and enhanced services. It is recognised however that this needs to be complemented by more general project dissemination within the NREN community. The networking activities NA2 and NA4 will be specifically targeted with the promotion of the services developed. This will be achieved by a more NREN-specific approach to dissemination than has historically been the case. In particular, NA4 will enter into individual dialogues with NRENs about their requirements and the issues associated with a developing the European service portfolio. NA2 will open a specific dissemination channel to communicate the project progress at an NREN organisational level. NA4 will also liaise with other world regions to seek to maximise the global impact of GN3 developments; to achieve harmonised and were possible equivalent global service capabilities, and to reinforce Europe's position as a hub for global research networking.

The development and promotion of the portfolio of services available across the GÉANT service area, together with the introduction of a specific task charged with liaising with European projects and initiatives will address the ever growing requirements of advanced scientific communities and be of more general benefit to researchers organised on a pan-European basis.

In addition to this, the project will take a more active role in managing its contributions to standardisation and intellectual property rights. Regarding standardisation it is recognised that it is important to ensure that the work in GN3 influences and is influenced by standards activities. A dedicated task in NA4 will deal with liaison with industry and contribution to standards bodies. It is the case that standardisation work can be very resource consuming thus a pragmatic policy will be developed to maximise impact of the GN3.

### 3.4.2 Management of IPR

GN3 will base its management of IPR on the experience gained in GN2. A policy relating to the management of IPR is currently being finalised by the GN2 NRENPC. This policy recognises that the bulk of development has been, and will continue to be, based on open source software. The issues that surround the use of open-source software, particularly in a telecommunications service environment, are ensuring version consistency and providing ongoing support for the software maintenance and development. Further points relating to the housekeeping aspects of licensing, the ongoing rights of project participants to use software and the potential for commercial exploitation are also addressed in the IPR policy. As recognition of the importance of the management of IPR in GN3, it is a function that will be managed in the Project Office and staffed by a knowledgeable IPR professional.

# 4 Section 4: Ethical Issues

**ETHICAL ISSUES TABLE**

| | YES | PAGE |
|---|---|---|
| **INFORMED CONSENT** | | |
| Does the proposal involve children? | | |
| Does the proposal involve patients or persons not able to give consent? | | |
| Does the proposal involve adult healthy volunteers? | | |
| Does the proposal involve Human Genetic Material? | | |
| Does the proposal involve Human biological samples? | | |
| Does the proposal involve Human data collection? | | |
| **RESEARCH ON HUMAN EMBRYO/FOETUS** | | |
| Does the proposal involve Human Embryos? | | |
| Does the proposal involve Human Foetal Tissue / Cells? | | |
| Does the proposal involve Human Embryonic Stem Cells? | | |
| **PRIVACY** | | |
| Does the proposal involve processing of genetic information or personal data (eg. health, sexual lifestyle, ethnicity, political opinion, religious or philosophical conviction) | | |
| Does the proposal involve tracking the location or observation of people? | | |
| **RESEARCH ON ANIMALS** | | |
| Does the proposal involve research on animals? | | |
| Are those animals transgenic small laboratory animals? | | |
| Are those animals transgenic farm animals? | | |
| Are those animals cloned farm animals? | | |
| Are those animals non-human primates? | | |
| **RESEARCH INVOLVING DEVELOPING COUNTRIES** | | |
| Use of local resources (genetic, animal, plant etc) | | |
| Benefit to local community (capacity building i.e. access to healthcare, education etc) | | |
| **DUAL USE** | | |
| Research having direct military application | | |
| Research having the potential for terrorist abuse | | |
| **ICT IMPLANTS** | | |

| | | |
|---|---|---|
| Does the proposal involve clinical trials of ICT implants? | | |
| **I CONFIRM THAT NONE OF THE ABOVE ISSUES APPLY TO MY PROPOSAL** | ✓ | |

# 5 Acronyms

| | |
|---|---|
| **AAI** | Authentication and Authorisation Infrastructures |
| **AMPS** | Advance Multi-domain Provisioning System |
| **AutoBAHN** | Automated Bandwidth Allocation across Heterogeneous Networks |
| **CBF** | Cross Border Fibre |
| **CLG** | Company Limited by Guarantee |
| **cNIS** | Common Network Information Service |
| **DICE** | DANTE, Internet2, CANARIE & ESnet |
| **DWDM** | Dense Wavelength Division Multiplexing |
| **IDC** | Inter-Domain Control |
| **IRU** | Indefeasible Right of Use |
| **ISS** | In-Service Support |
| **JRA** | Joint Research Activity |
| **MPLS** | Multi Protocol Label Switching |
| **NOC** | Network Operations Centre |
| **NREN** | National Research and Education Network |
| **OAM&P** | Operations, Administration, Maintenance & Provisioning |
| **OPN** | Optical Private Network |
| **OWD** | One Way Delay |
| **PBT** | Provider Backbone Transport |
| **PERT** | Performance Emergency Response Team |
| **QoS** | Quality of Service (Premium IP) |
| **ROADM** | Reconfigurable Optical Add/Drop Multiplexer |
| **SA** | Service Activity |
| **SOA** | Service Oriented Architecture |
| **T-MPLS** | Transport Multiprotocol Packet Label Switching |
| **V/OPN** | Virtual/Optical Private Network |
| **VLBI** | Very Long Baseline Interferometry |
| **VPN** | Virtual Private Network |

# Appendix A *Individual Participants*

This Appendix contains section 2.2, which has been extracted here due to its length, for ease of use and better readability.

There are several areas in which all participants will contribute at least a small amount of either effort or other types of resource. The two main activities of this type are:

- NA1 – for the management of the affairs of the project both day to day and in terms of long-term policy. This will include attendance at management meetings such as NREN Policy Committee, Project Board, Supervisory Committees and Project Symposia.
- SA1 – for the operation and maintenance of the backbone network and its connections to NRENs. This will include Access Port Manager (APM) meetings as well as any effort required for day-to-day operational work.

Participants' profiles below contain more information on the contributions of each participant which are proposed to be funded**.**

## A.1 *Participant 1: DANTE*

### A.1.1 *Description of Organisation*

DANTE (Delivery of Advanced Network Technology to Europe) was established in 1993 in Cambridge, UK. It is a limited liability company and a "Not for Profit" organisation. The location of Cambridge was chosen as a result of an international competition, with the tax benefits which the UK government offered constituting a significant factor in determining the choice of location. The ownership of the company is of fifteen shareholding organisations, which are either NRENs or else government funding bodies which finance the NREN for their country.

DANTE's purpose is to plan, build and operate pan-European research networks. It was set up, and is owned, by a group of National Research and Education Networks (NRENs). It was established in 1993 and has since played a pivotal role in four consecutive generations of pan-European research network: EuropaNET, TEN-34, TEN-155, GÉANT and now GÉANT2.

### A.1.2 *Main Tasks in the Project*

As the Coordinator of the project, DANTE will be extensively involved in a large number of activities. DANTE will primarily contribute to NA1 and SA1and will be involved in SA2, SA4, JRA1, JRA3, NA2 and NA4.

### A.1.3 *Previous Relevant Experience*

At present, DANTE is the managing partner in five projects: GÉANT2, ALICE (to develop an IP research network infrastructure within the Latin American region and towards Europe), EUMEDCONNECT (a pioneering initiative to develop an IP research network infrastructure within the Mediterranean region), ORIENT (collaboration Sino-European to connect the research and education networks of China and Europe.) TEIN2 (to develop IP research network infrastructure across the Asia Pacific region and between Asia and Europe).

GÉANT2 is only the latest in a succession of highly advanced Europe-wide data networks DANTE has managed, following in the footsteps of GÉANT(1), EuropaNET, TEN-34 and TEN-155. DANTE has an enviable record of success in delivering and operating these networks. As a result of this experience, during its ten years

of operation DANTE has developed considerable knowledge and expertise in the technical and commercial disciplines required to provide high-speed international networks ahead of the market.

Based in Cambridge, UK, with roughly 40 employees, DANTE currently manages an annual turnover of approximately 50 M Euro. DANTE's specific focus on providing advanced pan-European research networking services makes the company unique and is key to its success.

### A.1.4 *Key Personnel*

**Dai Davies - Joint General Manager -** has been General Manager of DANTE for fifteen years, since its foundation. He has degrees in engineering and computer science from Cambridge University. He worked for British Telecommunications for over fifteen years, both in technical and commercial positions. Before coming to DANTE he was director of the COSINE Project Management Unit.

**Hans Döbbeling - Joint General Manager -** joined DANTE as General Manager in August 2004. He studied physics, and obtained his PhD from the University of Heidelberg in 1981. He worked for twelve years as an experimental physicist in medium-energy nuclear physics at MPI für Kernphysik Heidelberg, at CERN in Geneva, at KEK in Tsukuba, and at PSI in Villigen. In the early nineties, he became an IT services manager. He was head of the Analysis Software Development group at GSI in Darmstadt, and later in charge of the IT services of the European Molecular Biology Laboratory (EMBL) in Heidelberg.

**Miloš Karapandžić - Project Manager -** has been working for DANTE as Project Manager on GÉANT and other related projects since November 2002. Before joining DANTE, Miloš worked for Analysys Ltd, a telecoms consultancy also based in Cambridge, UK. After graduating in English Language and Literature at the University of Nis, Serbia (then Yugoslavia) in 1999, he completed a Masters course in English and Applied Linguistics at the University of Cambridge in 2001.

**Marian Garcia Vidondo - Chief Operations Officer -** finished her masters degree in Telecommunication Engineering in 1999 at the Public University of Navarra (Spain) specializing in optical communications. In April 2000 she became part of the Operations team at DANTE, working on day-to-day operational issues. Since January 2003 Marian became Operations Manager at DANTE and in July 2007 she was promoted to Chief Operations Officer. Marian is responsible for the operations of GÉANT2, the Pan-European research network, providing IP services and point-to-point Ethernet connections to the National Research Networks in Europe. She is as well responsible for the operations of advanced multi-domain services in Europe such as the multi-domain monitoring service. Marian works together with other networks like Internet2 and Esnet in America in the definition of the global operations for such services..

**Roberto Sabatino - Chief Technical Officer -** joined DANTE in July 1997 as a Network Engineer. In November 1998 he was promoted to Head of Network Planning and became Chief Technical Officer in August 2002. Roberto has a degree in Computer Science (Italian Laurea) from the University of Turin and prior to joining DANTE he worked for two years at the University of Cambridge Computer Laboratory as a Research Associate, from April 1995 to May 1997. From January 1984 until April 1995 he worked in Italy in the telecommunications industry and at the University of Turin.

**Matthew Scott – Chief Financial Officer** - joined DANTE in June 1996 as Commercial Manager responsible for the financial operation of DANTE. He has considerable experience in procurement and commercial negotiations, having been involved in the procurements for the last four pan-European networks that DANTE has implemented, and has extensive knowledge of the international telecoms carrier market. He is qualified as a Chartered Accountant and has an Engineering degree from the University of Newcastle upon Tyne.

**Melanie Pankhurst – Joint PR Manager** - joined DANTE in September 2007. She has a Business degree from the Polytechnic of Wales and the CIM Diploma. She is an experienced marketing communications specialist and has been involved with networking technology since the early days of commercial Internet: with PIPEX, UUNET and software distributor Unipalm. She went on to manage international marketing communications for ANT plc, developer of client solutions for IPTV and digital television, followed by two years of consultancy. Prior to working in technology, Melanie worked for the Thai Trade Centre, British Gas and in contract roles in Hong Kong and Australia.

**Cathrin Stöver – International Relations Manager -** was promoted in December 2007 to the position of International Relations Manager responsible for the management of relationships with NRENs across Europe and also with those organisations DANTE co-operates with in other world regions. In addition, the IRM group oversees the portfolio of global products and services available to NRENs and their users, and provides support and information. Cathrin originally joined DANTE in October 1997 as External Relations Manager and became Project Manager of the ALICE project in 2002. Under her management, ALICE led to the creation of

the Latin American RedCLARA network and the CLARA organisation. Cathrin has a degree in European Business Studies and having spent time studying and working in Germany, France, the UK and US, she is now based in Madrid, Spain.

**Otto Kreiter – Service Introduction Manager -** works in the Project Management team of DANTE. He joined the company in 2003 as a member of the Network Engineering and Planning team. Before joining DANTE he worked for 3 years as a Network Engineer at the Technical University of Cluj-Napoca and the Cluj Branch of RoEduNet. Otto graduated from the Technical University of Cluj-Napoca (Romania) in 2000 with a Bachelors degree in Telecommunication, and completed a masters' degree in Digital Telecommunication at the same university in 2001.

**Anand Patil – Head of Systems -** graduated with a bachelors degree in Mechanical Engineering from India in 1994. He started his career as a software engineer with Infosys in Bangalore. In 1996 he moved to Singapore and worked with NCS, a Singapore Telecom subsidiary, as a senior consultant. He has worked as a Systems Architect in the field of bespoke application development in a wide range of business sectors and technologies. Anand came to the UK to pursue an MSc degree in Distributed Systems and Networks from the University of Kent at Canterbury in 2002. As a part of the Masters course he did a summer project at DANTE developing a Premium IP reservation system and decided to work for DANTE. In 2004 he was appointed as the head of systems group for the management and coordination of software development activities.

## A.2 *Participant 2: TERENA*

### A.2.1 *Description of Organisation*

TERENA is the association of National Research and Education Networks in Europe. In 2008 the organisation counts 37 national members, two international members – CERN and ESA - and a number of associate members, including, DANTE, NORDUnet, and a few industrial organisations, which are normally highly involved in cooperation activities and projects with the research and education Community. The mission of TERENA is to promote and participate in the development of high-quality international information and telecommunications infrastructure and services for the benefit of research and education. The activities of TERENA fall into four categories, which are the pillars of the organisation, and which are all ideally relevant to the FEDERICA project.

- Fostering new activities: TERENA provides an environment for fostering new initiatives of the European research networking community.
- Technical Programme: TERENA supports joint European work in developing, evaluating, testing, integrating and promoting new networking, middleware and application technologies.
- Knowledge transfer: TERENA organises conferences, workshops and seminars for the exchange of information between TERENA member organisations and in the wider research networking community, and to make them and the Internet community at large aware of relevant developments.
- Promoting members' interests: TERENA represents the common interests and opinions of its member organisations in contacts with governments, funding bodies, industry and other organisations.

### A.2.2 *Main Tasks in the project*

TERENA's main contributions will be to NA3 and SA3, with involvement in NA1, NA2 and NA4.

### A.2.3 *Previous Relevant Experience*

In recent years TERENA successfully coordinated the SEEFIRE (ended in 2006) SERENATE (ended in 2003) and SCAMPI (ended in 2004) projects. In addition, TERENA has been involved in information dissemination activities in various EC projects, including 6NET, EGEE, 6DISS, SEEREN, SEEREN2, LOBSTER and NoAH. TERENA is currently leading two SAs and one JRA in the FEDERICA project TERENA is a contractor in the GN2 project, where, among other activities, it is responsible for the networking activities on NREN Development and Support, on the Foresight Study and on Coordination of RTD; starting from 2007 TERENA has also been involved in the GN2 networking activity on training. TERENA is running the TRANSITS training courses for security incident response teams twice a year.

### A.2.4 *Key Personnel*

**Karel Vietsch - Secretary-General -** took up the duties of Secretary-General of TERENA in 1996. His responsibilities include the day-to-day management of the TERENA Secretariat staff. He has overall

responsibility for the execution of TERENA's policies and activities and he reports to the TERENA Executive Committee. Karel also represents TERENA in contacts with other organisations. Currently, Karel's Tasks include the direction of the GLIF secretariat and the leadership of the Foresight Study into the expected development of research and education networking in Europe. He is one of TERENA's representatives in the Policy Committee and the Executive Committee of the GN2 project. Karel represents TERENA in a number of policy and co-ordination bodies, including the Coordinating Committee for Intercontinental Research Networking CCIRN and the ENPG. Karel holds a PhD in Mathematics from Leiden University. Before joining TERENA he was a teacher and researcher at Leiden University, a department manager at Delft University of Technology and a policy advisor and head of unit in the Science Policy Department of the Dutch Ministry of Education, Culture and Science.

**Licia Florio - Project Development Officer -** joined TERENA in October 2001 as one of the Project Development Officers to support TERENA's Task Forces and contribute to technical projects. She is currently responsible for the middleware area within TERENA. Licia is the secretary for TF-Mobility, which focuses on testing and development of mobile technologies as well as the deployment of eduroam (one of the major results of the Task Force). She is also the secretary of TF-EMC2, the Task force which focuses on the middleware developments in Europe. TF-EMC2 embraces projects like TACAR (the repository for roots Certification Authorities), SCHAC (the SChema Harmonisation Committee) and the Server Certificate Service (SCS) project, which provides low cost server certificates pop-up free for the NRENs involved. The latest new activity of TF-EMC2 is REFEDS to define procedures and guidelines to allow for peering of federations. Licia also organises EuroCAMP (European Campus Architecture Middleware Planning) and is the liaison for Grid activities and as such, represents TACAR/TERENA in the EuGridPMA. Licia graduated in Computer Science at the University of Bologna and before joining TERENA, worked at an Italian IT company as analyst-programmer to develop Java-based secure web-applications.

## A.3 *Participant 3: ACOnet*

### A.3.1 *Description of Organisation*

The University of Vienna (Universität Wien) is the oldest university in the German-speaking world, founded by Duke Rudolf IV in 1365. 65,000 students from 130 countries are currently enrolled at the University, which offers 130 Bachelor, Master, Diploma and Doctoral programmes in the fields of study covered by its eight Faculties.

The Vienna University Computer Centre is divided into four departments with a total staff of approximately 130. The Networking department is responsible both for the local computer networks and the telephony system of the University of Vienna, as well as for the national research and education network ACOnet and its international connectivity.

Information about the University of Vienna can be found at http://www.univie.ac.at and about the Vienna University Computer Centre at http://www.univie.ac.at/zid. Information about ACOnet is available at http://www.aco.net.

### A.3.2 *Main Tasks in the project*

ACONET will not claim any manpower under the GN3 project. However, they will provide an unfunded contribution applied to the common goals of the consortium in terms of the management of the project as well as the operation of the GÉANT network and its connections to NRENs and higher-level associated services.

### A.3.3 *Previous Relevant Experience*

The Vienna University Computer Centre is a service organisation within the University of Vienna, providing IT services to the University and its students and staff. The Vienna University Computer Centre was instrumental in the development of the Internet in Austria. In 1990, this organisation was in charge of the first computer in Austria to establish a connection to the Internet. As a consequence, research network connections spread to other universities, and in 1992 the Ministry of Science and Research entrusted the Vienna University Computer Centre with the management and operation of ACOnet, the Austrian Academic Computer Network. ACOnet provides networking services to all institutions of research, education and culture in Austria. In addition to its services for the academic community, the Vienna University Computer Centre also operates the Vienna Internet Exchange (VIX).

### A.3.4 *Key Personnel*

Peter Rastl, **Director of the Vienna University Computer Centre**

Christian Panigl, **Chief Technical Officer (Networking)**

## A.4 *Participant 4: AMRES*

### A.4.1 *Description of Organisation*

Academic Network of Serbia (AMRES) is the national research and education network of Serbia, offering to its users modern information-communication services and Internet connection. AMRES is the most significant scientific and research and educational resource and carrier of the Information Society development in Serbia, it's considered to be the most advanced network in our country with over 130 connected institutes and more than 100.000 active users. AMRES presents one of most important national-research and educational resource and carrier of Information Society development.

More information about AMRES can be found at: http://www.amres.ac.yu/

### A.4.2 *Main Tasks in the project*

AMRES will contribute to activities SA2, SA3, SA4, JRA2 and NA3.

### A.4.3 *Previous Relevant Experience*

Academic network of Serbia (AMRES) is a scientific research and education computer network. AMRES was created in the beginning of 90's and now it has grown to become the most advanced computer network with more than 140 connected institutes and over 100.000 active users. AMRES is the most important resource of the scientific research and work and carrier of Information Society development in Serbia. Effective capacity of international Internet links is approx. 350 Mbit/s. The latest increase in link capacity was realised in 2006. as part of the SEEREN2 project .

AMRES is a member of TERENA, CEENET and an observer in GN2.

AMRES infrastructure presents a scientific research and education network of Serbia in the functional and technical sense, together with its external links (Internet, SEEREN, GÉANT2, other providers etc.). Network infrastructure can be divided in functional units:

- Accessible network serves for connecting institutes-end users to the point of access to the Academic network of Serbia - AMRES POP, under the administrative and technical control of AMRES service centres
- Backbone presents a number of connections and links between AMRES POP. Backbone infrastructure relates to intercity links that connects University centres in Belgrade, Novi Sad, Kragujevac and Nis, as well as faculties that are located in other cities: Subotica, Sombor, Zrenjanin, Sabac, Pancevo, Valjevo, Uzice, Cacak, Kraljevo, Krusevac, Leskovac, Vranje, Bor, Pirot, Novi Pazar and Kosovska Mitrovica.
- External links presents all links towards networks that are not members of AMRES - academic networks of other countries, Internet providers, and partner institutes.

Technology is used for AMRES infrastructure conditioned with type and usage of the same link:

- Optical technology: Used for transfer of data via optical infrastructure (dark fibre) - Gigiabit Ethernet technology (1000BASE-X) is used in AMRES, as well as satellite modules and singlemode or multimode cables.
- xDSL VPN: Used for accessing the network. It is accomplished in cooperation with Telekom Srbija.
- Analogue lines: Used for accessing the network and presents a technology that has been intensively used in the past. HDSL modems are used for transfer of data, this technology is problematic due to the stability of functional services.

### A.4.4 *Key Personnel*

Zoran Jovanovic

Deputy PC representative?

More information about AMRES staff can be found at: ??

## A.5 *Participant 5: ARNES*

### A.5.1 *Description of Organisation*

he Academic and Research Network of Slovenia (ARNES) is a public institute which provides network services for research, educational and cultural organizations and enables them to connect and cooperate with each other and with related organizations abroad.

ARNES builds, maintains and manages infrastructure which links universities, institutes, research laboratories, museums, schools, databases and digital libraries. It offers its users the same services as the national academic networks in other countries with which it cooperates in European Commission projects in testing, development and the introduction of new Internet protocols and services. It also performs services which are not offered by commercial organizations but which are preconditions for the operation of the Internet in Slovenia.

The members of the ARNES Board of Directors are appointed by the Government of the Republic of Slovenia. The Board of Directors adopts the Operating Plan and the Final Account, and the Technical Board deals with programme and development issues.

More information about ARNES can be found at: www.arnes.si

### A.5.2 *Main Tasks in the project*

ARNES will contribute to activities SA3 and JRA3.

### A.5.3 *Previous Relevant Experience*

The ARNES network links over 1000 Slovenian organizations and makes ARNES' services available to nearly 200,000 people. International connections with educational and research networks in other countries are provided through the several-dozen gigabit GÉANT2 network, which is co-financed by the European Commission. Users can therefore cooperate in international projects which require fast and reliable information-communications connections, stable videoconference transmission and the transmission of large amounts of data.

### A.5.4 *Key Personnel*

**Marko Bonač – Director** - received B.Sc. in Mathematics (1981) and M.Sc. in Computer Science (1988) from the University of Ljubljana. From 1981 to 1992 he has been working as a researcher and project leader in many projects in the field of computer networks. Since 1992 he has been director of Academic and Research Network of Slovenia. He is also Member of the Board of EURid.

**Avgust Jauk – Deputy Director -** has been active in the area of computer networks since 1989. He received B. Sc. (1988) and M. Sc. (1992) in Computer Science from the University of Ljubljana. Since 1993 he has been working for ARNES, where he is responsible for development and operations.

## A.6 *Participant 6: BELNET*

### A.6.1 *Description of Organisation*

BELNET is the Belgian national research network and provides network services to research and education establishments across Belgium. BELNET customers include all of the country's universities and research institutes, plus most of Belgium's colleges for higher education. BELNET also has a limited number of other customers, such as government agencies and a small number of research departments from private companies. In all, BELNET has approximately 160 customers, with more than 590,000 end users comprising researchers, academic staff and students.

More information about BELNET is available at: www.belnet.be

### A.6.2 *Main Tasks in the project*

BELNET will not claim any manpower under the GN3 project. However, they will provide an unfunded contribution applied to the common goals of the consortium in terms of the management of the project as well as the operation of the GÉANT network and its connections to NRENs and higher-level associated services.

### A.6.3 *Previous Relevant Experience*

BELNET's core activity is providing network access for research and education. The BELNET network is strategically important to Belgian researchers. It allows them to communicate with colleagues throughout the world, giving them access to the commercial Internet but also to the GÉANT2 European research network and the North American and Asian research networks. Some 5,000 terabytes of data are exchanged yearly via the BELNET network.

BELNET manages a total of three networks:

- The national research network for the Belgian universities, colleges, schools, research centres, and public departments.
- The Belgian National Internet eXchange (BNIX), the Belgian exchange node that enables high-speed data exchange between Internet Service Providers (ISPs) in Belgium.
- The Federal Metropolitan Area Network (FedMAN), that connects the buildings of the federal administrations with one another and with the Internet.

In addition to a stable, high performance network, BELNET is increasingly providing its users with practical services such as multi-party videoconferencing. The BELNET CERT has been in operation since 1 July 2004. It distributes information on security issues via its website, publishes a newsletter and sends mailings with security warnings or notifications. The CERT department supports organisations affiliated with BELNET with their security-related issues.

BELNET is an official registrar for .be and .eu domain names. BELNET customers can register and manage domain names using an online application. Today it manages approximately 2000 .be domain names and 400 active .eu domain names.

### A.6.4 *Key Personnel*

**Pierre Bruyère – Director**

Engineer in electricity (microelectronics)., University of Louvain-la-Neuve (1976-1982)

Since 1988, initiator and Director of BELNET, the Belgian research network.

**Jan Torreele - Technical Director**

Masters. Computer Science, summa cum laude, University of Brussels (1984-1988)

Responsible for all technical operations within BELNET, including Network Engineering, Network Operations and Services. Managing a team of 16 network engineers.

| | |
|---|---|
| 1988-1995: | Researcher, University of Brussels (artificial intelligence, distributed systems, complex dynamics) |
| 1996-2000: | Network Engineer, BELNET |
| 2001-now: | Technical Director, BELNET |

## A.7 *Participant 7: BREN*

### A.7.1 *Description of Organisation*

The Bulgarian Research and Education Network (BREN) association is a non-profit legal entity, registered under the Non-profit Legal Entities Act. BREN aims at deploying, developing, and operating the Bulgarian research and education networks, as well as facilitating the integration of Bulgarian educational, scientific, and cultural resources in the global information space.

BREN provides the Bulgarian Universities and scientific institutes with access to the pan-European and global research and education networks through high performance information infrastructure.

More information about BREN is available at: http://www.bren.acad.bg/

### A.7.2 *Main Tasks in the project*

BREN will contribute to activities SA2, SA3, SA4, JRA2, JRA3, NA1 and NA4.

### A.7.3 *Previous Relevant Experience*

The activities of BREN cover such aspects as:

- Providing access of the representatives of the scientific, research and cultural community to the European and world-wide communication and information resources and networks.
- Development and organization of educational courses, seminars and learning, including the distant one for the scientific and research community.
- Stimulation of the development and presentation, as well as practical implementation of vanguard computer and information technologies and multimedia information services.
- Publication of bulletins and other information materials aiming at promoting (advertising) the Association activities.

The scope of the supplementary business activities enlists:

- Providing consultations and expert assistance for development, application, support and execution of projects in the area of information and communication technologies.
- Training in the field of information and communication technology applications.
- Organisation of conferences, seminars, symposia, meetings, courses and practical training to resolve organizational, intellective (creative) and legal issues, connected with the cybernetic space and implementation of new information and communication technologies, as well as translation and publication of complementary literature, reference books, multimedia carriers and other educational appliances.
- Development and maintenance of Internet portals for exchange of information and ideas among research network users, and among the various strata of society and different social groups, using the new information technologies.
- Providing access to world research networks and information resources of Bulgarian organizations and representatives (workers) in the fields of science, education and culture.
- Participation in projects in the area of information and communication technologies, as well as other activities, connected with the basic aims of the Association.

### A.7.4 *Key Personnel*

**Krasimir Simonski – Vice Chair -** has a long carrier of positions with increasing responsibility at the American Unersity in Bulgaria (AUBG). His business experience in the private business was with the position of Head of Project Management Office of TravelStoreMaker.com, a successful e-Business company in Bulgaria under US management. He has been the force behind the success of other large projects – the Cisco Networking Academy Program (Cisco EMEA Award for Best Collaboration Project), the Military Retraining Project, and the Roma Leader project of AUBG. In addition he has a long consulting and teaching experience. He was a consultant with the American Farm School in Thessalonica, Greece, the Forest University in Bulgaria, the European Commission's JEP+ TEMPUS project, Pirin.com, and the Open Society Institute. He was an Adjunct Faculty in AUBG Computer Science Program, Cisco Networking Academy Program (CCNA and CCAI) regional instructor, Microsoft Office User Specialist Program Certified Expert Instructor, Business IT skills and Operational Management courses.

**Kiril Boyanov – Member of Board -** is the head of the Institute of Parallel Processing (IPP) - BAS. He is the head of the Department for Distributed Systems and Networking - IPP.

## A.8 *Participant 8: CARNet*

### A.8.1 *Description of Organisation*

The Croatian Academic and Research Network (CARNet) was created in 1991 as a project of the Ministry of Science and Technology of the Republic of Croatia. In 1995 the Government of the Republic of Croatia issued a Decree founding the CARNet institution. Apart from 80 employees, CARNet has about 20 external associates, and the employees of several institutions and companies participate in various project teams. The most important CARNet partners are the University Computing Centre - SRCE and the Faculty of Electrical Engineering and Computing in Zagreb.

CARNet missions are:

- Development of advanced information and communication infrastructure for the academic and research community, including fast and safe network, diverse contents and services.

- Improvement of higher education and science as well as of the work and lives of students, associates, lecturers and scientists by applying the information and communication technology, getting to know its capabilities and assisting in its implementation.
- Stimulating information and communication technology implementation, and especially providing support to knowledge dissemination and information exchange as well as the development of contents available through the network.
- Co-operation with the international organizations and linking with the academic and research networks, establishing and maintaining of central national services for the Internet.

Although CARNet activities are significant for the whole region of the Republic of Croatia, these are primarily targeted at the academic and research community. The role of the academic and research community in every society, including also the Croatian society, is to design, introduce and implement new technologies. This is the reason why the best and the latest information technology and infrastructure have to be made available first and foremost to the academic and research community.

More information about CARNet can be found at: www.CARNet.hr

### A.8.2 *Main Tasks in the project*

CARNet will contribute to activities SA2, SA3, SA4 and JRA3.

### A.8.3 *Previous Relevant Experience*

CARNet was founded in 1991 as an institution with basic activities of development, building and maintenance of a network. CARNet network is a private network of the Croatian Academic and Research Network and the scientific and research community. The owner of the network infrastructure is CARNet institution, while copper and optical connections are rented from several commercial telecommunication providers. CARNet's Wide Area Network - a network distributed over large distances, in CARNet's example on a national level - enables maximum level of the network monitoring, which is of great importance for fast and high-quality implementation of new network technologies and services.

CARNet network is a data network whose principal purpose is to transfer data through TCP/IP protocol (Transport Control Protocol/Internet protocol). This protocol is an agreed standard for the currently most widespread computer network - Internet. The currently supported version of TCP/IP protocol on the greatest part of Internet, as well as CARNet network as its integral part, is version 4 (IPv4).

CARNet network established its international connection through the pan-European research network GÉANT2. CARNet is a part fo GN2 dark fiber footprint. Connection to other Internet providers in Croatia has been implemented through the Croatian Internet Exchange Point - CIX.

Within Croatia, CARNet network connects all major Croatian cities and on several different technology and connection speed levels. The backbone of CARNet network connects larger university centers (Dubrovnik, Osijek, Pula, Rijeka, Split, Zadar, Zagreb) with high connection speeds (ranging from 155 Mbps to 1 Gbps), while other, smaller centers are connected with ethernet speed connections. Zagreb has a particularly advanced infrastructure, connecting larger faculties and scientific institutions at the speed of up to 10 Gbps. The network is run by CARNet in co-operation with a partner, University Computing Center - SRCE, which builds and maintains the network.

CARNets provides a full set of services to its users in Croatia including internet access, email, web hosting, domain registration, educational services, CERT, videoconferencing and multimedia and other services.

### A.8.4 *Key Personnel*

**Zvonimir Stanic – CEO –** received in-service training in the field of application of information and communication technologies and graduated from Faculty of Mechanical Engineering and Naval Architecture, major in engineering constructions, in 1988.

Work background:

- 2004 Croatian Academic and Research Network - CARNet CEO
- 2000 IT Department director at Croatian Railways
- 1992 Information technology architect at Croatian Railways IT Department
- 1989 Maintenance planner at the Factory of Railway Vehicles

Major projects:

- Project manager on development project of the system for service sales in Croatian Railways passenger transport with 138 online sale sites
- Project manager for development of the Croatian Railways optical base
- Project manager of Croatian Railway LAN infrastructure development with over 1500 connections
- Project manager on the project of implementation of the first Microsoft Windows Data Centre in Croatia
- Project manager on the project of development of the passenger information service system at Croatian Railways stations
- Project manager on the project of implementation of an integral secure Microsoft infrastructure on Croatian railways network
- Project manager on the project of BMC patrol implementation for monitoring of Croatian Railways network services and central computers
- Project manager on the project of analysis and modelling of business processes through the use of ARIS tools at Croatian Railways
- Project manager on the project of SharePoint portal development as the Croatian Railways' central intranet portal
- Project manager on the development project of trial wireless infrastructure on trains

**Vlado Pribolsan - Deputy CEO**

Education:

2002 - completed the General management program, Business School IEDC, Bled, Slovenia

1998 - acquired Master's degree at the Faculty of Electrical Engineering and Computing, University of Zagreb

1990 - graduated at the Faculty of Electrical Engineering and Computing, University of Zagreb

Professional experience:

2002 - assistant to the Croatian Academic and Research Network - CARNet CEO

2000 - 2002 - head of the CARNet CERT service

1998 - 2000 - head of the Department of Internal Technical Support at the Croatian Academic and Research Network - CARNet

1996 - 1998 - head of the Department of the Internet at the Croatian Post and Telecommunications

1990 - 1995 - system engineer for the videotext system at the Croatian Post and Telecommunications.

More information about CARNet staff is available at: http://www.carnet.hr/people/CARNet-team

## A.9 *Participant 9: CESNET*

### A.9.1 *Description of Organization*

CESNET was established in 1996 as an association of all the universities of the Czech Republic and the Academy of Science of the Czech Republic. The main goals of CESNET are research and development of advanced network technologies and applications, dissemination of information and the operation and development of the backbone network that interconnects the networks of the Association members and other R&D organisations. This activity is supported by the Ministry of Education, Youth and Sports under a 7-year research plan called “Optical National Research Network and its New Applications“, started in 2004.

This research plan comprises activities regarding:

- NGN network development and operation.
- Research and verification of new principles and technological trends for building of advanced optical networks
- Programmable HW development.
- Network and traffic monitoring tools development and implementation.
- AAI and mobility.
- CSIRT.
- National computing and storage Grid development.
- Collaborative technologies including VoIP, videoconferencing and media streaming.
- Advanced network application support (e.g. Implementation of network technologies for data sharing for medical purposes).

CESNET, implementing results of above mentioned R&D activities, designs and operates hybrid network called CESNET2 and provides advanced network services for the R&D community in Czech Republic.

More information about CESNET is available at: http://www.ces.net/

### A.9.2 *Main Tasks in the Project*

CESNET will contribute to activities SA1, SA2, SA3, JRA1, JRA2, JRA3, NA1, NA3 and NA4.

### A.9.3 *Previous Relevant Experience*

CESNET operates national research backbone network which connects all public universities, institutes of the Academy of Science of the Czech Republic and other R&D organization in the Czech Republic.

CESNET was involved in all previous projects which built Pan-European networks TEN-34, Quantum, GÉANT and also in the current Multi Gigabit Network GN2 project.

Recently, level CESNET has been participated in several international collaboration projects: EGEE II (III), 6NET, LOBSTER, SCAMPI, Porta Optica Study, Phosphorus, ORIENT, EGI-DS and FEDERICA. In addition to those projects, CESNET takes part in Task-Forces coordinated by TERENA.

### A.9.4 *Key Personnel*

**Jan Gruntorad - Director -**holds Dipl. Ing. (1975) and Ph.D. (1989) degrees from the Faculty of Electrical Engineering of the Czech Technical University in Prague. In 1992 he was awarded a grant by the Ministry of Education for the establishment of an Internet-type network in the Czech Republic - CESNET. The legal body CESNET – the NREN of the Czech Republic - was founded in March 1996. CESNET is an association of all Czech Universities and the Czech Academy of Sciences. Since the creation of the CESNET legal body, Dr. Gruntorád has been a member of its Board of Directors and Chief Executive Officer responsible for research and operational Tasks within CESNET. From 1998 to 2003 Dr. Gruntorád was Chairman of the CEENET (Central and Eastern European Network Association). From 1996 to 1999 he served on the Board of Directors of the EBONE Company (pan-European Internet provider based in Copenhagen, Denmark). In January 2003 Dr. Gruntorád became a member of the Board of Directors of DANTE. He also represents the Czech Republic in TERENA. Since 1999 Dr. Gruntorád has also been a consultant for NATO in the field of computer networks for the Research and Educational community in the Caucasus.

**Helmut Sverenyak - Research and Development Manager -** holds Dipl. Ing. (1991) degree from the Faculty of Nuclear Sciences and Physical Engineering of the Czech Technical University in Prague. Helmut Sverenyák has joined CESNET in 1998 as a member of Research and Development department. In 2004, he was promoted to Head of Research and Development department with the responsibility of co-ordination and support of R&D activities in network applications area managed by CESNET.

## A.10 *Participant 10: CYNET*

### A.10.1 *Description of Organisation*

CYNET is a non-profit association under the Cypriot law. It is co-founded by the Government of Cyprus, the University of Cyprus, and the National Research Foundation (IPE). CYNET provides advanced network services to the Cypriot academic and research community. It is in charge of administering, planning and implementing the Cyprus Academic and Research Network, including evolution toward higher speeds and advanced services.

CYNET is a member of TERENA, a member of the NREN Policy Committee consortium and was a member of the QMED consortium, a supplementary consortium to QUANTUM. It is a partner in the GÉANT, GÉANT2, EUMEDCONNECT, EumedGrid projects. CYNET has a 310Mbps connection to the pan-European research network GÉANT2 hosts in its premises one of the two PoPs used in the EUMEDCONNECT network providing interconnectivity to both CYNET and the Syrian NREN. CYNET currently provides advanced network services to tertiary education organizations and research institutions.

More information about CYNET can be found at: http://www.cynet.ac.cy/

### A.10.2 *Main Tasks in the project*

CYNET will contribute to activities SA3 and JRA2.

### A.10.3 *Previous Relevant Experience*

CYNET is operated by the Network Operations Centre of the University of Cyprus. It is a member of the GÉANT2 consortium and was a member of QMED consortium, a supplementary consortium to QUANTUM. It has participated in the perfSONAR project under GN2 and was the initiator for the IP Telephony Cookbook delivered by a TERENA Task force.

### A.10.4 *Key Personnel*

**Agathoclis Stylianou - Executive Director -** holds a BSc in Systems Information Management and a PhD in Computer Science, both from Brunel University (London). He worked for a period as a Lecturer at Brunel University before taking up the post of Director of the Computer Centre at the University of Cyprus. He is also Co-founder and holds the posts of Executive Director of the Cyprus Academic and Research Network and Administrator of the .cy Country Code Top Level Domain. Dr. Agathoclis Stylianou is Member at Large of the TERENA Executive Council.

**Andreas Pitsillides - Chairman of the Board of Directors -** is Professor of Computer Science, University of Cyprus (UCY). He is also the Co-founder, Chairman & Scientific Director, of the Cyprus Academic and Research Network (CYNET). His research interests include communication networks. Published over 190 referred journal and conference papers, participates in EC and locally funded projects (e.g. GÉANT, GINSEG, C-CAST, C-MOBILE, MOTIVE, B-BONE, SEACORN, MB-Net, QUANTUM / QMED), presented invited lectures at major research organisations, short courses at international conferences and short courses to industry. He is extensively consulted by industry and the Government. Regularly serves on international conference executive committees (e.g. INFOCOM 2001, 2002 and 2003, ISYC'06, MCCS'05, ICT97), technical program committees, member of the International Federation of Automatic Control (IFAC) Technical Committee TC 1.5 on Networked Systems, and a member of the Editorial Board of Computer Networks (COMNET) Journal. (http://www.NetRL.ucy.ac.cy)

## A.11 *Participant 11: DFN*

### A.11.1 *Description of Organisation*

The DFN-Verein is a non-profit association of the research, development and education sector in Germany to promote computer-based communication and information services. Founded in 1984 as an institution comprising universities and technical colleges, non-university research institutions and private sector research bodies, the DFN association has currently more than 350 institutional members.

More information about DFN is available at: http://www.dfn.de/

### A.11.2 *Main Tasks in the Project*

DFN's main contribution will be to SA2, with participation in SA3, JRA1, JRA2 and JRA3.

### A.11.3 *Previous Relevant Experience*

Deutsches Forschungsnetz is Germany`s National Research and Education Network. It provides a high-performance infrastructure for the German Research and Education Community. DFN connects universities and research institutions and supports the development of innovative applications. Since 2006 the national backbone of DFN is the X-WiN. Being connected to the European Backbone GÉANT2, X-WiN is an integral part of the worldwide community of research and education networks. Based on contracts and peering agreements X-WiN is connected to the Global Internet as well.

The Research Network X-WiN is the highspeed infrastructure of the DFN-Verein, which allows services to be connected with rates from 2 Mbit/s up to 10 Gbit/s. X-WiN is an hybrid network with a combination of switched and routed infrastructure. X-WiN provides standard IP connections alongside switched links. DFN uses dark fibre to achieve maximum performance for the science community.

With Research Network X-WiN the DFN-Verein offers a communication system designed to meet the specfic demands of the research and science sector. Addressing the high standards required by multimedia applications, X-WiN is capable to handle very large amounts of data in the best possible quality. This potential is brought to the user through various services: DFNInternet service with up to 10 Gbit/s access capacity provides high-performance access to other scientific networks and all other networks of the world-wide Internet.

### A.11.4 *Key Personnel*

**Klaus Ullmann - Managing Director –** began his career in network development at the Hahn-Meitner Institute. Since that time, he has contributed extensively to the development of research networking in Germany. He was the project leader of a regional network for the Berlin Universities and research establishments, and then head of the Planning Team for DFN. He has been the Managing Director of DFN since 1984. In addition, Klaus was a member of the Executive Committee of the European umbrella organisation of national research and education networks, RARE, and later President of RARE from 1986 to 1990. He was also elected Chairman of the GÉANT2 Executive Committee.

**Martin Wilhelm – Deputy Director**

## A.12 *Participant 12: EENet*

### A.12.1 *Description of Organisation*

The Estonian Educational and Research Network (EENet) is a governmental non-profit organization that was established in August 1993 by the Ministry of Education with the Task of managing, coordinating and developing the computer network of science, education and culture. Since 1997 EENet has been operating as a state agency administered by the Estonian Ministry of Education and Research. EENet has a National Member status in TERENA and CEENet since October 1996.

More information about EENet is available at: http://www.eenet.ee/EENet/

### A.12.2 *Main Tasks in the project*

EENET will not claim any manpower under the GN3 project. However, they will provide an unfunded contribution applied to the common goals of the consortium in terms of the management of the project as well as the operation of the GÉANT network and its connections to NRENs and higher-level associated services.

### A.12.3 *Previous Relevant Experience*

The mission of EENet is to provide a high-quality national network infrastructure for Estonia's research, educational and cultural communities. Its services include a permanent Internet connection as well as webhosting, e-mail, ftp, DNS and consultations in the event of security problems. Development projects are being carried out in cooperation with universities and institutes, among them the Estonian GRID project launched in 2004.

In 2007 there are approximately 140,000 end-users of the EENet network, including researchers, university students, teachers and school pupils. The network covers most of the counties in Estonia.

EENet manages Estonia's top level domain (.ee).

The current international connection of EENet is a 1 Gbps channel to the GÉANT2 network. The backbone of the educational and research network in the country connects most of its counties.

As a state-owned institution, EENet offers its services to the educational, scientific and cultural establishments located in Estonia. The other important requirement is that the establishment must refrain from commercial activities within the educational and research network.

### A.12.4 *Key Personnel*

**Mihkel Kraav – Director** - has been the director of EENet for more than six years. He has a degree in Archival Studies from Tartu University. Before his job in EENet, he was a member of Estonian Parliament (1993-1995). He is also a part-time lecturer in Tartu University.

**Tarmo Ainsaar - Head of Development Department -** joined EENet in October 1999. Before that he was teaching in high school and leading at the same time several educational IT-projects. He has a degree in Physics from Tartu University.

More information about EENet staff is available at: http://www.eenet.ee/EENet/staff_en.html

## A.13 *Participant 13: FCCN*

### A.13.1 *Description of Organisation*

FCCN is a private non-profit organisation. It started its activity in January 1987. Since then, with the support of Universities and various national R&D institutions, FCCN has continued to play its part in the expansion of the Internet in Portugal. The main activity of FCCN concerns the planning, managing and operating of the Science, Technology and Social Community Network [Rede Ciência, Tecnologia e Sociedade (RCTS)]. This is a high-performance network for those institutions with the most need for communications, and is thus an experimentation platform for advanced communications software and services. RCTS is a computer network that uses Internet protocols to provide a communication and co-operation platform among institutions in the system of education, science, technology and culture. Apart from managing RCTS, FCCN is also the registry for the .pt top level domain.

More information about FCCN is available at: www.fccn.pt

### A.13.2 *Main Tasks in the Project*

FCCN's main contribution will be to SA2 with participation in SA3.

### A.13.3 *Previous Relevant Experience*

FCCN has acquired a solid experience in GN2-SA3 activity. In GN2 we are also present in JRA1, as software production coordinators, in JRA2, with a small CERT role, in JRA3, as tester of the software being developed and in JRA5 with a more active role in AAI (EduRoam and EduGain). FCCN has also much experience of giving training courses (e.g. on IPv6, through the 6DISS project).

### A.13.4 *Key Personnel*

**Pedro Veiga – Chairman -** has a degree in Electrical Engineering (1975) and a PhD on Electrical Engineering (1984) from the Technical University of Lisbon. He is a full professor at the Faculty of Sciences of the University of Lisbon since 1993, in the Informatics Department. He is the Chairman of FCCN since 1997. He was Manager of the Information Society Operational Programme (2000-2002), a member of the Portuguese Task-force on the Information Society (1996-2000), Visiting Scientist at the JRC/Ispra (1989-1990). He is responsible for the .PT TLD, Portuguese representative at present at the MB of ENISA and at the GAC of ICANN.

**João Nuno Ferreira – Technical Director** - finished the Master of Science in Data Communications, Networks and Distributed Systems at University College in London, UK in 1993. Since then he has been working as the Technical Manager of the Portuguese Academic and Research Network in FCCN. His main areas of work are: planning, operation management and quality control of WAN networks, namely IPv4 and IPv6. Security management: SNMP based systems, Firewalls, Security Policies and X.509 Certification. Technical coordination and management of European funded projects. Planning, operation management and quality control of LAN networks.

## A.14 *Participant 14: GARR*

### A.14.1 *Description of Organization*

Consortium GARR is an Association under Italian law. It was established by the national Academic and Research Community. Its member institutions are the Italian Universities and the main governmental Research organizations as CNR (the Italian National Research Council), ENEA (Italian National Agency for New technologies, Energy and Environment) and INFN (Italian National Institute of Nuclear Physics).

The aim of Consortium GARR is to plan, manage, and operate the Italian National Research and Education Network, implementing the most advanced technical solutions and services. It supplies the Italian Academic and Research Community with connectivity to the GARR backbone, interconnecting over 300 universities, laboratories, libraries, observatories and other research facilities. Also, Consortium GARR provides its member institutions with the main Operational and Application Networking Services.

More information about Consortium GARR is available at: http://www.garr.it

### A.14.2 *Main Tasks in the Project*

GARR's main contribution will be to SA2 and JRA2, with participation in SA1, SA3, JRA1, NA1, NA2 and NA4.

### A.14.3 *Previous Relevant Experience*

The GARR network covers the whole Italian territory; its backbone, organized around 40 PoPs, is based on a mesh of 10 Gbps lambdas and guarantees high reliability, security and error resilience. Technologies such as IPv6, QoS, multicast and VPN on GARR allows to supply new advanced services and to fully support innovative applications such as Grids, tele-medicine, eLearning, Multimedia, High Energy Physics, Radio Astronomy, Earth Observation and Supercomputing.

GARR is connected at more than 10Gbps to GÉANT and to the North American and Japanese networks and is currently taking part to the EUMEDCONNECT and ALICE initiatives, which aim to widen such connectivity to the Mediterranean and Latin American Countries.

GARR provides operational and application services to its constituents.

Operational services:

- NOC GARR Network Operations.
- LIR GARR Local IP Registry.
- CA GARR Certification Authority.
- GARR Certification Authority for GARR's Community.
- CERT GARR Security Service.
- NIC GARR Domain Names Service.
- MBS GARR Managed Bandwidth Service.

Application Services:

- MIRROR FTP Mirror Service.
- NEWS Usenet News Service.

### A.14.4 *Key Personnel*

**Enzo Valente -** High Energy physicists, University of Rome La Sapienza and INFN. He has been Chairman of INFN Computing and Network Committee 1986 to 1992, director of INFN-CNAF 1992 to 1998, head of GARR-Broadband Network Project 1998 to 2003, then director of Consortium GARR since 2003. He is one of the members of the famous ECFA-SG5, that, starting its activity in the 70s, brought to the birth of HEPNET (Decnet based) and to the setup of a number of organizations like CCIRN, RIPE, ISOC, RARE, DANTE, etc.

**Claudia Battista - Chief Technical Officer** -as previously Head of Network Planning. She has a degree in Physics from the University of Rome. She will be responsible for the technical work carried out by GARR on behalf of the GN3 project.

Claudio Allocchio – **Chief User Application Officer**

Mauro Campanella – **Chief Research and Development Officer**

More information about GARR staff is available at: www.garr.it

## A.15 *Participant 15: GRNET*

### A.15.1 *Description of Organisation*

The Greek Research and Technology Network (GRNET S.A. www.grnet.gr) is a state-owned company operating under the auspices of the Greek Ministry of Development - General Secretariat for Research and Technology. Its sources of funding are both national and through European Commission projects. National funds are secured through both the Ministry of Economy and Finance and its Operational Programme of the Information Society and by the Ministry of Development, General Secretariat for Research and Technology, which is the mother institute of GRNET S.A.. GRNET S.A.'s mission is to provide advanced, high-quality electronic infrastructure services to the Academic, Research and Educational community of Greece and to disseminate Information & Communications Technologies to the general public.

GRNET S.A. currently migrates to a 10 Gbps backbone network in Greece (GRNET2), interconnected with the pan-European High Speed Network GÉANT2 through 3x10 Gbps links. GRNET S.A. has acquired more than

8000km of dark fibre throughout the country, as well as optical equipment to light the fibres. GRNET3 will be offering dedicated switched connections upon request in addition to IP connectivity by the end of 2008. On top of the network, GRNET S.A. provides a series of advanced production- or pilot-level network services, ranging from backup mail exchange and DNS, to IP telephony and QoS services. GRNET is a partner in the projects: GN2 (Multi-Gigabit European Academic Network), EGEE-I/II/III (Enabling Grids for E-sciencE), FEDERICA, Porta-Optica, EuMedConnect and Orient. It has coordinated a number of projects, among which the regional networking projects SEREEN1/2, and is a member of RIPE, TERENA, CEEnet, EuroIX and an international partner of Internet2.

More information about GRNET is available at: www.grnet.gr.

### A.15.2 *Main Tasks in the Project*

GRNET's main contribution will be to SA2 and JRA2, with participation in SA1, SA3, SA4, JRA1 and JRA3.

### A.15.3 *Previous Relevant Experience*

GRNET has significant experience in designing and deploying the national R&E network infrastructure as well in delivering advanced provisioning tools for access to network resources to its users. GRNET leads the research activity on multi-domain provisioning in the GN2 project, dealing with control and management in a multi-domain, multi-technology environment and liaising with similar projects and standardization bodies worldwide. With its connection to the GÉANT2 network and participation in the GN2 project, GRNET is also a key partner in the provisioning of multi-domain services at different layers (Premium IP, Bandwidth on Demand) and contributes in the research activities related to multi-domain monitoring, AAI, security. Through the development of the dark-fibre enabled GRNET3 network, GRNET has obtained useful experience in optical and switching technologies. Finally, GRNET's Virtual NOC (VNOC) has also extensive experience in delivering production level tools for network management and operations.

### A.15.4 *Key Personnel*

**Tsanakas Panayiotis – President of the Board of Directors** - received his BS degree in electrical engineering from the University of Thessaloniki in 1982, his MSc in Computer Engineering from Ohio University in 1985, and his PhD in Computer Engineering from the National Technical University of Athens in 1988. He is currently serving as professor in the School of Electrical and Computer Engineering of the National Technical University of Athens. He has been also with the George Washington University, as a visiting scholar. He has participated in several national and EU-sponsored projects, in both basic research and general RTD themes, in subjects covering distributed systems, parallel computer architectures, embedded systems, grid computing, and medical informatics. During the last 1ast 14 years he has published four Greek textbooks and more than 60 research articles in scientific journals and international conferences. His research interests include high performance computer systems architectures, and distributed applications in medicine and education.

**Tryfon Chiotis - Chief Technical Officer** - obtained a Ph.D. degree in 1998 and a Diploma degree in 1992 in Electrical Engineering from the Electrical & Computer Engineering Department of the National Technical University of Athens (NTUA). He is the Technical Director of the Greek Research & Technology Network since 2001. He is working in GRNET as a Research Associate since 1999. He also works as a Research Associate for the Network Management and Optimal Design Laboratory (NETMODE) in NTUA since 1992. From 1994 to 2001, he worked as a Research Associate for the Greek Standardization Organization (www.elot.gr). During 1999-2000 he joined OTE Consulting, where he participated in European Research projects (SPRITE-S2 PROJECT No 502074, PEPPER Process re-Engineering and Procurement Planning ex-tending EOTIP coverage as mandated by new work Requirements). He conducts research in projects funded by R&D programmes of the European Union (RACE R2037 - DIDOS, TELEMATICS RE1004 - DESIRE, TELEMATICS EN1001 - ARTEMIS, TELEMATICS IE2081 – MBLN, IST-1999-20841 SEQUIN, IST-2000-26417 GÉANT, SEEREN, EUMEDCONNECT). He also conducts research in projects funded by the Greek government (EKBAN-229, GSRT, for the establishment of an EDI node between Greek computer companies, PABE96 "HPRESS WEB: Electronic Editorial System for Newspapers", PABE96 "Establishment of the necessary infrastructure for the provision of chamber's information through the Internet").

**Afrodite Sevasti - Service and Infrastructure Development Coordinator** - graduated from the Engineering School of Patras University (Greece), where she also received her PhD in the field of QoS enhancements on IP-based networks. She also holds an MSc degree in Information Networking from Carnegie Mellon University. She has participated in several R&D projects and is currently a member of the GÉANT2 project Technical Committee, coordinating the pan-European initiative on multi-domain Bandwidth on Demand. She is also

leading the Standardization and Liaisons activity of the FEDERICA project (RI). She has published 30 papers in refereed conferences and journals.

## A.16 *Participant 16: HEAnet*

### A.16.1 *Description of Organisation*

HEAnet Limited is Ireland's National Education and Research Network, providing Internet services for more than 40 subscriber institutions and over 150,000 staff and students in Ireland's Universities, Institutes of Technology and other educational and research organisations, as well as almost 4000 primary and second level schools.

HEAnet provides IP transit services to its clients by means of high-end IP routing equipment in a number of PoPs. Beside the IP transit service, a layer 2 based 1 Gbps Ethernet service is provided towards clients. Furthermore HEAnet is actively working to procure as much dark fibre as possible.

### A.16.2 *Main Tasks in the Project*

HEANET's main contribution will be to SA3, with participation in JRA1, JRA2 and NA3.

### A.16.3 *Previous Relevant Experience*

HEAnet has been an active participant in several previous FP projects, such as GN1, and is currently involved in a number of research and development activities both at a national and international level: GN2 (Multi domain monitoring-JRA1, BoD-JRA3 and Advanced Services-SA3). HEAnet also is working on small scale UCLP related projects together with industry, including such partners as Cisco, i2CAT, Juniper and Glimmerglass. Implementations of UCLPv1.5 have been made for native and L2 MPLS VLL Ethernet services (using Cisco equipment) and pure optical switches (using Glimmerglass switches). A project, MANTICORE, is progressing the development of logical IP network using UCLPv2.

### A.16.4 *Key Personnel*

**John Boland – CEO** - was appointed to this position in October 1997 when HEAnet was incorporated as a limited company with its own staff. Prior to 1997 John worked as Systems and Networks Manager in the Computer Services Department of Dublin City University and represented DCU on the HEAnet Network Management Committee, before its incorporation. Prior to joining DCU John worked in industry with a number of international companies including Marconi Communications Systems in the UK, Motorola Information Systems in the UK and the US and Westinghouse in Australia. John holds a B. E. in electronic engineering from University College Dublin and has embarked on an ongoing M. Sc. in Computer Applications.

**Mike Norris – Chief Technical Officer** - was network coordinator from 1992 until 1998, and before that worked at University College, Dublin. He was the hostmaster for the IE top level domain, and was local IP registrar for Irish education and research. He has served on the Board of RIPE NCC and while chairman of the Local IR working group, co-authored ripe-152. A founder-member of INEX, he is currently a Director. He is a member of the Board of the Irish Centre for High-End Computing.

## A.17 *Participant 17: IUCC*

### A.17.1 *Description of Organisation*

IUCC (Inter-University Computation Center - "MACHBA" in Hebrew), is a non-profit organization established by eight universities in Israel, and is supported by the Planning and Budgeting Committee of the Council for Higher Education. The eight universities are:

- The Technion - Israel Institute of Technology.
- The Hebrew University of Jerusalem.
- Weizmann Institute of Science.
- Tel Aviv University.
- Bar-Ilan University.
- The University of Haifa.
- Ben-Gurion University of the Negev.
- Open University.

IUCC deals with communication infrastructures, digital information services, learning technologies and grid infrastructures. It also promotes cooperation and assistance in these areas among its member institutions, and between them and research institutes and organizations dealing with research and instruction, which share the same interests.

Further information about IUCC can be found at: http://www.iucc.ac.il/

### A.17.2 *Main Tasks in the project*

IUCC will contribute to activities SA2, SA3, JRA2, NA1 and NA4.

### A.17.3 *Previous Relevant Experience*

The IUCC communications network began in 1984 with a 9.6 Kbps international link to the EARN network in Europe. In 1990 IUCC introduced the first international Internet line from Israel to the USA at a rate of 64 Kbps. For three years (1994-1996) the IUCC switch was the primary Internet connection node for Israeli high-tech companies and various suppliers of communications services (before the days of IIX). Since 1999, IUCC has been connected to Internet-2 in the USA, and the TEN-155/GÉANT research network in Europe, as a regular member. To date, the IUCC communications network serves some 20,000 academic faculty members, about 80,000 students in the eight universities, and several thousand students in regional colleges and teacher-training colleges. IUCC has also been appointed to operate Israel's Internet2 project.

IUCC operates the ILAN-2 network. Its internal communications infrastructure in Israel is based on a unique network with seven nodes and two international aggregation points known as GigaPoPs. Connectivity between nodes is achieved through fibre-optic cables. The international aggregation points are linked by an optical dark fibre. The IUCC operates a backup network for the main network, based on Bezeq's ATMnet network using virtual circuits. The intra-campus infrastructure in each university is based on Gigabit Ethernet and ATM protocols.

IUCC provides several communications services including Commodity Internet services, Research Internet Services, Proxy services, FTP services, News services, Universal time service, Distribution list service, Network Operation and Control (NOC).

### A.17.4 *Key Personnel*

**Yigal Burstein – Chairman of Executive Committee** - graduated from the Hebrew University of Jerusalem and received his Ph.D. in Biophysics from the Weizmann Institute of Science, Israel. He joined the Faculty of the Weizmann Institute of Science in 1974 and serves there as a Professor of Chemistry. He was a visiting scholar at the Universities of Washington, Cornell University and Harvard University in the USA and at Imperial College, UK. He served as Chair of the Departments of Chemical Research (1980-1989) and Organic Chemistry (1990-1996) at the Weizmann Institute; member and Chair of several National and International Appointments and Promotion committees for Scientists, for Staff-Scientists and for non-scientific staff members of universities in Israel and in Europe; on Steering Committees of international Research Programs in Biotechnology, Life Sciences and Exact Sciences; Chair and Member of Research Grants Committees in Israel and in Europe and on Editorial Board of International Scientific Journals. He serves as Head, Division of Information Systems (Chief Information Officer) of the Weizmann Institute of Science and as Senior Adviser to the President on Information Systems. He served on the Board of Directors of Israel Inter-University Computation Centre (IUCC) ( )(2000-2003), and since 2003 he is Chairman of its Executive Committee.

**Moshe Gottlieb - Director General**

## A.18 *Participant 18: JANET*

### A.18.1 *Description of Organisation*

JANET is the network dedicated to the needs of education and research in the UK. It connects the UK's education and research organisations to each other, as well as to the rest of the world through links to the global Internet. In addition, JANET includes a separate network that is available to the community for experimental activities in network development.

JANET(UK) manages the operation and development of JANET on behalf of JISC (Joint Information Systems Committee) for the UK Further and Higher Education Funding Councils. JISC also works in partnership with the Research Councils.

JANET(UK) is government funded, with the primary aim of providing and developing a network infrastructure that meets the needs of the education and research communities.

The concept of a community underpins everything JANET(UK) does and the network is based on the need for organisations to communicate, collaborate and co-operate in the shared interests of education and research. JANET(UK) offers many feedback mechanisms to ensure that an open communication channel exists between itself and the community it serves.

### A.18.2 *Main Tasks in the project*

JANET's main contribution will be to SA3 and JRA1, with participation in JRA2, JRA3 and NA4.

### A.18.3 *Previous Relevant Experience*

The JANET network connects UK universities, FE Colleges, Research Councils, Specialist Colleges and Adult and Community Learning providers. It also provides connections between the Regional Broadband Consortia to facilitate the UK government's initiative for a national schools' network. Over 18 million end-users are currently served by the JANET network.

The range of activities facilitated by JANET allows individuals and organisations to push back the traditional boundaries of teaching, learning and research methods. For example, JANET's videoconferencing and video streaming capabilities are being used to deliver lectures to remote groups of students. For researchers, the high capacity of the JANET backbone allows the linking of large data storage and high performance computing facilities at a national and international level.

### A.18.4 *Key Personnel*

**Bob Day - Chief Technology Officer –** is one of JANET(UK)'s Executive Directors. He joined originally to oversee the transition of JANET's transmission services from an X.25 base to the use of IP and other Internet protocols. Since then he has had overall responsibility for successive architectural changes to the technology and service models for JANET, and for the accompanying procurement, contractual and policy arrangements. He has also overseen the widening of the JANET user base from serving tertiary education and research, to serving the wider education community across the UK, and in particular the schools' community. Current work involves considerations as to how JANET, as the UK's education and research network, interworks and collaborates with other government and public-sector networks, in particular in the areas of health and of local government. Bob has been JANET(UK)'s main representative to the NREN-PC for many years, and has recently been elected as a non-executive director of DANTE.

**Jeremy Sharp - Head of Strategic Technologies** - is JANET(UK)'s Head of Strategic Technologies. His responsibilities cover the strategic development of the JANET network and the management of a technical programme that identifies emerging technologies and then develops production services.

**Josh Howlett – Technical Specialist: Authentication and Authorisation** - is the technical lead for JANET(UK)'s Authentication, Authorisation and Identity programme. This programme includes activities such as the JANET Roaming Service, the UK's instance of eduroam, the UK Access Management Federation and the OpenSEA Alliance's 802.1X supplicant. Josh also participates in a variety of international collaborative activities, including TERENA's Mobility and EMC2 Task-forces, TERENA ECAM, Internet2 MACE, GN2 JRA5 and the Trusted Computing Group's Trusted Network Connect Working Group.

More information about JANET staff is available at: http://www.ja.net/company/staff/staff.html

## A.19 *Participant 19: LITNET*

### A.19.1 *Description of Organisation*

Academic and Research Network in Lithuania (LITNET) is an association of Academic research and other non-profit organizations. The members of this association use, manage and develop the network. The highest governing body of LITNET is the LITNET Board whose structure and regulations are confirmed by the Ministry of Science and Education in Lithuania. The LITNET Board coordinates the development and the management of the network. The LITNET Network Operating Center (NOC) carries out about network activity. LITNET NOC is located in the Kaunas University of Technology. The main expert of this network is LITNET Technical Expert group. LITNET gets financial support from Ministry of Science and Education. LITNET takes part in several international support programs and projects which are financed by external funds.

More information about LITNET can be found at: www.litnet.lt

### A.19.2 *Main Tasks in the project*

KTU-LITNET will not claim any manpower under the GN3 project. However, they will provide an unfunded contribution applied to the common goals of the consortium in terms of the management of the project as well as the operation of the GÉANT network and its connections to NRENs and higher-level associated services.

### A.19.3 *Previous Relevant Experience*

A 2,5 Gbit/s link connects LITNET to GÉANT. A backup link 100 Mbit/s connection to Teo. A second high capacity is urgently required. The LITNET backbone has 10 Gbit/s links between Vilnius and Kaunas and a ring between the 5 major cities 1 Gbit/s. Leased lines provide 10-50 Mbit/s connectivity to other 26 cities. Number of PoPs on the network (defined as the number of sites where the NRENs manages routing or switching equipment) is 31.

### A.19.4 *Key Personnel*

**Laimutis Telksnys -** is professor in informatics at the Institute of Mathematics and Informatics, Vilnius, Lithuania, and a Member of the Lithuanian Academy of Science. He has been active in the networking area for over 20 years. Key qualifications: Expertise of situation in CEE countries in field of development and usage of ICT, computer networking for research, education, Information Society consolidation (since 1991); Investigation of IT applications for computer networking (1980 – 2003) and multimedia information presentation (1994 – 2003); Investigation theory, computerised methods and applications of recognition of random processes (1965 – 2003).

**Rimantas Kavaliunas -** was head of the Computer-Aided Learning Department of the Computer Centre KTU since 1981. He started work in the networking area from 1991, and has been Head of the LITNET NOC since 1995. He is involved in perspective planning of both LITNET infrastructure and services, and has practical experience in network design, maintenance, monitoring and management.

## A.20 *Participant 20: MARNET*

### A.20.1 *Description of Organisation*

Macedonian Academic and Research Network (MARNET) is an organizational unit of Ss Cyril and Methodius University in Skopje (UKIM), under auspices of the Ministry for Information society. It was founded in 1994 by a Decision of the University Board and endorsement of the Ministry of Science.

MARNET mission is to provide, organize and manage the sole high-quality academic and research eInfrastructure in the country and to disseminate ICT to the academic and research community. Therefore it manages the '.mk' country code top level domain, plan, develop, implement and manage the communication infrastructure backbone in the country as well as attain and maintain international and Internet connectivity for its users. MARNet is also responsible for the provision of membership in the international networking organizations and associations (TERENA, CEEnet and Ripe) and participation in projects of interest for the academic community. In the domestic environment it is obliged to implement different information services and to support the academic and research user community by organizing educational activities and events like workshops help desks etc.

More information about MARNET is available at: dns.marnet.net.mk/index-en.php

### A.20.2 *Main Tasks in the project*

MARNET's main contribution will be to SA2 and JRA2, with participation in SA3 and NA1.

### A.20.3 *Previous Relevant Experience*

MARNet currently operates at 1 Gbps Internet backbone in Skopje based on deployment of the intra-city gigabit infrastructure of own 20 km fiber optics and giga-Ethernet technologies, serving academic community of around 70.000 users. Deployment of own interconnections to other public universities in the country (located in towns Stip, Bitola and Tetovo) is in progress.

MARNet participated in regional network projects, such as the integration of the National Research Networks of South-Eastern Europe (SEEREN www.seeren.org), South-East Europe Fibre Infrastructure for Research and Education (SEFIRE www.seefire.org) and dark fibre network for the region SEELight.

MARNet coordinates Macedonian Academic and Research Grid Initiative (MARGI), representing the national GRID community and integrating research potentials for establishing "human network" in the GRID area of several country institutions as Faculty of Electrical Engineering and Information Tehnologies (FEIT), Institute of Informatics at the Faculty of Science (FNSM) and others. It is part of the SEE-GRID2 www.see-grid.eu and SEE-GRID-SCI www.see-grid-sci.eu project for the grid developments in SEE. UKIM/MARNet participates also in the other regional projects concerning eInfrastructure and ICT development (FP, TEMPUS, Interreg III, NATO Science for Peace program and similar).

MARNet research potential is based on faculty and research staff of FEIT and FSNM. They had deployed two grid clusters utilizing existing expertise in parallel computing and are conducting own research on IPv4 to IPv6 migration of existing academic network in RM. This includes: definitions of generic framework for IPv6 applications and their evaluation, performance evaluation of IPv6 tunnels and QoS provisions, IP mobility and clustering, IP route optimization and embedded security. The theoretical research is combined with experimental results obtained from the operational testbed using IPv6-enabled network elements. MARNET expect to contribute in developing the common regional testbed and work in specific area such as resource management, security, interfaces, virtual organization building and multimedia databases storage and retrieval systems.

### A.20.4 *Key Personnel*

**Margita Kon-Popovska – Chair of Management Board -** received the Diploma in Technical mathematics in 1972, the M.Sc. in Operations research and the PhD in Information and Management Sciences from the University of Ljubljana, Slovenia. She is professor at the Sts Cyril and Methodius University in Skopje, Institute of Informatics and the South East European University in Tetovo. She served in various academic and professional boards, TRACE Board for Yugoslavia (1990), EARN Board of Directors (1993-1994), GA TERENA (from 1994), Director of National Contact Point for Distance education and representative in the Board of National Contact Points for Distance learning of Central and East Europe (1999-2001). She was visiting academic and/or worked on common projects with numerous universities in Europe and US and has participated in various positions including coordinator and co-director in international projects TEMPUS, PHARE, NATO NIG, UNESCO/HP and FP projects MATHIND, Tristan, SEEREN, SEFIRE and SEEGID. Her current research interest is in information technologies in education, e-learning, e-science, distance education, distributed web based database and information systems design and processes, operations research and simulation with visualization.

## A.21 *Participant 21: MREN*

### A.21.1 *Description of Organisation*

Montenegrin Research and Education Network (MREN) was established in June 2005. MREN is the name given to the collection of all networking services and facilities, which support the communication and information requirements of the education and research community in Montenegro. MREN aims to create, promote, offer, participate in and preserve the requisite bases for effective use of modern telecommunication technologies in the education and research in Montenegro. The main mission is to connect MREN to GÉANT.

The main objective of the MREN is to represent and protect the interests of the scientific community of Montenegro in the research communications' area as well as to support further the implementation of information society technologies in all social and economic fields.

University of Montenegro manages the MREN and in the same time coordinates Montenegro GRID Initiative (MGI), established 2006. It is supported by the Ministry of Science and Education of Montenegro. Since MREN and MGI is not a legal entity, they are ruled and legally represented by University of Montenegro (UoM), the only university in Montenegro. Centre Of Information System (CIS) is the main network operation centre (NOC) of the MREN, coordinating the international cooperation and technical network development. At present, all research and education institutions (faculties, institutes, student campus, libraries and National Academy of Sciences and Arts - CANU) are connected to MREN. We estimate that there are altogether more than 20.000 individuals connected to MREN network and use MREN services. UoM/MREN is based on fibre optic infrastructure. CIS UoM is a fulltime member of TERENA as a representative of MREN.

More information about MREN is available at: http://www.mren.ac.me/

### A.21.2 *Main Tasks in the project*

MREN will contribute to activities SA2, SA3, JRA2, NA1 and NA2.

### A.21.3 *Previous Relevant Experience*

Activities of MREN are focused on the management of the National Research &Educational Network, the planning, design and implementation of technological and developmental projects with emphasis in Research Networking and Grid areas, the representation of Montenegro in the field of European and World-wide research networks as well as the promotion of e-business technologies and practices.

CIS UoM/MREN represents: communication core of academic network, academic Internet provider, development centre of complete application software, university eLearning centre (video conferencing, video on demand, LMS,...), provider of MSDN and Cisco academy programs and Grid application development UoM/MREN participated in two FP6 projects SEEREN2 and SEE-GRID2 and many national projects. Government of the Republic of Montenegro recognized CIS UoM as a technical administrator of country code top level domain (ccTLD) for Montenegro (.me).

### A.21.4 *Key Personnel*

**Božo Krstajić – member of MREN Board** – is Associate Professor, Faculty of Electrical Engineering, University of Montenegro and Director of Computer Centre of University of Montenegro (CIS UoM). Education: BSEE 1992, M. Sci. EE 1996, Dr. Sci. 2002 at the University of Montenegro. Career/Employment: - Associate Professor on Faculty of Electrical Engineering (1992-2002) and Director of Computer Center - CIS of University of Montenegro (since 2003). He was visiting professor on University of Shkodres (Albania) 2004-2007. Specialization: Adapting Signal Processing, Operating Systems, Networking. He is member of IEEE. He was national coordinator in FP6 (SEEREN2 and SEE-GRID2) projects.

**Dejan Abazovic – electronics engineer** - studying MS in Computer Science, head of network and communication department in Computer Centre of University of Montenegro. Specialization: system programming, network development and administration, server and database administration, WLAN development, software development and testing.

## A.22 *Participant 22: NIIFI*

### A.22.1 *Description of Organisation*

The management/coordination of the National Information Infrastructure Development Program (NIIF) is provided by NIIFI, the NIIF Institute. NIIFI handles the access for the related community to a wide range of national and international network services, operates HBONE, the community's country-wide private 10 Gbps backbone network, and provides international connectivity to the entire community. In early 2007, almost 700 R&E sites of more than 400 institutions/organisations and about 600.000 users have been served by NIIF/Hungarnet. The budget of NIIFI for academic and research networking within the Hungarnet community in 2006 has been some €7M.

More information about NIIFI is available at: http://www.niif.hu/en

### A.22.2 *Main Tasks in the Project*

NIIFI's main contribution will be to SA3 and SA2, with participation in JRA3, NA1, NA2 and NA3.

### A.22.3 *Previous Relevant Experience*

NIIF/Hungarnet has been continuously developing the Hungarian academic and research network for more than 20 years and intensely participating in international research networking activities from the early 90s. As a member of the TEN-34, QUANTUM (TEN-155 ), and GÉANT consortia, NIIF/Hungarnet gradually developed the country wide research network and its international connectivity – in the early 2000s both the internal network and the international capacity have achieved the 10 Gbps speed. The more than 400 connected user institutions and almost 700.000 individual users within these institutions enjoy a wide spectrum of services, including advanced videoconferencing, VoIP, grid/ClusterGrid, HPC, digital libraries/archives services etc. IPv6 is widely used on the DWDM-based backbone and the access network using multiple technological variants. A number of development projects have been and are running, some of them by EU FP5 and FP6 supported international co-operations (GN1,GN2, 6NET, 6DISS, EGEE-1, EGEE-2, KnowARC, SEEREN-1, SEEREN-2,

SEEFIRE).NIIF/Hungarnet is a partner in several NAs, SAs and JRAs within GN2, including JRA2, JRA3, JRA4 and JRA5. Although the optical segments of the NIIF/Hungarnet infrastructure is dominantly based on leased lambdas, some parts of the network are built on dark fibre CEF, especially within the capital and its neighbourhood. A plan of building an own country-wide successor network based on dark-fibre technologies is planned for the years of 2008 and 2009.

### A.22.4 *Key Personnel*

**Lajos Balint – Vice President** - has graduated and received his MSc, "doctor technicus" and PhD degrees from the Technical University of Budapest, in 1969, 1976, and 1997, respectively. He is Vice President of HUNGARNET, and Director of International Relations at the National Information Infrastructure Development Institute (NIIFI) in Hungary. Earlier he has been affiliated at different research and development organisations in information technology, telecommunications, human-computer interaction, and computer-aided design. He has been working on about 45 grants during the last 38 years. He is a part time Honorary Professor at the Technical University of Budapest and a Professor at the University of Pannonia. He has presented more than 150 publications between 1969 and 2007. Dr. Balint has been a member/representative/officer at a number of national and international professional organisations, including TERENA, DANTE, GÉANT, ENPG, e-IRG, ISOC, NATO AP CNSP, etc.)

**Tamas Maray - Technical Director and Head of R&D** - graduated and received his MSc degree from the Technical University of Budapest at the Faculty of Electrical Engineering as an electrical engineer in 1988. He serves as technical director at NIIFI, the National Information Infrastructure Development Institute. Since 1992 he has been Professor of Informatics at the Technical University of Budapest, Faculty of Electrical Engineering and Informatics. His main areas of activity are: computer networks, networking protocols, system integration, SW engineering. Earlier he has worked for Telematika Co., and for Bertelsmann Co., as a software engineer. Dr. Maray has also been a consultant for the NATO Scientific Program, the EC DG-XII (Etcetera project) and DG-XIII (INCO-Copernicus, FEMIRC projects).

More information about NIIFI staff is available at: http://www.niif.hu/en/organization

## A.23 *Participant 23: NORDUNET*

### A.23.1 *Description of Organisation*

NORDUnet is the regional research & education network for the 5 Nordic countries (Norway, Finland, Sweden, Denmark, Iceland). NORDUnet has more than 25 years of history in state of the art networking for the research community, and has participated in numerous advanced international initiatives, including EU-funding initiatives. Recent initiatives include strong contributions to GN2 and the 6NET project.

NORDUnet today has a fiber-and-DWDM core infrastructure providing lambda and hybrid networking services and a state of the art 10 Gbps IP network. In addition, NORDUnet hosts the Nordic Data Grid Facility (NDGF), an advanced facility for e-Science and grid computing, several high-level services for the research community, and is provides operations and management services through the Nordic University NOC (NUNOC). As such, NORDUnet is a provider of infrastructure for education and (e)science.

### A.23.2 *Main Tasks in the Project*

NORDUnet's main contribution will be to JRA1, SA2, SA3 and NA3, with participation in SA1, JRA2, JRA3 and NA3.

### A.23.3 *Previous Relevant Experience*

NORDUnet has been a major contributor to research networking in Europe since its beginning. It is currently active in the GÉANT2 project and involved in various other EC funded projects, as well as other projects within the international research networking community, some of which are closely focused on user community support, infrastructure creation, and future technologies. NORDUnet is likewise active in the Nordic Infrastructure workgroup and hosts and manages the pan-Nordic grid facility NDGF.

### A.23.4 *Key Personnel*

**René Buch – Chief Executive Officer -** joined NORDUnet in 2005 and has since evolved an all ready capable network organization to a service oriented e-Infrastructure company that serves scientists, students and staff at universities and educational institutions in the Nordic countries. René Buch heads the evolution of the

NORDUnet network into a dark fibre based versatile infrastructure that enables a range of services for the Nordic and global user communities. In addition to the NORDUnet network René Buch has added the capabilities of NUNOC, the Nordic University Network and Infrastructure Operations Centre to the NORDUnet portfolio of services alongside heading the Nordic Data Grid Facility (www.ndgf.org) that support the Nordic Grid community with highly capable production environment. René Buch represent the Nordic Countries in the GÉANT2 Policy Committee and has also been a member of The Nordic Council of Ministers eScience Workgroup. René Buch came to NORDUnet from MCI (Now Verizon Business) where he served as Managing Director and board member for MCI in Denmark and Norway and as the company representative with the Telecommunications Industry association in Denmark. Prior to this René Buch has significant international experience within design, installation & maintenance of high availability computer and communications systems for a number of large international companies. Adding to this René has substantial experience within IT Education and Training and a broad operating systems background within UNIX & Windows OS. René Buch holds a B.Sc. degree in computer engineering from Odense University College of Engineering which has been supplemented with management courses from several acknowledged Management Schools.

**Lars Fischer - Chief Technology Officer -** is responsible for driving development initiatives and projects at NORDUnet, NORDUnet participation in European projects and initiatives (GN2, MANTICORE, and FEDERICA), relationships with European NRENs and the European networking community, coordinating Nordic e-Infrastructure initiatives in collaboration with Nordic partners, working with Nordic advanced users of e-Infrastructure as well as for GRID and high performance computing. Lars Fischer has been at NORDUnet since 2004. Before joining NORDUnet he spent 10 years in the Internet & Telecoms industry as technical director at Tele2 and COLT Telecom. Previous to this, Lars did research in programming systems and collaborative computing environments. While in research, Lars helped establish network infrastructure at Danish academic institutions and establish early research and education networks. Lars has worked with advanced networking and computing systems as a programmer, systems administrator, researcher, and manager for the past 25 years.

**Tony Breach - Optical Network Manager -** joined NORDUnet in the beginning of 2006 and has since been evolved in the selection and deployment of a Dark fibre based versatile infrastructure that enables NORDUnet's Optical Private Network (OPN) and NorthernLight Optical Exchange (NOX). Tony Breach heads the Optical Network Department which encompass highly skilled architects and managers which supports the operation of the NORDUnet OPN, NOX and all related POP facilities. The Optical Network Department acts as a knowledge base for the Nordic NRENs and resources for research and development activities in general for the Global user communities. Tony Breach came from Cybercity (now acquired by Telenor) where he served as senior research and development network architect. Prior to this Tony Breach has served as transmission product manager at Telia Sonera, as Senior Operation Engineer at Powercom. Tony Breach started his career at Dong Energy former NESA as research and development network architect. Tony Breach has significant experience within design, installation & maintenance of transmissions and broadband aggregations systems, design and deployment of operational and support systems for large telecommunications providers. Tony Breach holds a M.Sc. degree in electromagnetic engineering from Aalborg University which has been supplemented with telecommunication courses from several acknowledged Schools.

## A.24 *Participant 24: PIONIER*

### A.24.1 *Description of Organisation*

PIONIER is the name of national research and education network in Poland. PIONIER is operated by Poznan Supercomputing and Networking Center (PSNC) affiliated to the Institute of Bioorganic Chemistry of the Polish Academy of Sciences. The infrastructure is based on dedicated fibres and DWDM equipment owned by PIONIER. The network consists of over 4000km of fibre cable lines interconnecting 21 MANs in Poland, all Polish universities and the Polish Academy of Sciences institutes. PSNC also connects research and development institutes in Poznan, with POZMAN metropolitan area network. This network consists of 220 km of optical fibres equipped with 10Gbps Ethernet technology.

The PIONIER infrastructure is connected to the GÉANT2 network with 10Gbps connection and also fibre links are located at the borders to the Czech Republic, Slovakia and Germany. New fibres are being built to connect the Kaliningrad Region, Lithuania, Belarus and Ukraine.

PSNC is not only building and operating the network infrastructure: as the manager for the Polish NREN, PSNC is responsible for the introduction of new networking technologies and for network expansion. Research and development are performed in cooperation with European partners in the form of IST projects. Another branch

of PSNC activity is the hosting of high performance computers, including SGI, SUN and clusters of 64-bit architecture PC application servers.

More information about PIONIER is available at: http://www.pionier.gov.pl and about PSNC at: www.man.poznan.pl.

### A.24.2 *Main Tasks in the Project*

PIONIER's main contribution will be to SA2 and SA4, with participation in SA1, SA3, JRA1, JRA2, JRA3, NA1, NA3 and NA4.

### A.24.3 *Previous Relevant Experience*

In addition to GN2 activities JRA1, JRA3, JRA4 and SA3, PSNC was participating in multiple national and international projects (SEQUIN, ATRIUM, 6NET, EEGE I/II, MUPBED, COREGRID, CROSSGRID, EMANICS, FEDERICA, etc.). It was/is also a coordinator of pan-European projects GRIDLAB, RINGGRID, PORTA OPTICA STUDY, DORII and PHOSPHORUS.

### A.24.4 *Key Personnel*

**Jan Węglarz -** (Ph.D. 1974, Dr. Habil. 1977), in years 1978-83 Associate Professor and then Professor in the Institute of Computing Science, Poznan University of Technology, member of the Polish Academy of Sciences (PAS), Director of the Institute of Computing Science, Poznan University of Technology and its predecessors since1987, Director of Poznan Supercomputing and Networking Centre. vice President and Scientific Secretary of the Poznan Branch of the PAS, vice President of the Committee for Computer Science of the PAS, member of the State Committee for Scientific Research, Principal Editor of the Foundations of Computing and Decision Sciences, member of several editorial boards, among others Internat. Trans. Opnl. Res. and European J. Opnl Res. Representative of Poland in the Board of Representatives of IFORS and in EURO Council (President of EURO in years 1997-98). Member of several professional and scientific societies, among others the American Mathematical Society and the Operations Research Society of America. Author and co-author of 11 monographs, 3 textbooks (3 editions each) and over 200 papers in major professional journals and conference proceedings. Frequent visitor in major research centres in Europe and in the USA Co-laureate of the State Award (1988) and the EURO Gold Medal (1991), laureate of the Foundation for Polish Science Award (2000).

**Artur Binczewski -** received his M. Sc. degree in Computer Science from the Poznan University of Technology in 1993. His research interests concern computer networks, routing, multicasting and management. He is the Manager of Network Division at the Poznan Supercomputing and Networking Center. He was involved in several EC projects: SEQUIN, ATRIUM, 6NET and others. He coordinates the Porta Optica Study and Phosphorus projects. His research interests concern computer network protocols and management. He is author or co-author of papers in major professional journals and conference proceedings. He takes an active part in the development of the PIONIER fibre network.

## A.25 *Participant 25: RedIRIS*

Red.es is a public entity which belongs to the Spanish Ministry for Industry, Trade and Tourism, through its State Department for Telecommunications and Information Society. Red.es, inter alia, manages the Registry for domain names under ".es", manages several programmes related to the promotion of Information Society, provides some e-government services and manages RedIRIS, the Spanish Research and Academic Network. Red.es will participate in this project through its Department RedIRIS (http://www.rediris.es). RedIRIS, with a staff of approx. 25 people, has over 300 institutions currently connected, such as universities, technological centres, research centres and units of biomedical investigation.

RedIRIS manages a national backbone with 18 regional nodes (one in each autonomous region). RedIRIS has a network of high capacity, with a core backbone of 10 Gbps, and a dark fibre connection to the Pan-European Research and Education Network GÉANT2. At the networking level, RedIRIS continuously develops new services (IPv6, L2 VPN, multicast) to support the high level requirements of the research community. RedIRIS also provides middleware, applications and services to the affiliated institutions: it coordinates a Spanish Grid initiative, IRISGRID and has developed its own AAI, PAPI. It manages a security team, promotes a mobility project (Eduroam), provides distribution lists to researchers, etc.

RedIRIS participates in several EU-funded projects, such as GN2, MUPBED, ALICE, EUMEDCONNECT, EGEE-II, EUMEDGRID and EELA.

More information about Red.es is available at: http://www.red.es

### A.25.1 *Main Tasks in the Project*

RedIRIS' main contribution will be to JRA3, with participation in SA2, SA3, SA4, JRA2 and NA1.

### A.25.2 *Previous Relevant Experience*

RedIRIS participates in several research and development projects funded by the EU: GN2, MUPBED, ALICE, EUMEDCONNECT, EGEE-II, EUMEDGRID and EELA.

In the field of networking, the experience of RedIRIS in GN2 and MUPBED is particularly relevant. In GN2 RedIRIS, together with other National Research and Education Networks, is involved in the JRA related to network monitoring, security, Bandwidth on Demand and QoS, AAI, mobility, etc. In MUPBED, RedIRIS has provided support for the deployment of services related to the validation of advance network protocols (ASON/GMPLS).

RedIRIS has led the AAI work item in GN2, playing a key role in developing and deploying eduGAIN, and providing AA services to the perfSONAR and AutoBAHN initiatives. RedIRIS also collaborates with the European industry through the ITEA OSIRIS project.

RedIRIS also collaborates with universities, research groups and vendors. For example, it is currently involved in a collaboration project with Cisco, related to the testing of advanced functionalities on its high-capacity router CRS-1.

### A.25.3 *Key Personnel*

**Tomas de Miguel, Director** - has a Doctorate Engineer of Telecommunications, from the Polytechnical University of Madrid and is a Professor Titular of University in the Department of Engineering of Telematics Systems of the ETSI Telecommunication UPM from 1988.

**Alberto Perez - Deputy Director for International Relations -** is RED.es Deputy Director for International Relations and actively participates in all NREN Policy Committee deliberations.

## A.26 *Participant 26: RENATER*

### A.26.1 *Description of Organisation*

RENATER, French Research and Education Network, was deployed in the early 90s in order to federate telecommunication infrastructures for Research and Education. To achieve this goal, a non profit organisation called "Groupement d'Intérêt Public" RENATER was created in January 1993. Members of the GIP RENATER are eminent French Research organisations (CEA, CIRAD, CNES, CNRS, INRA, INRIA, INSERM, BRGM, CEMAGREF and IRD), and the French Ministries for Education and for Higher Education and Research.

Staff headcount is about 35 for the GIP ("Groupement d'Intérêt Public") RENATER. Office premises are in Paris (ENSAM) and in Montpellier (CINES).

More information about RENATER is available at: http://www.renater.fr

### A.26.2 *Main Tasks in the project*

RENATER will contribute to activities SA2, SA3, JRA1, JRA2 and JRA3.

### A.26.3 *Previous Relevant Experience*

Today about 1000 sites involved in research, technology and education are interconnected through RENATER infrastructure. This network makes possible for these sites to exchange data and have access to the whole Internet. This network is a national backbone and is connected to other Research and Education networks through very high speed GÉANT links. It does also connect French overseas territories (Pacific, Atlantic and Indian ocean areas).

The major characteristics of RENATER network are:

- A meshed backbone with 10 Gbps links or dark fibre between the points of presence.
- The use of advanced routing techniques to efficiently distribute traffic on the network links.
- A high availability and implementation of Classes of services.

- End-to-end services with a very high capacity can be offered through dedicated lambdas, nationally and internationally as well.

RENATER has several 10 Gbps connections to GÉANT to reach other research and education networks in the world for IP connectivity and for specific research projects. Interconnection with the Internet is done through the Internet eXchange SFINX managed by RENATER in Paris, where more then 80 ISPs exchange traffic. RENATER also has 2x10 Gbps connections to 2 transit providers to get access to the rest of the Internet.

Services are offered to users who are compliant to RENATER AUP. Among these services, we can underline IPv6, IP multicast, QoS, videoconferencing, Eduroam, dedicated CERT, various VPN capabilities and advanced monitoring.

### A.26.4 *Key Personnel*

**Dany Vandromme – Director -** has been a university professor since 1988 at the National Institute for Applied Sciences at Rouen. As a researcher, he is responsible for the Computational Fluid Dynamics Laboratory (LMFN), a component of CORIA, UMR 6614 of CNRS (National Centre for Scientific Research). His research domain is numerical modelling applied to supersonic and reactive flows with a special interest for turbulence physics. Responsible for the regional network SYRHANO (Upper Normandy region) since its beginning in 1993, and chairman of the networking and computing Centre of Upper Normandy (CRIHAN) since its creation (1992), Dany Vandromme has been a user of ARPANET in the early 80s, and, later on, of INTERNET, as a post-doc and associate research fellow at NASA Ames Research Center from 1980 to 1990. He was in charge of the networking and computing activities at the Engineering Sciences Department of CNRS from 1993 to 1998. He has been Director of GIP RENATER since July 1st, 1998. As Director of RENATER, Dany Vandromme works on evolutions of the public Internet in France, on technical aspects as well as on economy models, suited to the specific requirements of the research and education community. Dany Vandromme represents RENATER in the European NREN consortium in charge of GÉANT. From January 2001 to December 2006, he has also served as a member of the DANTE Board of Directors, and from January 2003 to December 2004, as Chairman of the DANTE Board. Dany Vandromme is one of the French representatives in the European Strategy Forum for Research Infrastructures (ESFRI) and in eIRG.

**Sabine Jaume-Rajaonia – External Relations Director -** joined RENATER in 1995, after graduating from the National Institute for Telecommunications (INT- Evry, France). At RENATER, she was initially responsible for external relations. Later on, she became responsible as well for RENATER's international affairs and for the launch of the French Internet Exchange (SFINX). She is active in the development of the European Network dedicated to research and academic users (TEN 34, TEN 155 and now in each generation of the GÉANT network) by participating in the policy committee. She is also taking part in building the EUMEDCONNECT network. Former Member at Large of the TERENA Executive Committee, she has also been active in the SERENATE project and in the EARNEST study.

**Franck Simon - Chief Technical Officer** – joined RENATER in 1995, after graduating in Computer Science from the Robert Gordon University (Scotland - United Kingdom).

He started at RENATER as a network engineer, and then became responsible for the Network Operations Service team. The role of the Network Operations Service is to manage the overall QoS of the RENATER network, and to be the main contact with the RENATER NOC for the day to day management of the network. As his job included the management of the backbone evolutions, the network architecture design, and deployment/integration of new services, he did manage the overall deployment of the national RENATER network each time major changes were planned.

In 2006, Franck Simon became the RENATER Chief Technical Officer and since he does pilot the three main technical activities of the technical department (Network Operations Service, Advanced IP and Optical technologies service, and security service – RENATER-CERT).

He is also the SFINX technical manager, the SFINX being one of the major GIX in France, and an important GIX in Europe. He is in relation with all the other GÉANT NRENs, especially via its role of French Access Point Manager (APM).

More information about RENATER staff is available at: http://www.renater.fr/spip.php?article179&lang=en

## A.27 *Participant 27: RESTENA*

### A.27.1 *Description of Organisation*

RESTENA is the very high speed network for the education and research community of the Grand Duchy of Luxembourg. Operational since 1989 and connected to the global Internet in 1992, the network is today deployed and operated by the RESTENA Foundation.

The primary objective is to provide network services for all public and private institutions and organisations involved in the field of education, research, culture, health and administration, providing them with cutting-edge solutions for their communications needs.

Set up in 2000, the Foundation brings together all types of research and teaching bodies, as well as the ministries for education, research and of finance.

The Foundation also co-ordinates Internet resources nationally, managing .LU domain names, and providing a neutral platform for the interchange of national Internet traffic.

More information about RESTENA is available at: http://www.restena.lu

### A.27.2 *Main Tasks in the project*

RESTENA's main contribution will be to JRA3, with participation in SA3 and NA4.

### A.27.3 *Previous Relevant Experience*

The RESTENA network (Réseau Téléinformatique de l'Education Nationale et de la Recherche) was installed in 1989 by the Ministry of Education to respond to the communication needs of the Luxembourg education and research community. Since 1992, when RESTENA first connected to the Internet through the EUROPANET backbone, the connectivity has increased considerably in order to match the ongoing demands of Internet services.

Additionally, some key Internet services are operated by the RESTENA Foundation. The Foundation manages the Domain Name Service for the Internet top-level domain .lu for Luxembourg and operates the Luxembourg Internet eXchange (LIX), a facility for Internet Service Providers based in Luxembourg to easily interconnect within Luxembourg.

Together with the other European NRENs, the RESTENA Foundation is part of the international organisation TERENA.

As registry for the Luxembourg Internet top-level domain, the RESTENA Foundation keeps up with the international developments concerning the reorganisation of Internet name space and represents Luxembourg at the European and international level as well in CENTR (Council of European Top Level Domain Registries) and in the domain name supporting organisation of ICANN.

### A.27.4 *Key Personnel*

**Théo Duhautpas – Director** - is one of the initiators of the RESTENA project and, currently with Antoine Barthel, Director of the RESTENA Foundation. He has a diploma as electrical engineer of the Swiss Federal Institute of Technology of Zurich and is professor for network and telecommunications at the Computer Science Department of the Institut Supérieur de Technologie, now part of the University of Luxembourg. He has been a project manager of RESTENA from the COSINE Project to the current GéANT project.

**Antoine Barthel – Director**

## A.28 *Participant 28: RoEduNet*

### A.28.1 *Description of Organisation*

Romanian Education Network, or RoEduNet, is an organization and in the same time a data communication system, which connects a large number of Local Area Networks to a national WAN data communication infrastructure. This infrastructure is operated by Network Operations Centers (NOCs) in Bucharest, Galati, Iaşi, Târgu-Mureş, Cluj, Timişoara and Craiova. The aim of this technical complex is to offer the participants - universities, high schools, cultural, scientific and research non-profit institutions - the means to communicate with each other, as well as to have access to Internet information resources.

RoEduNet was officially founded in august 1998, through a Romanian Government Decision (HG 515/August 21st, 1998 modified by HG 1056/September 8th 2005) as a separate institution under Romanian Ministry of Education and Research administration.

More information about RoEduNet is available at: www.roedu.net

### A.28.2 *Main Tasks in the project*

RoEduNet's main contribution will be to JRA2, with participation from SA1, SA2, SA3, JRA1 and NA1.

### A.28.3 *Previous Relevant Experience*

RoEduNet act as Romanian NREN (National Research and Education Network) and it is a member of the GÉANT consortium as well as a member of TERENA and CEENet (Central and East European Networking Association).

### A.28.4 *Key Personnel*

**Octavian RUSU - General Manager -** has a PhD in Electronic Physics and he is also Associate Professor at the Alexandru Ioan Cuza University in Iasi Romania (selected courses: Computer Networks, Operation Systems, UNIX, and Medical Electronic). From 1996 he also manages the Digital Communications Department at Alexandru Ioan Cuza University that is in charge of the development, operation and maintenance of University's campus computer and telephony network. He has published 39 scientific articles and was involved in several national and international projects. The most relevant are: co-director for two NATO grants: Consolidation of Romanian Education Network in N-E of Romania and RENAM-RoEduNet networks direct link and gateway construction and Work Package leader in SEEREN project. He is member of IEEE Computer Society and IEEE Communications Society.

## A.29 *Participant 29: SANET*

### A.29.1 *Description of Organisation*

The SANET Association was established in Bratislava in 1991 and network was set in operation in January 1992. SANET is a legal body founded by the Slovak Government through Ministry of Education. SANET provides network service to its members which are primarily academic and scientific institutions, universities, other high educational institutes, as well as other organisations with significant links to academic institutions as a libraries, public health-care organisation and marginal also governmental institutes and other organisations with cooperation on scientific programs.

SANET is involved in several important networking organisations as a member or participant. These are TERENA, CEENET and also participate to GÉANT2 project as a member of NREN PC consortium.

More information about SANET is available at: http://www.sanet.sk/

### A.29.2 *Main Tasks in the project*

SANET will not claim any manpower under the GN3 project. However, they will provide an unfunded contribution applied to the common goals of the consortium in terms of the management of the project as well as the operation of the GÉANT network and its connections to NRENs and higher-level associated services.

### A.29.3 *Previous Relevant Experience*

The SANET network is build in frame of SANET2 project and at this time it covers 23 towns. The network infrastructure is based on leased dark fibres, which are terminated in Cisco Catalyst gigabit ethernet switches. Building of SANET network went through two phases. The first one started in July 2001 and was finnished in February 2002 Second phase started in March 2002 and was finished in January 2003. At this time all main nodes of SANET network topology are fully functional. SANET Network is configured as two ring providing full redundancy with maximum delay 5ms. The national connectivity is realized through the Ethernet link in to Slovak Peering Center SIX placed in Computer Center of the Slovak Technical University (CVT STU) in Bratislava. Its speed is 10Gbps. The foreign connectivity is realized through leased dark fibre at the speed 10Gbps to ACOnet node in Viena (AT), CESNET node in Brno (CZ), Pioner node in Bielsko-Biala (PL) and local link to GEAT PoP in Bratislava (1Gbps) and GTS PoP in Bratislava (1,2Gbps).

At present, SANET provides

- Access to the SANET network.
- Access to the European academic gigabit network GÉANT.
- Access to the global Internet.

It is through:

- Dial - IP (analog/ISDN).
- Fixed line (19,2 Kbps - 2 Mbps).
- Microwave connection.
- Optical cable up to speed 1 Gbps.

In addition to access services, the SANET provides:

- WWW hosting and housing.
- Mail hosting (access through POP3 or UUCP).
- DNS hosting.

### A.29.4 *Key Personnel*

**Pavol HORVATH – President –** Director of University Computing Centre, gives lectures at the Faculty of Informatics and Information Technologies at the SuoT. Since 1991 president of SANET and deputy of Association of Network Providers. He leads several country projects in the informatics and networking areas. His professional interests are Networking and Information Systems.

## A.30 *Participant 30: SIGMANET*

### A.30.1 *Description of Organisation*

Institute of Mathematics and Computer Science, University of Latvia (IMCS UL) is the host organisation for SigmaNet, the Latvian National Research and Education network. IMCS UL is the leading research institution of mathematics and computer science in Latvia. It conducts research in Internet technologies and their applications, system modelling and design, simulation of physical and technological processes, natural language processing, etc.

SigmaNet is a successor of LATNET, which was established in 1992 and since then has provided Internet services for the academic community in Latvia, including connectivity to GÉANT and GÉANT2, hosting, e-mail services, Grid resources, etc. In 2007 due to internal changes the name of the NREN was changed to SigmaNet.

More information about the IMCS UL can be found at http://www.lumii.lv/ and about SigmaNet at http://www.sigmanet.lv/?lang=en.

### A.30.2 *Main Tasks in the project*

SigmaNet's main contribution will be to SA2, with participation in NA1 and NA2.

### A.30.3 *Previous Relevant Experience*

SigmaNet is participating in the FP7 project BalticGrid2 and has participated in several FP6 projects, e.g. BalticGrid, Porta Optica Study, GN2, etc. SigmaNet has been very active in structural funds projects as well, including Latvian Grid project and Baltic Rural Broadband project.

The current international connection of SigmaNet is a 1 Gbps channel to the GÉANT2 network, which will be upgraded to 2,5 Gbps in 2008.

### A.30.4 *Key Personnel*

***Baiba Kaškina*** - **Acting General Manager and Researcher** - at SigmaNet participating in several projects including Grid related activities, CERT team as well as the network monitoring and optical technologies areas, day-to-day management of SigmaNet is also performed by her. Baiba Kaškina used to work in the Latvian NREN NOC and has strong network management and monitoring background. She worked at TERENA as the Project Development Officer and has extensive experience in management and coordination of multinational

projects and activities. Baiba Kaškina holds a MSc in Computer Science from the University of Latvia and has been working at IMCS UL since 1995.

***Katrina Sataki*** - **Researcher and Project Manager** - at SigmaNet. She holds a MSc in Computer Science and BS in Law from the University of Latvia. Katrina Sataki is the Network provisioning activity leader in the BalticGrid2 project and has experience of managing and participating in other EC funded projects. She is also managing the TDL .LV department at IMCS UL. Her areas of expertise are network provisioning, DNS, legal issues, dissemination. Katrina Sataki is working at IMCS UL since 1995.

## A.31 *Participant 31: SURFnet*

### A.31.1 *Description of Organisation*

SURFnet enables groundbreaking education and research. The company designed and operates the hybrid SURFnet6 network and provides innovative services in the field of security, authentication and authorisation, group communication and video. Due to sustained innovation its users always have one of the world's fastest and most advanced networks at their disposal enabling system level research and multimedia collaboration between institutions, researchers and students. SURFnet's activities are a stimulus for the innovation and use of new communications facilities in other areas in the Netherlands and as such is an engine for innovation that strengthen the whole economy.

SURFnet is a subsidiary of Stichting SURF, in which Dutch universities, universities for applied sciences and research centres collaborate nationally and internationally on innovative ICT facilities. Other subsidiaries of the SURF organisation are SURFfoundation and SURFdiensten.

More information about SURFnet is available at: http://www.surfnet.nl/

### A.31.2 *Main Tasks in the project*

SURFnet's main contribution will be to JRA2 and JRA3, with participation in SA3 and JRA1.

### A.31.3 *Previous Relevant Experience*

The SURFnet network is the national computer network for higher education and research in the Netherlands, and is delivering advanced communication services to its constituency since the mid 80's of the last century. SURFnet is one of the founders of the Amsterdam Internet Exchange (AMS-IX) that is currently the largest Internet Exchange in the world, and is the founder of NetherLight, the GLIF Open Lightpath Exchange in Amsterdam, The Netherlands. SURFnet6, the national high-performance network infrastructure became operational since 2005 as the first country-wide hybrid network in the world with Dark Fibre connections to all connected institutions. Currently, SURFnet owns and operates 9000 km of dark fibre pairs, of which the most part is equipped with high-end DWDM equipment capable of scaling up to 72 wavelengths of 40 Gbit/s each, per fibre pair.

Connecting to the SURFnet-network is restricted to the following organisations:

- Universities.
- Academic hospitals and teaching hospitals.
- Institutes for higher professional education.
- Research institutes.
- Corporate R & D departments.
- Scientific libraries.
- Other organisations funded by the Ministry of Education, Culture and Sciences.

The communication and information services provided to these institutions include full Internet connectivity and are intended for both the staff and the students of the connected institutions. On SURFnet6, lightpath services are available to almost all 160 connected institutions.

### A.31.4 *Key Personnel*

**Erik-Jan Bos – Managing Director -** Since January 2007, Erik-Jan is one of the Managing Directors of SURFnet. He holds a Master of Science degree from Delft University of Technology, where he graduated Cum Laude in 1987 at the Faculty of Electrical Engineering. After his study Erik-Jan joined SURFnet where he has

been responsible for all lower layers of SURFnet's infrastructure. During this period, he was heading the group that was responsible for the design and the building of many generations of SURFnet's infrastructure, including the most recent one SURFnet6, the world's first hybrid optical and packet switching network. He also played a key role, in the GigaPort Projects, in the development of the GLIF Open Lightpath Exchange point in Amsterdam, NetherLight, in close collaboration with researchers in Amsterdam, Chicago and Canada. One of Erik-Jan's current responsibilities is co-chair of the GLIF WG on Technology and Control Planes.

**Kees Neggers - Managing Director** - has been Managing Director of SURFnet since the start of the company in 1988. He has been a key player in the technical and organisational evolution of research networking and the Internet. He was involved as an initiator and Board member in several International network related organizations such as RARE, TERENA, Ebone, Internet Society and RIPE NCC. He is the European Co-Chair of the CCIRN, the Coordinating Committee for Intercontinental research networking and Chairman of GLIF, the international virtual organization that pioneers, promotes and coordinates the development and use of lambda networking for the research and education community worldwide.

## A.32 *Participant 32: SWITCH*

### A.32.1 *Description of Organisation*

SWITCH is a foundation with the Task of "creating the necessary base for an efficient use of leading-edge telecommunication methods at the service of higher education and research in Switzerland, offering such services and participating in their elaboration and maintenance" (statutes of SWITCH). The members of the foundation are the Swiss Confederation and eight "cantons" supporting a University. SWITCH provides services to all the Universities, the Universities of applied sciences, the Universities of Teacher Education, the two Federal Institutes of Technology, and several research sites in Switzerland. A team of 55 persons at the Zurich Head Office is responsible for the operation and development of the services. SWITCH meets the needs of Swiss universities by:

- Providing customised access to SWITCH's own national network with high-quality Internet technologies.
- Providing fast connections to the world wide research networks (SWITCH is partner in the current GN2 project) as well as the commodity Internet.
- Providing advanced network services which are not available on the market.
- Maintaining excellent international contacts.

Today, the SWITCH national network is based on long-term lease of dark fibre and use of DWDM/CWDM (dense/coarse wavelength division multiplexing). This infrastructure allows SWITCH to offer to its users very high bandwidth as well as separate connections (in the 1 to 10 Gbps range) for especially demanding projects. Over the past years SWITCH has gained considerable expertise in optical networking.

More information about SWITCH is available at: www.switch.ch

### A.32.2 *Main Tasks in the project*

SWITCH's main contribution will be to SA2, with participation in SA3 and JRA3.

### A.32.3 *Previous Relevant Experience*

SWITCH has experience of many years in running an NREN and supporting academic users. Since 2001 SWITCH has built its own dark fibre based network and gathered significant experience in optical networking. SWITCH has actively participated in several previous FP projects, like Sequin, 6NET, GÉANT and is currently involved in GN2 (focusing on JRA1 Multi-domain monitoring and SA3 PERT) as well as in EGEE-III and FEDERICA.

### A.32.4 *Key Personnel*

**Thomas Brunner - Managing Director -** studied mathematics at the Swiss Federal Institute of Technology (ETH) in Zurich. He began his professional career in 1972 working as a systems programmer in the Institute's computer centre. Later he assumed responsibility for all data communications at the ETH, a position he held until joining SWITCH. From 1980 to 1983, Thomas was Chairman of the Communications Committee of ECODU (European Control Data Users), and in 1981 laid the foundation for what is today the Swiss research and education network. In May 1988 Thomas joined SWITCH, the Swiss research and education network, as Deputy Director. He was appointed Technical Director in 1995 and since 2001 has held the position of Managing Director. During his career, Thomas has always been (and will continue to be in future) significantly

involved in creating and promoting the necessary basis for the effective use of modern methods of telecomputing in teaching and research in Switzerland.

**Willi Huber – Head of Networking -** In December 1974, he completed his education with the Masters degree "Dipl. Elektro-Ingenieur ETH" at the Swiss Federal Institute of Technology Zurich. After his studies he has worked for sixteen years at the computer centre of ETH, first as a system programmer for the central mainframe computer, later in the area of the upcoming data communications. In 1991 he joined SWITCH, the organisation that runs the Swiss academic and research network. Today he is head of the business unit "Network" and thus responsible for the "lower layers" of the SWITCH network.

**Ann Harding - Network Engineer** - has worked for SWITCH since 2007, focusing on service management issues and the development of service-specific key performance indicators. Before joining SWITCH, Ann also worked for HEAnet from 2000 to 2007 as a network engineer and as Network Operations Manager from 2002. Her main duties were network management, SLA management, change control, problem management and day-to-day operations of the HEAnet NOC. She was HEAnet's APM for GÉANT and GÉANT2 and was co-chair of a TERENA Task Force on Life Cycle and Portfolio Management for NRENs and continues her involvement in the subsequent Task Force on Management of Service Portfolios (TF-MSP).

## A.33 *Participant 33: ULAKBIM*

### A.33.1 *Description of Organisation*

Turkish Academic Network and Information Center (ULAKBİM) has been founded as a R&D service unit of TÜBİTAK, in 1996. The Scientific and Technological Research Council of Turkey – TÜBİTAK, founded in 1963, is the supreme organization put in charge of promoting, developing, organizing and coordinating research and development in the fields of exact sciences in Turkey in line with the National targets of economic development and technical progress. It functions under the fold of the Prime Ministry with adequate administrative and financial autonomy.

ULAKBİM's main objectives have been set as operating a computer network enabling interaction within the institutional elements of National innovation system, and providing information technologies support and information services to help scientific production.

ULAKBİM aims at providing technological facilities such as computer networks, information technology support, and information and document delivery services, to meet the information requirements of universities and research institutions, and to increase the efficiency and productivity of their end users. This have been achieved by operating a computer network enabling interaction within the institutional elements of National innovation system, and providing information services to help scientific production.

### A.33.2 *Main Tasks in the project*

ULAKBIM's main contribution will be to JRA2, with participation in SA2 and SA3.

### A.33.3 *Previous Relevant Experience*

ULAKNET provides network connectivity of universities and research institutes with similar institutions in Turkey and abroad. For ULAKBIM to provide services in order to be able to fulfil its primary duties, there is need for a high-speed reliable backbone and external connections. The main goal of ULAKBIM is to provide network services always one step ahead of the expectations of its users, made up of 100,000 academic personnel and more than 2.2 million university students.

ULAKBİM is a partner of GÉANT2 and ULAKNET backbone is interconnected with the trans-European Research Network GÉANT2 with 2.5 Gbps capacity and an upgrade on this link is in process. ULAKNET backbone consists of three PoPs located in Ankara, İstanbul and İzmir and the backbone links are 1 Gbps, 500 Mbps and 500 Mbps accordingly.

In addition it is member of of RIPE (Réseaux IP Européens), TERENA (Trans-European Research & Education Networking Association) and CEEnet (Central & Eastern European Networking Association).

The following organizations which are the institutional elements of the national innovation system are among the institutional users of ULAKBİM:

- Universities.
- National science and technology organizations.

- National information and documentation centres.
- The organizations which offer support, make evaluations, and determine policy and strategy, for research and development.
- The national metrology, accreditation, and documentation centres.
- Technology observation and evaluation centres.
- Test laboratories
- New technology display centres.
- Technology support units.
- Technoparks, science parks and technocities.
- Patent offices.

ULAKBİM leads and coordinates the activities of independent research communities in parallel processing towards a Turkish Grid representing the TR-Grid National Initiative (http://www.grid.org.tr) and organizes meetings and workshops to enable information exchange and knowledge dissemination on parallel processing and Grid computing.

### A.33.4 *Key Personnel*

**Cem Sarac - Executive Director -** is Professor of Engineering at the University of Hacettepe and Director of ULAKBIM (Turkish Academic Network and Information Centre). He holds a Ph.D. from Leeds University, U.K. His current interests are mainly related to computer modelling and simulation techniques. He has been acting as a director of several institutions in Turkey for eleven years in informatics technologies.

**Serkan Orcan - Deputy Director -** graduated from the Computer Engineering Department of Middle East Technical University. He also received his MS degree in Science and Technology Policy Studies of Middle East Technical University. His major areas of interest are national innovation systems, telecommunication, research and education networks.

## A.34 *Participant 34: University of Malta (UoM)*

### A.34.1 *Description of Organisation*

The University of Malta is the highest teaching institution in Malta. There are some 10,000 students including over 750 foreign/exchange students from nearly 80 different countries, following full-time or part-time degree and diploma courses. There are a further 3,000 pre-tertiary students at the Junior College which is also managed by the University.

University IT Services manages the University's IT infrastructure and offers a range of facilities and services to assist members of staff and students with their IT-related needs.

Through its IT Services, UoM manages the Maltese National Research & Education Network and also provides operations and technical support to the Malta Internet Foundation which is responsible for the .MT top-level Internet domain for Malta.

More information about the University of Malta and IT Services can be found at www.um.edu.mt and www.um.edu.mt/itservices.

### A.34.2 *Main Tasks in the project*

UoM will not claim any manpower under the GN3 project. However, they will provide an unfunded contribution applied to the common goals of the consortium in terms of the management of the project as well as the operation of the GÉANT network and its connections to NRENs and higher-level associated services.

### A.34.3 *Previous Relevant Experience*

The UoM IT Services manages the Maltese National Research & Education Network, provisioning access to the GÉANT2 network to the University and to other educational and research institutions in Malta. UoM has been participating in other related projects such as GÉANT, EUMEDCONNECT and EUMEDGRID.

### A.34.4 *Key Personnel*

**Robert Sultana – CIO & Director of IT Services –** will coordinate UoM's participation in GN3. He has been director of IT Services (previously called Computing Services Centre) since its inception in 1996 and has

coordinated UoM's participation in the GÉANT, GÉANT2, EUMEDCONNECT and EUMEDGRID projects. He also represents UoM in TERENA, UCISA and EUNIS, and is a Member of the Board of Directors of EUNIS. Robert Sultana is a Member of the Board of the Malta Internet Foundation and the coordinator of NIC Malta (.mt registry) operations.

**Victor Buttigieg - Member of the University IT Services Management Committee** – will act as scientific adviser for UoM in GN3. Dr Buttigieg is also Deputy Dean of the Faculty of ICT and Head of Computer Communication Engineering Department.

**Dave Mifsud – Head of Technical Services, IT Services –** will be coordinating on technical matters in GN3 for UoM. Dave has been the backbone of IT Services technical operations for the past ten years.

# Appendix B *Additional Information about Associate Partners of the Consortium*

**JSCC (Joint Super Computing Center of the Russian Academy of Science)**

A partner in the GN2 (FP6) project, assigned by the Russian Government to represent all Research & Education networking communities of the Russian Federation vis-à-vis GÉANT. It currently is an integral part of the GÉANT2 backbone network, hosting its Point of Presence in Moscow.

Key personnel includes Academician Genady Sabin (the JSCC Director) and Marat Biktimirov.

**URAN (Ukrainian Research & Academic Network)**

URAN currently holds an interconnection agreement with GÉANT2, physically implemented via the Polish NREN (PIONIER). It is governed by the Association of Users of URAN, led by Prof. Yuriy Yakimenko (Chairman) and Mikhail Dombrougov (Executive Director).

**BASNET (Belarusian Research Network)**

BASNET is affiliated with the United Institute of Informatics Problems, National Academy of Sciences, led by Prof. Sergey Ablameyko.

BASNET will be represented by Dr. Uladzimir Anishchanka and Sergey Aneichik.

**RENAM Association (NREN of Moldova)**

RENAM currently holds an interconnection agreement with GÉANT2, physically implemented via the Romanian NREN (RoEduNEt).

It is led by Prof. Academician Andrei Andries (Co-president & General Director) and Dr. Petru Bogatencov (Vice-Executive Director).

# Appendix C Supporting Information

## C.1 *NOMENCLATURE FOR MILESTONES AND DELIVERABLES*

The following nomenclature has been used when assigning numbered codes to Deliverables and Milestones. The codes are designed to easily determine which Deliverables and Milestones belong to which Activity and Task.

**Letters:**

M – Milestone; D – Deliverable; N - Networking Activity, S – Specific Service Activity, J – Joint Research Activity

**Numbers (in order from the left, as written):**

| | |
|---|---|
| First number | - Number of Activity |
| Second number | - Number of Task in that Activity (zero [0] if no Tasks exist in that Activity) |
| Third number | - Number of Deliverable (in that Task, in that Activity) |
| Fourth number | - Iteration sequence of an iterative Deliverable (such as Annual, Monthly reports, updated versions etc.). Note that ,n (comma n) is used as a generic demarcation of iterations with values 1 to n, depending on the number of iterations. |

**Examples:**

| | |
|---|---|
| DN2.2.1,3 | – Third iteration (updated edition or version) of Deliverable 1 of Task 2 of Networking Activity 2 (NA2) |
| MJ4.1.5 | - Milestone 5 of Task 1 of Joint Research Activity 4 (JRA4) |

## C.2 *CORRELATION OF EXPECTED PROJECT DATES WITH CALENDAR DATES*

For planning purposes, it is assumed that GN3 will start on 1 March 2009. March 2009 is therefore month 1 (M1) of GN3. All subsequent months should be numbered accordingly. Table below provides an easy reference for correlation of project dates with calendar dates.

| Project year | Calendar year | Project month | Calendar month |
|---|---|---|---|
| | | 1 | Mar-09 |
| | | 2 | Apr-09 |
| | | 3 | May-09 |
| | | 4 | Jun-09 |
| | | 5 | Jul-09 |
| | | 6 | Aug-09 |
| | | 7 | Sep-09 |
| | | 8 | Oct-09 |
| | | 9 | Nov-09 |
| | 2009 | 10 | Dec-09 |
| | | 11 | Jan-10 |
| Y1 | | 12 | Feb-10 |
| | | 13 | Mar-10 |
| | | 14 | Apr-10 |
| | | 15 | May-10 |
| | | 16 | Jun-10 |
| | | 17 | Jul-10 |
| Y2 | 2010 | 18 | Aug-10 |