FIREworks

D2.6 Consolidated Requirements of FIRE projects from GEANT

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Abstract

In order to build a European Experimental Facility the key elements and infrastructures need to be identified and their interfaces specified. Moreover, Europe cannot afford to waste any resources, but synergies and commitment need to be found and common vision for all parties developed. Not only there is a lesson to be learnt from the nearly fifty-year history of national research and education networks (NREN), in cooperation with FIRE (Future internet Research and Experimentation) initiative there is a huge mutual potential of resources to be utilised in terms of physical and knowledge capacity. FIRE is vivid, agile and hungry, despite its size and age well-linked to international experimental networks. It is complementary to NREN offerings, but could a) utilise the massive resources, b) offer services and tools for GEANT development. Sustainability, governance, as well as transparent and competitive business models are challenges to be overcome in addition to the technical issues. However, the same way as in the birth of NRENs, parties can be brought together and large-scale achieved also in terms of diversity.

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Executive summary

Research networking activity has been considered as an important stake in order to maintain European competitiveness and supporting economic development. Future Internet Research and Experimentation (FIRE) follows these footsteps, only that it expands towards industry. The involvement of organisations from so many countries in pan-European research networking is a very good example of the sort of European cooperation, which is fundamental to the objectives of the European Union itself. As experimentation has been acknowledged as a common nominator and community builder, European research networking also has grown from its nature as it cohesion – the research network.

Equal to the two FIRE dimensions, research and education networks (NRENs) have a multi-functional purpose with two primary objectives: 1) they act as a high-capacity information and communication infrastructure based on state-of the-art technologies to support the work of researchers; 2) they facilitate research in their own right by providing a platform to implement new services and advanced networking technologies through the establishment of experimental test-beds.

Therefore, as per definition NRENs and FIRE have a lot in common, the question is to indentify the possible cooperation and synergy areas, and agree on a plan to involve and incorporate more commitment and enable resources on both sides for mutual benefit and better service for user communities.

The FIRE facility projects' interconnection to FEDERICA project is elementary in bridging the gap between research and education networks and FIRE. As such it can pilot cross-offerings, NREN nodes as virtual resources, but also intermediate the tools and services from FIRE facilities for GEANT development. Common use cases have been identified and plans for interconnection trials have been made.

Primarily the dialogue and common planning on a FIRE-GEANT level are elementary. On both sides information needs to be exchanged and awareness increased. Project level cooperation has already started. Sustainability, governance, as well as transparent and competitive business models are challenges to be overcome in addition to the technical issues that seem to easier to solve at the first glance. However, then there is a will, there is a way.

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1 Introduction

How to bridge the gap between an infrastructure of 3O million users, 40 M€ funding and 50 years of experience, and a one-year initiative of 500 users (hopefully), but with 30 M€ annual budget? In order to build a European Experimental Facility the key elements and infrastructures need to be identified and their interfaces specified. Moreover, Europe cannot afford to waste any resources, but synergies and commitment need to be found and common vision for all parties produced.

Research networking activity has been seen as having an important contribution to make towards maintaining European competitiveness and supporting economic development. Now this view is expanded to experimental research on future network in its large, and irrespective of the organisation carrying out the research, or its evolutionary or revolutionary nature (reference to FIRE). The involvement of organisations from so many countries in pan-European research networking is a very good example of the sort of European cooperation, which is fundamental to the objectives of the European Union itself. European research networking also assists cohesion – the notion of narrowing the economic development differential between countries – by helping provide the ability for all researchers, wherever in Europe they work, to participate in collaborative research projects and contribute to the best of their abilities.

Research and education networks have a multi-functional purpose with two primary objectives: 1) they act as a high-capacity information and communication infrastructure based on state-of the-art technologies to support the work of researchers; 2) they facilitate research in their own right by providing a platform to implement new services and advanced networking technologies through the establishment of experimental test-beds. Research and education networks have been made possible by the rapid evolution of telecommunications technologies, and particularly data communications. They exist at the forefront of technological developments and are ideal for experimenting with new services before they become available to the general marketplace.

As per definition NRENs and FIRE have a lot in common, the question is to indentify the possible cooperation and synergy areas, and agree on a plan to involve and incorporate more commitment and enable resources on both sides for mutual benefit and better service for user communities.

2 NRENs and GEANT

Background [1]

The first research networks in Europe started to emerge as national initiatives. They concentrated on connecting major university and research sites together. The telecommunications networks, which were used at that time were starting to make the transition from analogue to digital technology. They were entirely optimised for voice telephony, which was the dominant traffic type. In Europe, the telecommunications industry was organised around a set of national monopoly organisations, typically combined with national postal organisations, who had absolute monopolies of nearly all aspects of service provision. This frequently included even "in building" wiring. These monopolies were technically conservative, lacked innovative forces and typically viewed data communications with considerable suspicion. In the USA however, the monopolies were more limited. Government sponsored "Computer Inquiries" which addressed the issues of computer communications led, in 1982, to the break up of the nation-wide Bell system and to the emergence of a more competitive national market.

The introduction of digital switches and digital transmission in telecommunications during the 1980s, replacing mechanical switches and analogue transmission technology, meant that the basic technology of the telecommunications industry became much more suitable for data communications. Access to this technology was, however, limited internationally as it would enable alternative network providers to bypass the transfer pricing regimes for international voice services that were so profitable for the monopoly operators.

The national research networks got together in 1986 to found RARE (Réseaux Associés pour la Recherche Européenne). In 1987 a number of European countries, co-operatively with the European Commission established the COSINE initiative. Cosine had two objectives. The first objective was to establish a common pan-European infrastructure to connect the National Research and Education networks together. The second objective was to foster the implementation of Open Systems Interconnection hence the name COSINE (Co-operation for Open Systems Interconnection in Europe). The overall plan for COSINE was very ambitious. It consisted of the construction of a pan-European X25 network to interconnect National Research networks, together with a programme of OSI related developments, covering a broad range of areas from file transfer protocols (FTP), through the provision of gateways to OSI services, and the provision of information services to targeted user support. Unfortunately, there was a significant time lag between the establishment of the goals of the COSINE project and the start of its implementation. In this time, the Internet, router-based networking technology and the associated suite of applications protocols started to have significant impact. In 1992, the EuropaNET network had the ability to support both X25 and IP protocols. It bridged the gap between the two potential networking solutions and allowed a migration from X25 to IP. EuropaNET represented the networking platform upon which successive generations of pan-European network have been built. EuropaNET was based on 2Mbps leased circuits.

COSINE had created an infrastructure, and it was recognised by those who were responsible for funding the project that if this infrastructure was to survive and develop, it was necessary to have a permanent organisation to continue to support and develop the network. As part of the project a working group was established to make proposals for the future organisation of European Research networking. This group produced a blueprint for the future organisation, which was described in the report "Towards a Single European Infrastructure". DANTE today is very much the implementation of this blueprint.

NRENs - National Research and Education Networks - are responsible for providing data communications networking facilities to the research and education community on a national basis. The ability of Europe's universities and research institutions to exchange information, and to collaborate together in world-leading research, relies on their ability to communicate effectively using the most powerful computer and communications technologies available. At a national level, the necessary data communications infrastructure is provided by NRENs.

DANTE is owned by 14 European NRENs. In addition, DANTE and 30 European NRENs are formal partners in the GÉANT2 project with the European Commission. GÉANT2 is the successor to GÉANT, and is the pan-European backbone, which connects the national (NREN) networks, and DANTE is responsible for GÉANT2's operation. DANTE is also involved in other projects whose partners typically include several NRENs. Hence the NRENs are not only DANTE's owners, but also its partners and customers.

DANTE's sister organisation is **TERENA**. TERENA is the Trans-European Research and Education Networking Association, and is based in Amsterdam in The Netherlands. TERENA carries out technical activities and provides a platform for discussion to encourage the development of a high-quality computer networking infrastructure for the European research community. The activities of DANTE and TERENA are separate but complementary, and our two organisations cooperate together in many activities. TERENA is the successor organisation to RARE, which founded DANTE

The **GÉANT2** network provides the high-performance, state-of-the-art network infrastructure that is fundamental to the European Union's vision of a European Research Area (ERA). The network is the core activity of a coherent set of initiatives that seek to develop all aspects of European research and education networking. The project within which the network is being built and developed also includes an integrated research programme, the development of support services for network users, initiatives to monitor and address disparities in the level of development of research and education networking around Europe, and a comprehensive study into the future of European research and education networking. The partners in the project are 30 European NRENs, DANTE and TERENA.

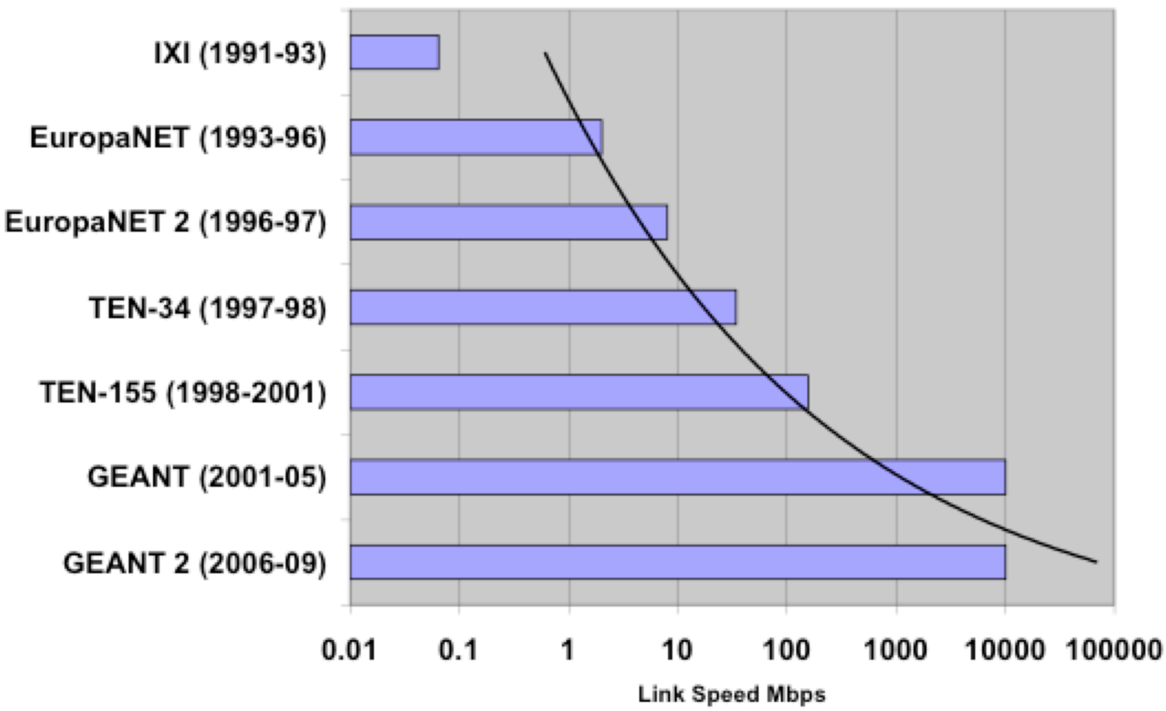

Figure 1 Evolution of European Research Networks

GÉANT2 offering

GÉANT2 provides the pan-European backbone to interconnect Europe's national research and education networks. Together, GÉANT2 and the NRENs provide advanced communications services to Europe's research and education community.

The network architecture is evolving to a more flexible structure based on a combination of routed IP and switched components. The objective is to create a hybrid infrastructure that meets the needs of different types of user with the most appropriate technology.

- Maximum efficiency in the centralisation of network management
- A high concentration of networking expertise in support of European research and education
- Easy access for users in other regions and countries around the world to resources and equipment which would otherwise be out of reach

The GÉANT network comprises three core network services:

1. GÉANT IP - providing high bandwidth international internet connectivity for millions of academic users
2. GÉANT Plus, and
3. GÉANT Lambda point-to-point services, providing dedicated bandwidth and guaranteed quality of service.

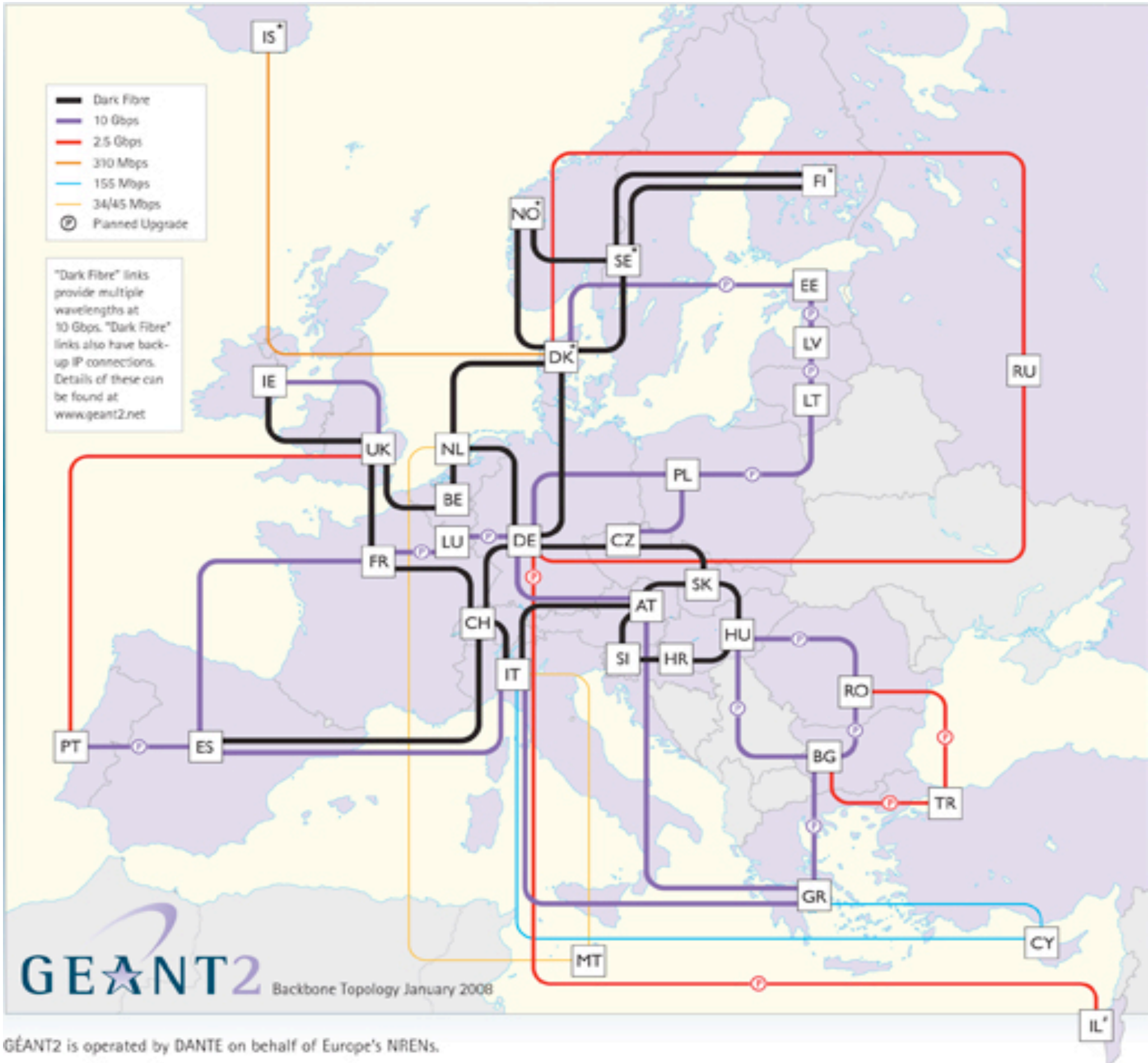

Figure 2 GEANT2 Infrastructure

3 Three facility projects, FEDERICA, Onelab2 and PII

3.1 FEDERICA [2]

FEDERICA is a two-and-a-half-year European project to implement an experimental network infrastructure for trialling new networking technologies. The FEDERICA project aims at creating a scalable, Europe-wide "technology agnostic" infrastructure, based on the NREN and GÉANT2 networks, that is able to host experimental activities related to new Internet architectures and protocols. This infrastructure is intended to be agnostic as to the type of protocols, services and applications that may be trialled, whilst allowing disruptive experiments to be undertaken. The aim is to develop mechanisms that will allow such experiments to be run over existing production networks without adverse effect.

The FEDERICA is a multidimensional network based on the Research & Education multi-gigabit networks footprint. Circuits are terminated in Points of Presence (PoPs) of NRENs and GÉANT2, hosting FEDERICA nodes capable of virtualising hosts e.g. open source routers and end nodes (V-nodes). The researchers will have full control on the allocated virtual nodes and network slice and access network monitoring information. Internal project research is focused on understanding and producing initial solutions for monitoring, management and control of parallel virtual networks.

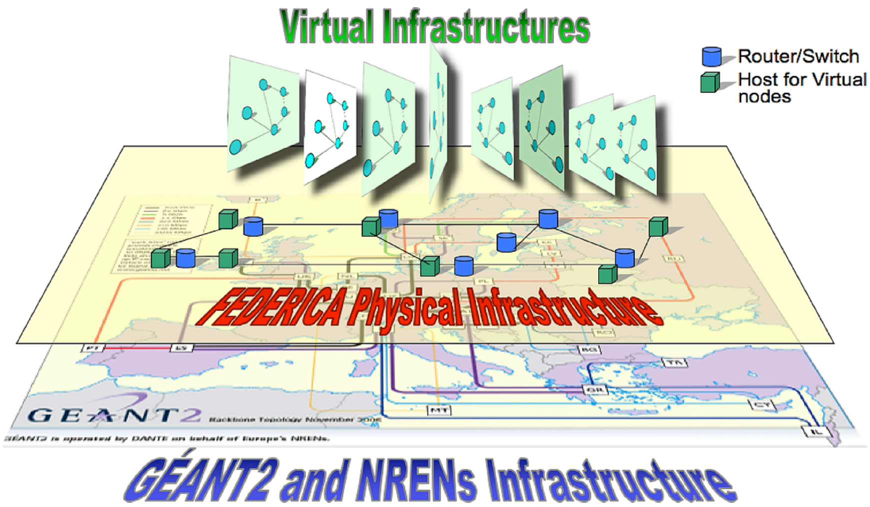

Figure 3 FEDERICA Infrastructure

FEDERICA provides computing resources using dedicated lines for connecting Physical Nodes (PN). Within boundaries of each PN multiple instances of Virtual Nodes (VN) may be created, including virtual machines based on various operating systems or emulating L2/L3 network equipment. Each virtual machine acts independently, and can run different applications at the same time. Connections between VNs is made via Virtual Paths (VP) created over the physical networking infrastructure, using techniques such as tunnelling. All VNs dedicated to the same purpose, along with the VPs connecting them together, represent one independent virtual infrastructure called a slice. A slice contains all distributed networking resources: routed IP circuits (IPv4, IPv6 unicasting and multicasting) and/or system(s) and/or routers, also end point virtual machines. All of these resources are seen by the end users as physical infrastructure and the virtualization layer is hidden from them. There is no theoretical limit to number of slices that can be created, and there is no limit on number of applications (of any type) running inside each slice.

The FEDERICA became operational as scheduled in September 2008. Users can request a virtual infrastructure ("slice") composed of a combination of circuits (up to 1Gb/s) and V-nodes.

3.2 OneLab2 [3]

PlanetLab is a group of computers available as a testbed for computer networking and distributed systems research. It was established in 2002. As of May 2009, PlanetLab was composed of 1043 nodes at 500 sites worldwide. Each research project has a "slice" or virtual machine access to a subset of the nodes. Since the beginning of 2003, more than 1,000 researchers at top academic institutions and industrial research labs have used PlanetLab to develop new technologies for distributed storage, network mapping, peer-to-peer systems, distributed hash tables, and query processing.

PlanetLab Europe is the core testbed provided by the OneLab project and is the European arm of PlanetLab. PlanetLab Europe has the freedom to innovate on behalf of European industrial and academic research priorities, and was established by OneLab1. The aim of this testbed is to give European internet stakeholders a means to experiment at the network and application layers and accelerate the design of advanced networking technologies for the future internet. It as such offers access to hundreds of Linux systems physically distributed across the world and available on the public Internet. Participants can provision private virtual servers on any PlanetLab node. These virtual servers can be used to deploy live Internet services that are exposed to the same issues as might be seen in production environments: bandwidth, latency, robustness and failure. In addition, diversity is progressively added to PlanetLab Europe in order to provide resources akin to those that exist or will be deployed on the Internet, namely some wireless components as well as emulation capabilities are now available and others will be made available in the future.

OneLab2 continues building a large-scale federated experimental facility based on PlanetLab. It extends and expands the existing PlanetLab Europe (PLE) by widening the offering with added nodes, features (e.g. wireless), tools (e.g. monitoring) and federation mechanisms. The PlanetLab framework also grows in Asia, as PlanetLab Japan is to be federated with PLE and PLC (Central). The OneLab2 project directly involves pilot projects that are potential customers of the testbed, trying out novel ideas in both real-world and synthetic environments. The PlanetLab federation concept will be further developed in terms of various incentives and also heterogeneous testbeds will be interconnected and included in the federation.

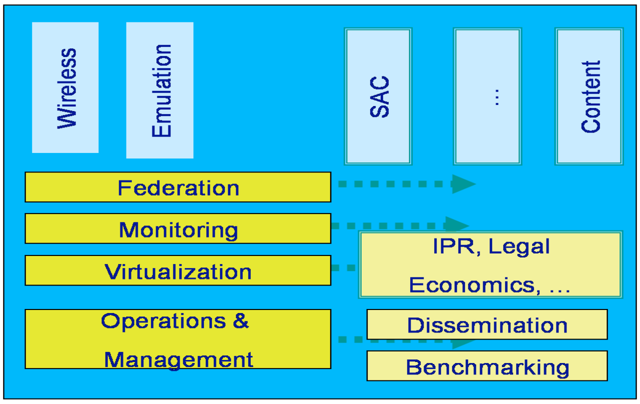

Figure 4 OneLab evolution

3.3 PII [4]

Pan-European Infrastructure Implementation (PII) addresses the need for large-scale testing facilities in the communications area by implementing an infrastructure for federating testbeds. The PII project uses the concept of European innovation clusters and builds on the existing testbeds that are supporting scientific and technological endeavour within these clusters. The central objective of PII is to create a testbed federation among these regional innovation clusters in Europe. This will enable companies participating in these clusters to test new communication services and applications across Europe. The testbed federation includes four core innovation clusters and three satellite clusters. Another common nominator in testbeds to be federated in PII prototype phase is IMS. PII benefits from the heterogeneous resource management resolved in IMS field and utilising this experience in implementing a governance structure for procuring testing resources cross separate administrative domains. PII develops an automated resource composition tool, Teagle, to identify and combine needed elements from various, (distributed) testing sources part of the federation, according to the request defined by the testing customer.

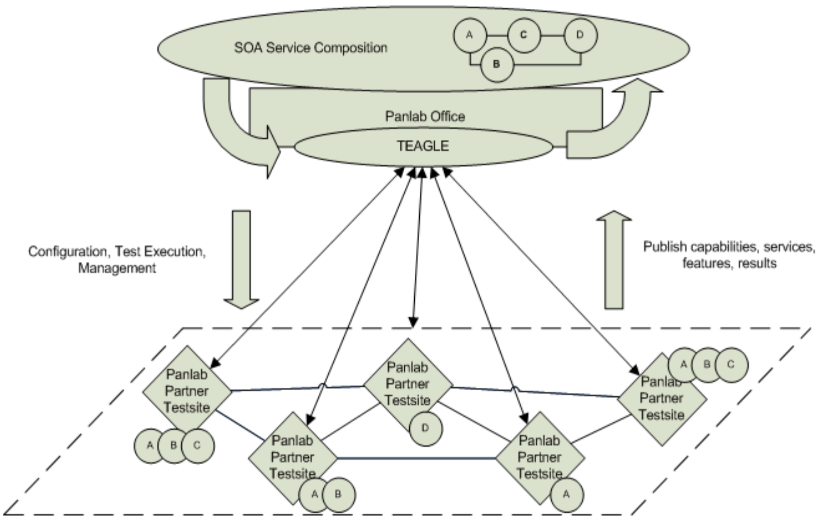

Figure 5 PII federation architecture

The stakeholders who can benefit from the federation of testbeds are effectively all stakeholders involved in the value chain for (tele-)communications services and applications. Smaller organisations can benefit from federation by compensating their lack of financial resources to deploy own testing infrastructures. However, even among larger stakeholders there is a trend not to deploy and operate expensive testbeds. In many cases, stakeholders who need large scale, diverse testing environments are organised in collaborative projects within large R&D programmes, such as EC Framework Programme 7, EUREKA Cluster CELTIC, as well as national ICT programmes.

3.4 Comparison of the projects

The summary and comparison of the three projects by Max Lemke, Anastasius Gavras and Scott Kirkpatrick is as follows.

	Panlab	OneLab	FEDERICA
Context	• Converged Telecom Internet Service & Network Environments • Industry focus	• Distributed system • IP networking • Research focus	• Networking Research • Network technology agnostic environment • GÉANT, NRENs
Platform	SOA-NGOSS (e.g. to federate IMS based testbeds among themselves and with others)	PlanetLab – both public and private versions	Gigabit transmission equipment and computing nodes both capable of virtualization
Focus	• Converging network, service platform and application infrastructures • Complete Control over Dedicated Resources • Reproducibility	• Shared Resources • Real World Environment • Applications enduring over time • Partial Control • Variability	• Virtual slices composed of networking and computing resources • Isolation of experiments in slices • Operational environment • Reproducibility & monitoring

Figure 6 PII, OneLab2 and FEDERICA in short

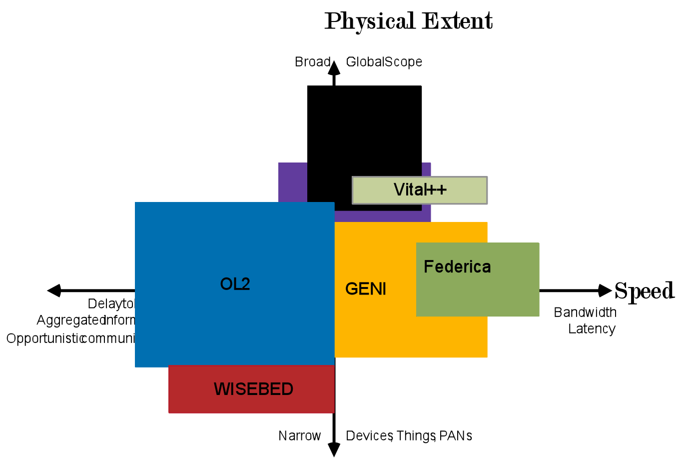

Figure 7 FIRE projects' global positioning

OneLab2 has global scope through its federation with the three existing (and several future) PlanetLab federations (US, Japan and Europe), and at a second level of the hierarchy down to private PlanetLabs and other heterogeneous testbeds (e.g. OMF). PII prototype is European-wide, but has global scope through its descriptive facilities and registry for the characterization of several heterogeneous testbed facilities provided by European industry. FEDERICA is a dedicated European-wide network, built using resources from NRENs and GÉANT, thereby enabling global coverage. The testbeds can also be categorised in terms of their suitability for experimentation from initial tests of concepts to market-ready solutions. Projects that support rather the initial testing of hardware and distributed application ideas, with a common preference for open source software and public access to results are OneLab2, WISEBED and FEDERICA. These projects have fewer – but still some - concerns about IPR, privacy, security and anonymity of measurements, whereas PII is much closer to market by definition and needs to be commercially sensitive.

4 OneLab2 views on NRENs and connection to FEDERICA

4.1 In general

Main points

- It can be stated that OneLab/Panlab/FEDERICA are presently the backbone of FIRE, with different approaches, but federation in common.
- OneLab can be seen as a customer of a virtualized instance of FEDERICA, including issues related to resource management and monitoring.
- Referring to NRENs, a shared interest in getting high-speed pipes between the respective testbeds (internally or for the federation) for all testbed federations.
- Onelab2 offered monitoring tools should be utilised in GEANT3
- A more detailed dialogue is needed to proceed further, aiming at beyond FEDERICA scope.

In detail

The overall objectives for collaboration is to set up a relationship in which all three of testbed federations, Panlab, OneLab and FEDERICA extract a common view of the major opportunities and best practices to create a FIRE test environment in which end-to-end deployments are possible. This may mean facilitating access to EARN and the NRENs for pre-competitive technology projects (which are still far more mature than academic protocol proposals). It is expected that the virtualization capability that FEDERICA is developing will first be useful to OneLab, if a facility is created to reserve e.g. tunnel bandwidth for direct interconnect between different wireless testbeds, both those with similar and very distinct (DTN-like) technologies. This will allow understanding better how wireless will scale up by allowing tests in which two testbeds are connected as if they were adjacent or intermingled. Linking simulations or linking simulations to real testbeds may also be an important step in this direction. Finally, OneLab offers several measurement modalities that can be coupled closely to the FEDERICA network. One of these, ETOMIC, is already proposing to exploit national funding to integrate their precise delay and capacity measurements with all access points to FEDERICA. What FIRE should add to that is really effective and usable modes of user access to the capability and to the archive of its results. This may serve as a model for what can be done more universally.

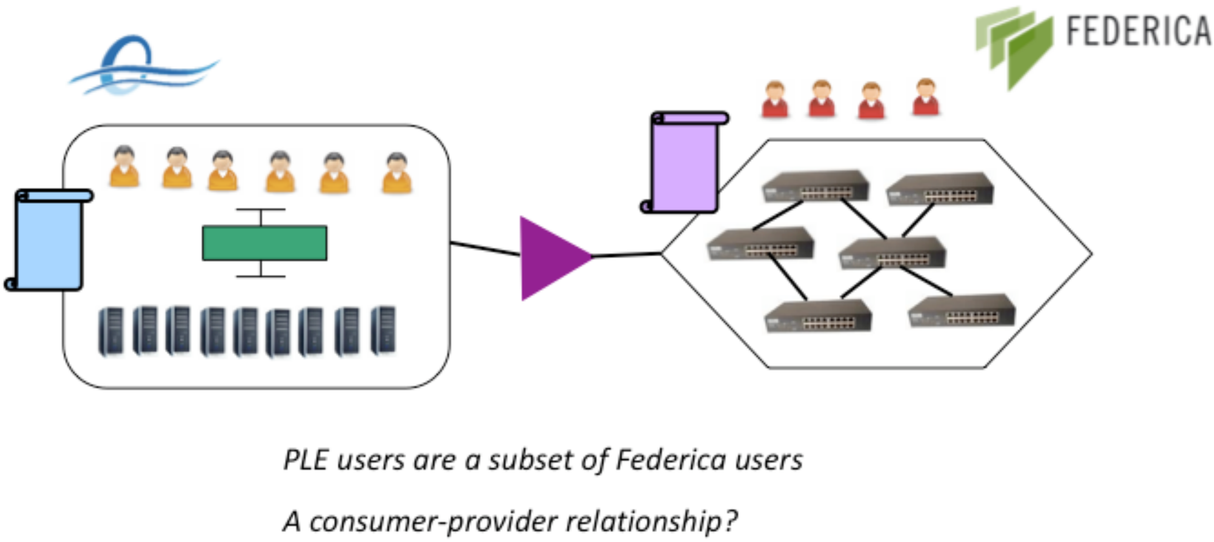

Figure 8 OneLab2 – Federica relationship

4.2 Use case for OneLab2 – Federica [5]

Congestion aware routing and network navigation – A Use Case from the Computer Research Institute of Hungarian Academy of Sciences

Background: Internet traffic is increasing in an unprecedented pace. According to Cisco Research, it will increase annually 46% in the period 2007-2012. This networking trend is driven largely by the increasing use of video and Web 2.0 social networking and collaboration applications. The combination of these technologies represents what is known as visual networking. Video on demand, IPTV, peer-to-peer (P2P) video, and Internet video are forecast to account for nearly 90 percent of all consumer IP traffic in 2012. This traffic is then not originated from large corporate server farms well connected to the backbone; it is generated in the access network. The server-client approach is no longer applicable and users need symmetric access to the network, rather than asymmetric like in current A-DSL. This involves not just an upgrade of the upload speeds of users and deployment of fibre to the home; it is also going to change how routers handle the traffic globally over the network. The access network will lose its tree like topological structure and becomes a complex network with a large number of loops and shortcuts like our current city street maps. Instead of minimizing hop count, new routing protocols should navigate packets just like current traffic information systems help drivers to avoid congested street segments.

Use Case: The Use Case exploits federation between FEDERICA and OneLab2, in order to test various routing strategies in the FEDERICA's virtualized environment. Strategies can involve new routing principles reacting to congestion on links and also strategies, where end users can select specific paths for the delivery of their data packets. OneLab2 is ideal for the testing of traffic generation and packet navigation strategies.

Realisation: The current PlanetLab/OneLab infrastructure supports the testing of various traffic sources in the access network. However, it explicitly prohibits the transfer of large amounts of data coming from high throughput sources between the nodes. The new FIRE facility should allow experiments where multimedia traffic from the access part (OneLab2 nodes) can flood the core network. The FEDERICA infrastructure supports the testing of complex routing strategies needed to navigate a flood of multimedia traffic through the core network and could therefore provide an ideal testing ground for various routing concepts. The physical access to FEDERICA still has to be resolved. An access from OneLab2 nodes via the NREN networks is considered the best technical solution, but it is not feasible at current pricing principles to finance experiments, where 10-100 Gbit/s traffic (each) from 50-100 different network locations would like to reach the GÉANT core simultaneously.

Commercial interest: This use case is important for IPTV providers, P2P video service providers, fibre to the home network providers, intelligent home applications and large-scale Internet of Things (RFID) players.

5 PII views on NRENs and connection to FEDERICA

5.1 In general

This paper summarises the outcome of a joint meeting between PII and Federica project participants from the point of view of PII. This joint meeting took place on 7 October 2008 in Amsterdam, hosted by TERENA. Participants from PII were Anastasius Gavras (Eurescom GmbH), Sebastian Wahle (Fraunhofer FOKUS) and Shane Fox (WIT TSSG).

Rationale

Currently both projects are defining ways for describing resources/assets and there is an opportunity to avoid duplication and fragmentation. The meeting aimed to allow PII participants understand how Federica describes (or plans to describe) available services and to discuss and to verify what PII will have to do to be able to broker Federica slices.

Vision scenario

The vision scenario is that descriptions of Federica slices can be stored in the PII repository and when a PII experiment requires an infrastructure such as a Federica slice, that this can be requested, reserved and provisioned by sending the appropriate management messages to some responsible control node in Federica.

Background – PII

The subject of the meeting can be positioned in the context of the ongoing discussion in PII on the options for applying the TeleManagement Forum SID (Shared Information Data) for resource description. The rationale behind is that this would allow the use of the eTOM (e-Telecoms Operation Map) framework and its nomenclature, when we explain what functions and process steps in the eTOM framework are necessary for the PII testing services repository.

A further reason is that the provisioning of PII testbed configurations will probably be easier through the standard interfaces and their implementations foreseen in the framework. PII participants believe that many of the systems that aim to satisfy certain PII quality criteria will have to be described in a standard way, and that currently this framework is the more complete one and available today.

Background – Federica

Federica is currently evaluating the work of the IPSphere forum. IPSphere provided a framework but the forum has just been merged into the TeleManagement forum. Currently the relationship between the IPSphere work and the eTOM framework is unclear. However Federica may have be consider it in the future although it is not directly relevant to Federica yet.

Within the Federica context there is no eTOM framework functions implementation. Besides the definition of the virtualisation process, Federica is currently working on a solution to allow accepting a request from the IPSphere framework, taking into account the IPSphere specifications, which are not eTOM based.

Federica is an experimental facility to be exposed to IPSphere (ContentSphere testbed), as it should be exposed to PII. So, Federica should aim to understand how eTOM works and how it is applied to PII, in order to assess how Federica can commit to it within the current Federica architecture.

Future directions

In the context of federation under FIRE, PII and Federica are complementary and can be positioned in both roles, namely user and provider of resources.

1. PII as a customer of Federica. This case can be illustrated by use scenarios in PII that require the interconnection of a Federica slice.

2. Federica as a customer of PII. This case can be illustrated by use scenarios of experiments that run in a Federica slice and require a breakout gateway to a live mobile network, or other public switched telecom network.

To progress the collaboration between PII and Federica it was agreed that a number of concrete steps need to be taken on both sides. Furthermore these steps need to be simple and small in order to motivate both teams in the long term.

- PII should analyse its use scenarios to determine whether one or more could benefit from incorporating a Federica slice.
- Federica should provide more details on the way it is defining the service templates. NOTE: the notion of a service template (IPSphere terminology) is used in Federica since a slice is being built when it is requested and does not pre-exist. Slices are built based on service templates.
- Determine how PII could store a simple Federica service template in the PII repository.
- Define the interfaces and web service messages sent between PII and Federica to provision a Federica slice.
- Federica should assess the impact on its architecture when Federica provisioning interfaces are exposed to other testing brokering and control instances like the PII Teagle.
- PII and Federica should work on a joint use scenario that illustrates the added value of the mutual use of the available resources in a FIRE federation.

Further actions

In order to sustain the momentum it is proposed that PII and Federica experts progress at future opportunities the excellent start made in Amsterdam. Therefore joined technical workshops should be organised in order to facilitate the work. In addition experts from Onelab2 should also join the discussion as all three projects (Onelab2, PII, and Federica) form the backbone of the FIRE facility.

5.2 Use case PII – FEDERICA [5]

SOA Scenario for Engagement with FIRE Testbeds

Background: The ideas behind distributed computing have been evolving continuously for the past 30 years. In each decade it seems a new distributed computing paradigm is invented which will deliver the holy grail of pervasive, secure, high performance application solutions for the public and private sectors. The latest paradigm was entitled Grid computing. Over the decade, the ideas behind Grid computing have gradually broadened out and been renamed Service Orientation. It is important to note that while the Grid very quickly became associated with particular middleware, Service Oriented Architectures (SOAs) follow much more a distributed application design methodology than a prescriptive set of technologies. Many different communities became involved in Grid computing. With the exception of the Particle Physics community (who, thanks to the very large data transfers which characterise their computing needs, experimented in detail with bandwidth reservation and high performance data transfer technologies), very little engagement with the networking community and those defining the underlying networking protocols has occurred. Most SOA applications today use the network as is (generally with IPv4 and no parameter tuning). It is clear that the number of large-scale applications built by both the public and private sectors will increase markedly over the coming years. Europe has led the way in the use of Web Services to build SOAs and much of the groundwork for the creation of complex SOAs built from large numbers of cooperating, widely dispersed services has been undertaken in a number of Framework 6 and 7 projects. It has been clear for some time to developers working on the higher level service technologies employed today that the underlying network protocols greatly influence the performance, security and scalability of their applications. In general, these developers work around network issues and have little or no engagement with network researchers.

Use Case: We therefore propose that a key FIRE scenario should be a collaboration between network researchers, service technology developers and service-based application developers to explore how next generation networks can support technology developments. A series of large-scale representative Use Cases from the business and scientific sectors should be selected and used to explore next generation network research ideas. In this context PII in particular can be a key resource along with the test facilities available at the NREN level. Example applications may include: large scale data access and integration for a multinational business wishing to join disparate and widely distributed data sets together for business advantage or the processing of scientific datasets requiring data and information from widely distributed data services, as is common in the bioinformatics sector. This will only succeed if all three communities work hand-in-hand. It is almost certainly the case that those working on SOA technologies will not know what questions to ask of the networking researchers and vice versa. However, by bringing these communities to skills to drive the Internet forward to our mutual benefit.

6 FEDERICA views on federation to OneLab2 and PII

6.1 On federation

If facilities share both a control plane and a data plane the user may connect only to a single facility and organize a joint experiment. The control protocol must be complex and has to export facility' s information description (like a routing protocol). In this case the clearinghouse may not be needed. The availability of a clearinghouse simplifies the tasks in each facility, but creates a single point of failure and a scaling issue. There are two desirable characteristics:

1. Lower the usage complexity for the user
2. Allow the use simultaneous use of more than one facility by the same user

For the first requirement there are two techniques:

1. A clearinghouse, that takes care of the protocol conversions and the different data and control planes, offering to the user a single interface and a "standard" representation of "services"
2. A standard control and data plane plus a connection between facilities

For the second requirement the need is:

1. At least a data plane between facilities
2. If a common control (inter- facility) plane is added a full peer-to-peer model is enabled lowering the need for the clearinghouse (its availability may in any case make the overall architecture simpler)

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- Data plane is IP based (packet switched Ethernet)
- Physical connectivity can be accepted, currently with wired Ethernet
- Access is regulated by humans for first access, automated protocols (control) can be used later (trust and AAI needed)
- Not yet resources representation schemas available (needed to describe the available services)
- Inter-facility control plane not available (SOA?)
- Intra-facility control plane is very complex, due to scheduling and slice mapping to physical topology tasks, still manual
- A slice may host whatever internal control plane

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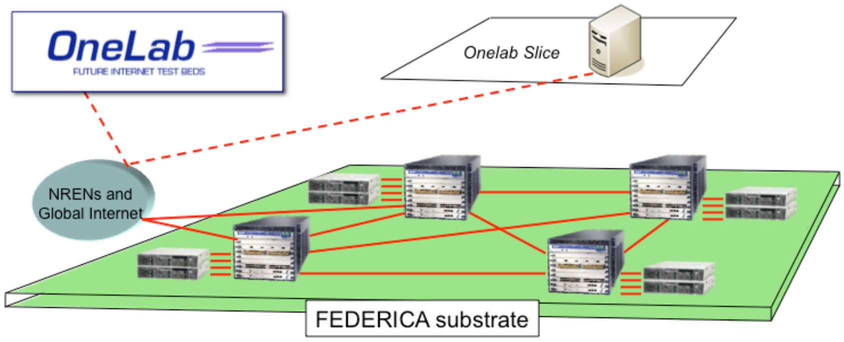
A PlanetLab node can be hosted in a slice. That specific node has full control of its network interface and circuits up to the egress from FEDERICA into General Internet.



6.2 NRENs and FIRE

Primarily the dialogue and common planning are elementary. On both sides information needs to be exchanged and awareness increased. Common projects would be an elementary tool. Secondly, the cost of resources is an issue. The pricing is not homogeneous or obvious. The role of industrial users is not always clear. Main issues for the dialogue are:

- Need for specific FIRE requirements
- May collaborate on local and international support
- Connectivity, topology and capacity type
- Services, lower layers expertise
- Standardisation of resource representation
- Cost of capacity is an issue, need to agree on a cost model for resource use
- Ensure that GN3 project elaborates and plans for FIRE needs
- Support FIRE initiatives explicitly, strengthen the communication between NRENs, FIRE
- Facilitate international (intercontinental) connections
- Key role for (connecting) national initiative
- Plan for extending FEDERICA

7 Conclusions

Not only there is a lesson to be learnt from the nearly fifty-year history of research and education networks, in cooperation with FIRE there is a huge mutual potential of resources to be utilised in terms of physical and knowledge capacity. FIRE is vivid, agile and hungry, despite its size and age well-linked to international experimental networks. It is complementary to NREN offerings, but could a) utilise the massive resources, b) offer services and tools for GEANT development.

Research networking activity has been seen as having an important contribution to make towards maintaining European competitiveness and supporting economic development. Now this view is expanded to experimental research on future network in its large, and irrespective of the organisation carrying out the research, or its evolutionary or revolutionary nature (reference to FIRE). The involvement of organisations from so many countries in pan-European research networking is a very good example of the sort of European cooperation, which is fundamental to the objectives of the European Union itself. Research and education networks have a multi-functional purpose with two primary objectives: 1) they act as a high-capacity information and communication infrastructure based on state-of the-art technologies to support the work of researchers; 2) they facilitate research in their own right by providing a platform to implement new services and advanced networking technologies through the establishment of experimental test-beds. Research and education networks have been made possible by the rapid evolution of telecommunications technologies, and particularly data communications. They exist at the forefront of technological developments and are ideal for experimenting with new services before they become available to the general marketplace.

As per definition NRENs and FIRE have a lot in common, the question is to indentify the possible cooperation and synergy areas, and agree on a plan to involve and incorporate more commitment and enable resources on both sides for mutual benefit and better service for user communities.

The FEDERICA project is a key-element in bridging the gap between research and education networks and FIRE, both in facility and research aspect. As such it can pilot cross-offerings, NREN nodes as virtual resources, but also intermediate the tools and services from FIRE facilities for GEANT development.

Primarily the dialogue and common planning on a FIRE-GEANT level are elementary. On both sides information needs to be exchanged and awareness increased. Project level cooperation has already started. Sustainability, governance, as well as transparent and competitive business models are challenges to be overcome in addition to the technical issues that seem to easier to solve at the first glance. However, with mutual will, same as in the birth of COSINE project, parties can be brought together and large-scale achieved also in terms of diversity.

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