



How to Support TERENA Community on End-to-End Networking

Version 1.2

by Peter Szegedi

December 2011

Executive summary

By 2008, when TERENA's End-to-End (E2E) Workshop series was initiated, the pan-European GÉANT network and most of the NREN backbones were able to provide static point-to-point connection services. Because of the underlying optical transport layer, that slowly became ubiquitous for NRENs, these connections were generally called as *lightpaths*. The role of TERENA in the E2E networking context was to facilitate and strengthen the working relationship among the various peer groups (multiple domains) by efficient information and knowledge sharing. Especially, to foster and maintain the cooperation between NRENs, metropolitan, campus and local networks, as well as between the application developer/designer and networking communities.

As technology evolved from static to dynamic connection provisioning and lightpath services slowly turned into production the main focus of the community also shifted from interoperability and technical issues towards E2E service definition, design, and architecture problems. However, the understanding of the campus and last-mile issues (technical and non-technical gaps), the clarification of the end-users' service demands, and the promotion of the appropriate NREN services remained equally important.

Starting from 2011, the TERENA E2E activity is going to be more campus and end-site oriented, demand-driven, flexible container (i.e. co-ordinated set of sub-activities) that ensures the efficient information sharing and long term sustainability of the community efforts in E2E networking. It aims at investigating the emerging technical and non-technical issues, challenges of E2E dynamic connection services/architectures on- and off-campus, and identifying, proposing potential community support activities (in form of tutorials, workshops, trainings, collection of technical documentations, use cases, business models, recommendations for campus policy makers, security officers, etc.) in order to cope with these challenges. The activity is going to liaise with various global peer groups (GÉANT, Internet2, APAN, GLIF, DICE, etc.) and transfer the knowledge towards the targeted customer groups via NREN community support managers, key service architects, where possible campus IT managers, information and/or security officers.

The potential events proposed to be organised by TERENA E2E activity in 2012/2013 are summarised below.

Event type	for NRENs	for Campuses
Workshop / Tutorial	<i>Workshop series (2008-2010) has been stopped, no demand for that at the moment. BoFs were held in 2011.</i>	Lightpath Services Workshop for Campuses (spring 2012)
Contest & Unconference	Pilot Project Ideas on E2E Service Architecture Design (autumn 2012)	End-user Research Project Ideas/Experiences Demanding E2E Lightpath (autumn 2013)
Tutorial / Training	Train the Trainers on Lightpath Services (spring 2013)	<i>Expected to be organised by NRENs and/or Campuses. (autumn 2013)</i>

Table of Content

Executive summary	1
Table of Content	2
End-to-End Provisioning Workshops 2008-2010	3
History	3
Communication and PR support	5
Technical roadmap and challenges.....	5
Impact of TERENA E2E Workshop series.....	8
Conclusions and lessons learned	10
Getting closer to communities in 2011.....	12
Session at GLIF Tech Winter/APAN meeting	12
Technical BoF at TERENA Networking Conference	13
Technical BoF at NORDUnet Conference.....	14
Community BoF at Internet2 Fall Member Meeting	15
Conclusions and lessons learned	15
Structural changes and new strategy for TERENA E2E activity.....	17
New challenges	17
Strategy for better community support and liaisons.....	18
Structure of the activity	18
Activities proposed for 2012/2013 (input to TERENA's activity plan)	19
References	20

End-to-End Provisioning Workshops 2008-2010

History

Back in 2007, when the TERENA activity plan for 2008 was discussed by the General Assembly, CESNET suggested TERENA to consider organising events (similar to EuroCAMP) on the topic of 'provisioning of End-to-End (E2E) services or lambdas' with the aim at bringing together NREN, metropolitan, and campus network people responsible for different parts of the E2E path.

Helmut Severnyák (CESNET) wrote on September 14, 2007:

“Currently, the provisioning of End-to-End services or lambdas becomes very important part of NREN’s service portfolios. For setting up E2E connection, the co-operation between NRENs, metropolitan, campus and local networks on both endpoints is necessary. Whereas the NREN’s backbones as well as GÉANT2 are ready to deliver that kind of services, the metropolitan, campus and local infrastructures could be the bottlenecks due to technical reasons. We suggest that TERENA considers organization of events similar to EuroCAMP or miniCAMP on E2E issues where the people responsible for the different parts of the E2E path will be put together.”

The proposal was also discussed by the TERENA Technical Committee (TTC) and the TTC felt that the time is not yet ripe to have a tutorial/hands-on type event (like EuroCAMP) on provisioning connection services but it would be more beneficial to figure out the real issues first and understand the interest of the community in form of a workshop [1]. Therefore, TTC decided to organise an E2E Provisioning Workshop in the second half of 2008 with potential follow up events in the next coming years. Valentino Cavalli and Peter Szegedi (TERENA) contacted with CESNET and other TERENA members to clarify the objectives and the potential target audience of the workshop in 2008.



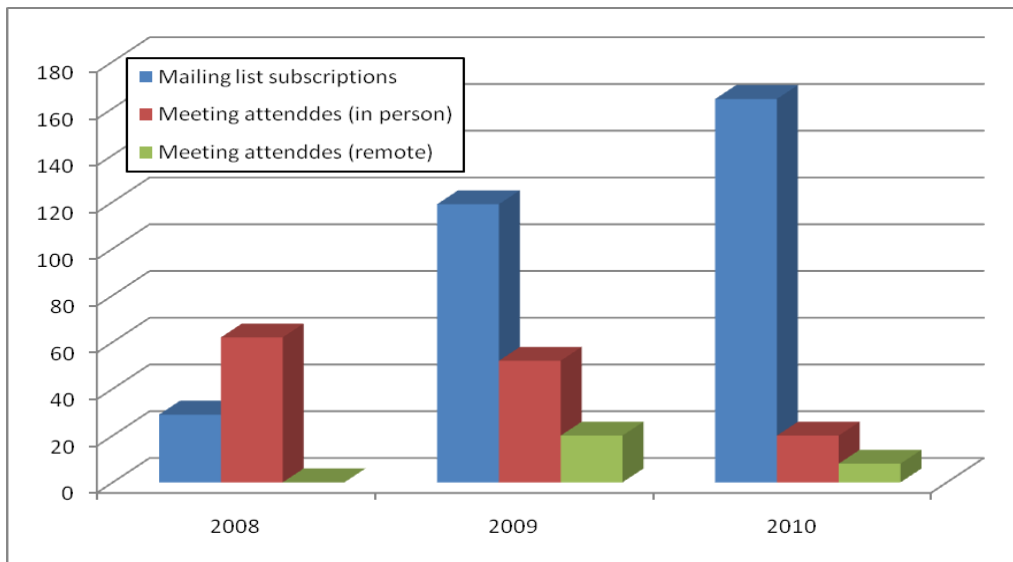
Valentino Cavalli and Peter Szegedi (TERENA) clarify the E2E Provisioning Workshop objectives with Stanislav Sima (CESNET) at TNC 2008 in Bruges, Belgium

TERENA organised three E2E workshops in a row between 2008 and 2010 (one per year) with different focus [2] as it is summarised below.

Date and location	Subtitle	Presentations	Attendee	Outcome
1-2 Dec, 2008 Amsterdam The Netherlands	Establishing Lightpaths	18 talks Panel discussion	62 in person No remote participation	Final report (pdf) News item
7 Dec, 2009 Amsterdam The Netherlands	Provisioning E2E Services	12 talks Panel discussion <i>+ ISOd workshop</i>	52 in person 20 remotely	AV recording Survey (ppt) News item
29-30 Nov, 2010 Prague Czech Republic	Applications and Services	14 talks Panel discussion	20 in person 8 remotely	News item Activity plan for 2011

Summary of the three TERENA E2E workshops

TERENA also created a mailing list <e2e-announce@terena.org> for the community gradually built around the workshop series. The list ended up with 164 individual members from 86 organisations (of which 24 are NRENs) by the end of 2010.



Number of mailing list members and workshop attendees

An E2E Expert Group and a restricted Wiki page [3] were set up in the beginning of 2010 to discuss and define a strategy on how to support NREN's activities related to end-to-end connection services. The expert group members are: Petr Holub (CESNET/Masaryk University), Victor Reijs (HEAnet), Yuri Demchenko (UvA), Ronald van der Pol (SARA), Maria Isabel Gandia Carreido (CESCA), Emma Apted (GN3/DANTE), Stefan Liström (GN3/NORDUnet), and Klaas Wierenga (Cisco).

Communication and PR support

Beside the dedicated e2e-announce mailing list and e-mail announcements to be sent out to other related TERENA lists, an extensive communication and PR support was given to the activity in form of news items, digital and printed infosheets, TERENA website material, etc.

Year	Infosheet	Workshop announcement	Follow up news item
2008	TERENA WORKSHOPS End-to-End Provisioning [4]	e-mail	"Successful workshop casts light on End-to-End Provisioning issues" [5]
2009	-	"TERENA invites NRENs and campuses to join forces at upcoming end-to-end provisioning workshop" [6]	"E2E workshop helps synchronise developments in the European research community" [7]
2010	End-to-End Service Provisioning Series [8]	e-mail	"E2E workshop group to intensively consult with various user communities in 2011" [9]

Summary of communication and PR support given to the activity

In addition to this, Peter Szegedi (TERENA) gave an invited presentation titled "Campus Networking End-to-End" at the EUNIS Conference to be held on 24 June, 2009 in Santiago de Compostella, Spain [10].



2008



2009



2010

Pictures of the workshops

Technical roadmap and challenges

By 2008, the pan-European GÉANT network and most of the NREN backbones were able to provide static connection services. The point-to-point connections were run from one boarder of the network domain to the other boarder (i.e. boarder-to-boarder) and could use a wide variety of technologies (e.g., Layer 2 Ethernet p2p VLANs, SONET/SDH circuits, or protocol transparent DWDM lambdas). Because of the underlying optical transport layer, that slowly became ubiquitous for NRENs, these connections are generally called (although that is technically incorrect) as *lightpaths*.

The obvious challenges in 2008 were; how to establish end-to-end connections over several domains, how to deliver connection services to end-users via various metropolitan, campus, and access networks, and last but not least how to provision connections dynamically in order to shorten the provisioning time. These challenges have been changed as the technical roadmap (see below) evolved.

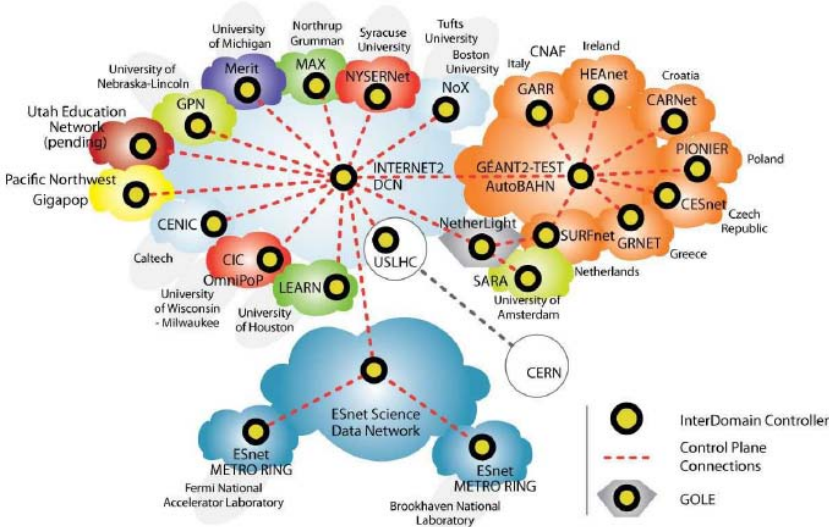
Date	Peer	Milestone
June 2007	GÉANT	Two workstations located in the Irish and Greek research networks (HEAnet and GRnet) are connected over the GÉANT2 test bed with a dedicated gigabit Ethernet circuit, provisioned within minutes using Automated Bandwidth Allocation across Heterogeneous Networks (AutoBAHN).
April 2008	Internet2	An instance of OSCARS, the IDC on Internet2's DCN, exists that allows users to preview the OSCARS web user interface, test new DCN applications, and test peering user IDC with Internet2 (no data plane yet).
May 2008	DICE	Inter-domain Controller (IDC) Protocol Specification is completed.
September 2008	OGF	The Network Service Interface (NSI) Working Group (WG) is initiated to provide the recommendation for a generic network service interface that can be called by a network external entity such as end users, middleware, and other network service providers.
October 2008	GLIF	GLIF Technical WG GNI-API Task Force is started to write Fenius Framework replacing the old GUSI architecture.
December 2008	TERENA	1st TERENA E2E Provisioning Workshop on Establishing Lightpaths
March 2009	GLIF	GLIF Technical WG initiates the new Dynamic GOLE Service Task Force and proposed an Automated GOLE Pilot project.
April 2009	GÉANT	GN3 SA2 (Multi-domain network service operation) activity is started.
July 2009	Internet2	Dynamic Circuit Network (DCN) Pilot Service is started.
October 2009	GLIF	Fenius interoperability demonstration is the first working demonstration ever of the new common interface developed by the GLIF Tech WG GNI-API Task Force (Fenius is closed; efforts go to OGF-NSI).
October 2009	Internet2	Interoperable On-demand Network (ION) service, a Production-Class Dynamic Circuit Network Service of Internet2 is launched.
December 2009	TERENA	2nd TERENA E2E Provisioning Workshop on Service Provisioning
February 2010	GÉANT	AutoBAHN operational pilot is started (AutoBAHN is IDC-compatible).
May 2010	DICE	Inter-Domain Controller (IDC) Protocol Specification is submitted to OGF-NSI in order to consider for publication as a NSI WG Informational Document.
October 2010	GLIF	Automated GOLE Pilot demonstration based on Fenius. GOLEs

		participating are: NetherLight, MANLAN, StarLight, JGN2, CernLight, NorthernLight, CzechLight, UvA and PSNC.
November 2010	TERENA	3rd TERENA E2E Provisioning Workshop on Applications
January 2011	OGF	OGF-NSI WG Network Services Framework v1.0 is completed.
May 2011	GLIF	GLIF publishes the “Role of Open Exchanges in the evolution of global research and education networking” paper.
May 2011	GÉANT	Initial roll-out of GN3 Bandwidth on Demand (BoD) service (technology agnostic) in 6 NRENs (PSNC, NORDUnet, GRNET, JANet(UK), HEAnet, SURFnet) and DANTE (BoD will be OGF-NSI compliant).
September 2011	GLIF	OGF-NSI plugfest demonstration. Domains participating are: OpenDRAC (SURFnet), OpenNSA(NORDUnet), OSCARS(ESnet), G-lambda (AIST), G-lambda (KDDI Labs), AutoBAHN (GÉANT project), and dynamicKL (KISTI).
March 2012	OGF	Final OGF-NSI v1.0 specification will be completed.

Overall technical roadmap of multi-domain dynamic circuit services

In summary, it can be said that between 2008 and 2010 the European NRENs and GÉANT established a working relationship with global peers [11] manifested in:

- international circuit stitching as it is embodied in achievements such as the GN2 E2ECU.
- the integration of NREN Cross-Border-Fibres (CBFs),
- the establishment of GÉANT global circuits and the use of GLIF Open Lightpath Exchanges (GOLEs)
- developing distributed monitoring architectures such as perfSONAR that was jointly developed by GÉANT and the US-based Internet2 & ESnet,
- testing automated Trans-Continental provisioning, e.g. by coordinating AutoBAHN with NREN initiatives, vendor solutions and the US Internet2 Dynamic Circuit Network (DCN) tools.

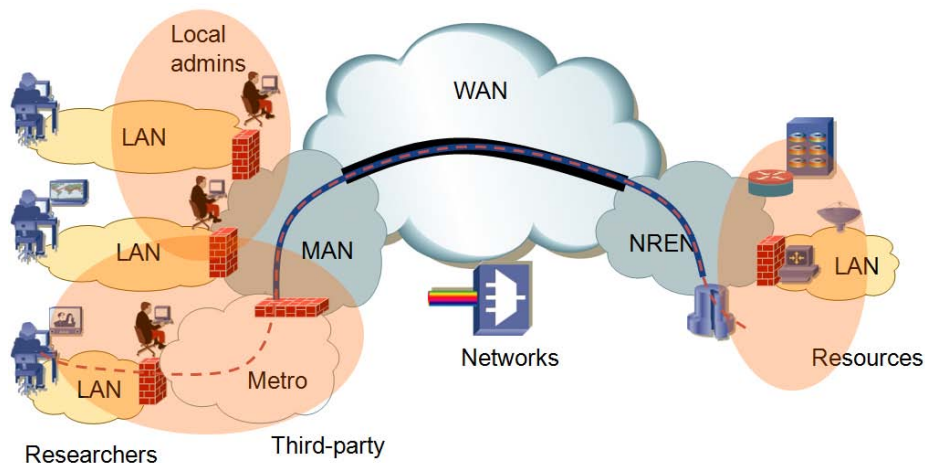


Multi-domain dynamic circuit provisioning infrastructure (2010)

Impact of TERENA E2E Workshop series

The role of TERENA in this E2E networking context was to facilitate and strengthen the working relationship among the various peer groups by efficient information and knowledge sharing. Especially, to foster and maintain the cooperation between NRENs, metropolitan, campus and local networks, as well as between the application developer/designer and networking communities.

The workshop series primarily targeted NRENs, regional/metro, campus, and local networking organisations to share expertise and experience in establishing real end-to-end services for universities and research labs in Europe and beyond. As it was identified at the very beginning, technical and other factors often cause 'bottlenecks' at the level of metropolitan, campus, and local infrastructures that is why the workshop series mainly focused on the end-sites and last-mile challenges.



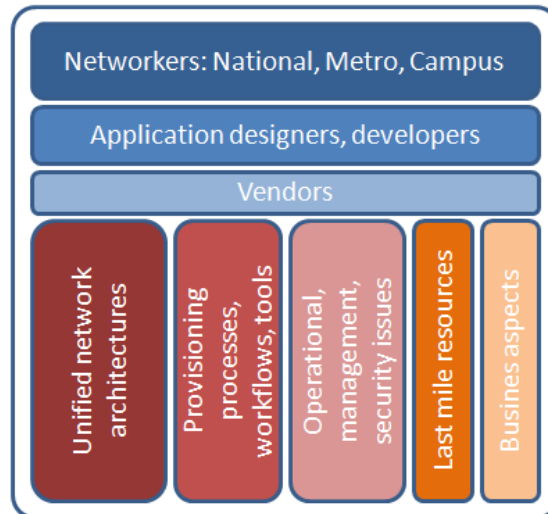
E2E Provisioning workshop focused on the last mile challenges

First E2E Workshop in 2008 [12]

The aim of the first workshop was to set the scene, understand the major issues, and start building a community that can address the issues together. The following main interest areas [13] have been identified:

- Unified/Standardised network architectures for end-to-end provisioning
- Simplicity of the provisioning processes and software tools
 - Faster provisioning has still highest priority over dynamic provisioning nowadays
 - Fast and automated restoration of the broken connections
- Availability of resources, especially in the last mile
 - Fibre availability, Spectrum efficiency
 - Access technology (PONs, Ethernet-based platforms), Cost efficiency
- Reliability of point-to-point circuits
- Implication of end-to-end connections on security (firewalling) aspects, routing integrity and IP addressing issues

- Operational issues: cooperation between network engineers and application engineers
 - AuthZ and AuthN, Scheduling, Fairness
- Business models and cost analyses for end-to-end lightpaths
 - Commercialization
- Facilitating tutorials on the provisioning systems' implementation and usage by the campuses



The structure of TERENA E2E Workshop activity

Second E2E Workshop in 2009 [14]

The second workshop further helped synchronise developments in the European research community. It took on a broader focus than last year's event, by including the administrative, operational and coordination issues of E2E connectivity services across the whole end-to-end work flow as seen from various perspectives.

It was concluded that key components of successful E2E services to campuses are: good collaboration, a solid infrastructure to reach the end user, familiar routing models, and a suitable security solution. For a scientific research laboratory E2E connection services are very important, but significant pieces of the process are missing, such as a unified operational model and a unique point of contact for service requests. It is essential that we understand the technical capabilities and service portfolios of the regional and end-site networks in order to make E2E services work seamlessly. When discussing user requirements and appropriate service definitions, the distinction between static and dynamic (on-demand) connection services is critical. Dynamic provisioning is lacking a common control plane over various domains and service level definitions and policies.

Furthermore, the panel recommended that support must be provided to end site operators in the form of white papers, how-to documents, procedure descriptions as well as practical, hands-on training. The TERENA Technical Committee also recommended [15] that to investigate the possibility to organise tool hands-on trainings (similar to the Internet2 DCN hands-on training in conjunction with the Internet2 Members Meeting) however, in principle these should be synchronised with the roll out of AutoBAHN

services by NRENs. The initial target audience should be campus network administrators. For this reason it would seem appropriate to attach these types of training events to national NREN conferences. However, it would be very important not to bypass NRENs in this activity.

Third E2E Workshop in 2010 [16]

The third workshop was dedicated to scientific and day-to-day applications such as ultra-high performance digital media applications for cinema post-production, real-time high-quality video conferencing and multi-channel streaming for teaching medicine, and virtual laboratories for high-performance computing and data sharing. These applications require high-capacity and, more importantly, low-latency and low-jitter end-to-end connection services from one application end to the other. The major challenges in establishing these connections relate to the service architecture, including the need for standardized protocols and interfaces, on-demand tools, management solutions for accurate troubleshooting, as well as clear service provider roles and responsibilities.

The meeting attendees concluded that:

- There is an issue with the lack of applications requiring e2e connections.
- Key applications need to be identified and promote e2e services for end-users.
- Application developers/designers should be more involved in the discussion.
- Need to deal with real application-to-application services and not just edge-to-edge connection services.
- Campus policies and motivations must be better understood.
- Attractive business models are needed and we need to understand and explain the cost implications of e2e services to users.

Participants agreed that the E2E community should be maintained to tackle the fundamental challenge of the last mile and end-sites.

Conclusions and lessons learned

As the technical roadmap of multi-domain dynamic circuit services shows the actual development work has been going under various peer groups (GÉANT, Internet2, GLIF, DICE, etc.) and none of these groups include/attract the end-site network administrators/managers or scientific application designers/developers in the first place. Therefore, the main objective of the TERENA E2E Workshop series was to establish and maintain the information flow between those communities and the NREN world. This goal has only been partly achieved due to various reasons.

The main issues and lessons learned during the workshop series are summarised below:

Issue	Reason	Potential solution
Less attendee from campuses and end-sites	Hard to mobilise campus people due to lack of travel budget and/or difficulty in justifying travel to	1) Provide remote participation facility for workshops. 2) In case of hands-on training, get closer to the local community by co-location with national

	international/NREN events.	conferences or visit end-site.
Huge NREN interest	It was not the primary intention but the TERENA E2E Workshop became a focal point where the various peer groups can be informed about the latest status of the development/deployment activities in other domains.	Needs no solution!
Lack of hands-on trainings for end-site administrators	Situation in Europe is different than in the US: DCN Software Suite vs. AutoBAHN Framework plus the various national domain controllers. General lack of training materials.	1) The role TERENA should play would be to organise an international-level tutorial event in order to kick-off local events that would have to be taken up by NRENs. The model followed in CSIRT training course would seem appropriate. TERENA could coordinate the production of training material to be developed internationally and made available both at European and national level. 2) An additional useful component would be training the trainers.
Find users of the technology before the technology is available to use	Chicken and egg problem! As the technical roadmap shows technology is still not fully ready for production in worldwide.	1) TERENA E2E Community should further be maintained to tackle the fundamental challenge of the last mile and end-sites related to multi-domain end-to-end connection services. 2) Consequently consult with end-site operators and user communities.
Difficulty in accessing end-user communities	TERENA cannot bypass the NRENs and even further sometimes NRENs cannot bypass the IT department of the University to get directly to the researcher/end-user.	1) Try to find and involve the NREN's 'community support managers' who venture out to the user space and collect the requirements at first hand. 2) If no such official role at an NREN, try to find and involve 'masterminds' of NREN services who rolled out a successful service to end-users.
Lack of knowledge of the NREN service portfolio at end-sites	Significant amount of time the users do not ask for the right service for their needs. Just ask for a lightpath service because they heard that exists.	Facilitate NRENs to promote their services better to users. GN3 Partner Services Promotion (PSP) activity is dedicated to help out here [17].
Lack of joint marketing efforts	No use cases and business models available.	1) Facilitate NRENs to provide use cases and work out business models. 2) Enlisting 'ambassadors' from end-user communities to tell about the benefits they have

		received. 3) SURFnet dynamic lightpath promotion video is a good example of NREN promotion [18]
Branding issues in promoting pan-European services at national level	Typically the GÉANT service element is embedded in a national service, which end users would see as provided by the NREN. For this reason, it was felt that centralised PR would not work.	Assisting NRENs with promoting their P2P services to end users is the part that GN3 PSP handles. It was agreed that this should entail promotion of P2P services in general, rather than Lambda and Plus by name (although materials would inevitably include mention of GÉANT).

Summary of main issues and lessons learned during the E2E workshop series

Getting closer to communities in 2011

Based on the conclusions of the workshop series it was found that the TERENA E2E activity must be reshuffled in some new forms for the future. Community agreed that it would be more productive to organise Birds of a Feather (BoF) meetings in parallel with major events in order to intensively consult with various communities in 2011. The further support (in 2012 and beyond) given to this community by TERENA must be determined based on the outcome of these BoF discussions.

In 2011, BoFs were organised during major community events such as

- GLIF Tech Winter meeting co-located with APAN conference,
- TERENA Networking Conference,
- NORDUnet Conference, and
- Internet2 Members meeting,

on the topic of "*E2E Service Architecture Verification*". This topic includes the discussions about tools and architectures as well as the roles and responsibilities undertaken by various players of the whole end-to-end (i.e. application-to-application) workflow.

Session at GLIF Tech Winter/APAN meeting

A session was organised at the GLIF Tech Winter meeting on 24-25 February 2011 in Hong Kong, China, to be held in conjunction with the APAN conference [19].

- Ronald van der Pol (SARA) presented the actual status of the GLIF Campus Networking Task Force.
- Peter Szegedi (TERENA) gave an overview on the TERENA End-to-End Provisioning Workshop series and its potential follow-up activity.
- Jerry Sobieski (NORDUnet) elaborated on the specific "service architecture verification" aspects of the end-to-end issues. An architectural proposal for defining, engineering, and verifying performance guaranteed services was presented and discussed.

Discussions concluded as follows:

- 1) Since similar discussions have been going on in various domains, it is expected that an open and global forum (such as GLIF) can practically accommodate such a long term discussion group that is highly multi-domain in nature. However, GLIF only focuses on lambda networking and not respected by all peers. TERENA is willing to bring many of these peer groups together and build one solid (global) community around the end-to-end campus issues and see how it fits.
- 2) It was also mentioned that campus issues are global; the problem space may well be larger than GLIF. More campus people from both Europe and overseas must be attracted by this activity. If TERENA wants to organise trainings or workshops (separate from GLIF) for the global community those campus network administrators/engineers who usually do not attend GLIF should also be addressed. Remote participation possibility is a key factor in that respect. GLIF is willing to fully support and contribute to any campus workshop organised beyond its boundaries.
- 3) It was agreed that the main technical challenge ahead is that the end-to-end service doesn't provide what the user expected. That is why end-to-end service architecture verification is important for both provider and end user parties. New protocols and new models of integrating the path verification function into the user virtual environment must be designed and developed. We need a comprehensive approach that considers how end-to-end performance verification processes are intrinsically linked to and parallel with the delivery of performance guaranteed services.

Technical BoF at TERENA Networking Conference

A BoF was organised during the TERENA Networking Conference on 17 May 2011 in Prague, Czech Republic. The agenda was similar to the session organised at GLIF [20].

Discussions concluded as follows:

- 1) The technical roadmap of multi-domain dynamic circuit services is converging towards the OGF-NSI standard specification (v1.0 is expected to be out in March 2012):
 - a. Both Internet2 ION service (based on DCN SS) and GÉANT BoD service (technology agonistic; i.e. AutoBAHN, OSCARS, OpenDRAC) are expected to be OGF-NSI compliant.
 - b. Efforts move away from DICE to OGF-NSI.
 - c. GLIF is planning to demonstrate the first worldwide 'NSI plugfest' including several domains and domain controllers such as: OpenDRAC (SURFnet), OpenNSA(NORDUnet), OSCARS(ESnet), G-lambda (AIST), G-lambda (KDDI Labs), AutoBAHN (GÉANT project), and dynamicKL (KISTI).

- d. We are facing with new challenges in the area of service definition and architecture.
- 2) Once the dynamic connections are technically in production the overall E2E service architecture must be carefully designed. That includes components such as E2E service verification, Authentication and authorization, Service negotiation, Management (eTOM), Operational support service (virtual, etc. These should be the focus of the future discussions.
- 3) It was suggested to issue a call for collecting research project/pilot ideas on potential service verification, authorization, negotiation, and management solutions. A workshop then can be organised to introduced these ideas and implement them e.g., on the top of the GLIF Automated GOLE Pilot infrastructure. The best ideas can be candidates for OGF standardisation.

Technical BoF at NORDUnet Conference

A BoF was organised during the NORDUnet conference on 8 June 2011 in Reykjavik, Iceland [21].

- Peter Szegedi (TERENA) gave an overview on the TERENA End-to-End Provisioning Workshop series and its potential follow-up activity.
- Victor Reijs (HEAnet) talked about the Virtualised Operational Support Service (VOSS) activity in GN3 and its relation to dynamic circuit service operation.
- Jerry Sobieski (NORDUnet) elaborated on the specific “service architecture verification” aspects of the end-to-end issues.



**Peter Szegedi (TERENA) mediates discussion on the “E2E Service Architecture Verification”
BoF at NORDUnet 2011 Conference in Reykjavik, Iceland**

Discussions concluded as follows:

- 1) An architectural proposal for defining, engineering, and verifying Performance Guaranteed (PG) services in an NSI framework was given. Delegation of responsibility for PG services allows us to decompose the problem to divide and conquer. Independent verification of service delivery is critical to future application requirements. We need a comprehensive approach that considers how performance verification processes is intrinsically linked to and parallel with the delivery of performance guaranteed services. Such a formalized and integrated conjunctive design strategy will provide a much more effective performance verification and fault localization architecture.
- 2) More extensive user community support is needed and the campus networking and end-user aspects of the activity must be strengthened in the future. The activity should better facilitate and boost the uptake of lightpaths and dynamic circuit services on demand. It was suggested to try:
 - a. Organising contests such as 'Enlighten Your Research' by SURFnet. Bring researchers and IT staff together to discuss the project ideas and possibilities. Involving security experts prior to potential realisation.
 - b. Gathering different end-sites (institutions) with different requirements together.
 - c. Work together with commercial suppliers in order to offer a complex service package (e.g., including storage, compute, etc.) not only a lightpath.

Successful end-user research projects with lightpaths and dynamic circuit services can help NRENs to collect real use cases, to build business models, and to gain learning by doing experience.

Community BoF at Internet2 Fall Member Meeting

TERENA organised a session during the Internet2 Fall Member meeting on 4 October 2011 in Raleigh, NC, USA [22].

- Jerry Sobieski (NORDUnet) presented the E2E architecture verification proposal and
- Peter Szegedi (TERENA) gave a talk about TERENA's support activity and about the plans for the future.

Some technical questions came up at the end of the session related to the service verification proposal and the presentations were acknowledged by the attendees (about 10 people).

Conclusions and lessons learned

During the discussions with different communities it became clear that the characteristic of the TERENA E2E activity must be less technology and more service oriented, getting much closer to the user communities in the future. More communication and community support components are needed. The new challenges are related to the multi-domain service development roadmap rather than the technology roadmap.

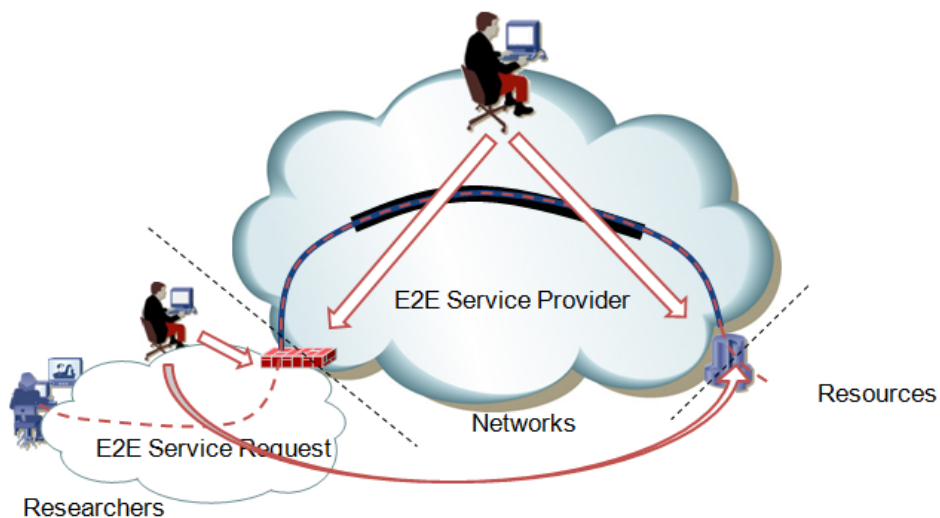


Illustration of the end-to-end connection service verification problem

The lessons learned during the BoF discussions in 2011 are summarised below:

BoF/Session	Main lesson learned	Implication
GLIF (& APAN)	Although GLIF is a global and open forum that can accommodate multi-domain worldwide activities, it is strictly focused on lambda networking and the campus and end-site problem space may well go beyond GLIF. Campus network administrators/engineers usually do not attend GLIF.	<ol style="list-style-type: none"> 1) GLIF (Campus Networking Task Force) is going to collect and document use cases based on the experiences with number of successful lightpath demonstrations in the past. 2) A potential 'Campus Workshop/Training on Lightpath Services' may be organised outside GLIF. GLIF is willing to fully support and contribute to any campus workshop organised beyond its boundaries. 3) TERNEA and GLIF should work together to organise a campus-focused workshop/training.
TERENA	Potential solutions for E2E service architecture verification, authorization, negotiation, and management are the key topics for the next coming years. Standardisation is important but that needs independent reference implementations.	<ol style="list-style-type: none"> 1) TERENA can issue a call for collecting research project/pilot ideas on potential E2E service verification, authorization, negotiation, and management solutions. 2) A workshop can then be organised to introduced these ideas and perhaps implement them e.g., on the top of the GLIF Automated GOLE Pilot infrastructure. 3) The best ideas can be candidates for OGF standardisation.
NORDUnet	More extensive user community support is needed and the campus networking	<ol style="list-style-type: none"> 1) TERENA can organise a pan-European/global contest for research project ideas using multi-domain dynamic lightpath service.

	and end-user aspects of the activity must be strengthened in the future. The activity should better facilitate and boost the uptake of lightpaths and dynamic circuit services on demand.	2) Successful end-user research projects with lightpaths and dynamic circuit services can help NRENs to collect real use cases, to build business models, and to gain 'learning by doing' experience. 3) International lightpaths, as a price, may be granted to the best project proposals...?
Internet2	Internet2 ION service is already in production with 12 DCN connectors in operational status (as of 2011). Campus connectivity to the Internet2 ION backbone is provided via an Internet2 Connector or Regional Optical Network as the access mechanism.	1) Both regional and campus participants need to understand how to connect to the Internet2 ION service. There are many ways this can be accomplished and those must be clearly explained. The same statement is true for similar services in Europe and Asia.

Summary of lessons learned during the BoF discussions in 2011

Structural changes and new strategy for TERENA E2E activity

New challenges

TERENA E2E Provisioning Workshop series partly achieved its initial goals. The BoF discussions with various communities in 2011 helped TERENA to understand the gaps and to develop a new strategy on how TERENA can more efficiently approach and support the pan-European and global E2E networking community in the future.

The technical development work of multi-domain dynamic circuit services has been going under various global peer groups (GÉANT, Internet2, GLIF, DICE, etc.) for several years and the technical roadmaps now seem to be converging towards the OGF-NSI standard specification and Open Lightpath Exchanges (OLE) that ensures the worldwide interoperability of dynamic connection/lightpath services. The main challenge to bring these peer groups together, facilitate and strengthen the working relationship between them (that determined the main characteristic of the TERENA E2E Workshops too) has now been dismissed.

The focus is now shifting from interoperability and technology issues towards E2E service definition, design, and architecture problems. However, the understanding of the campus and last-mile issues (technical and non-technical gaps), the clarification of the end-user service demands, and the promotion of the appropriate NREN services are equally important.

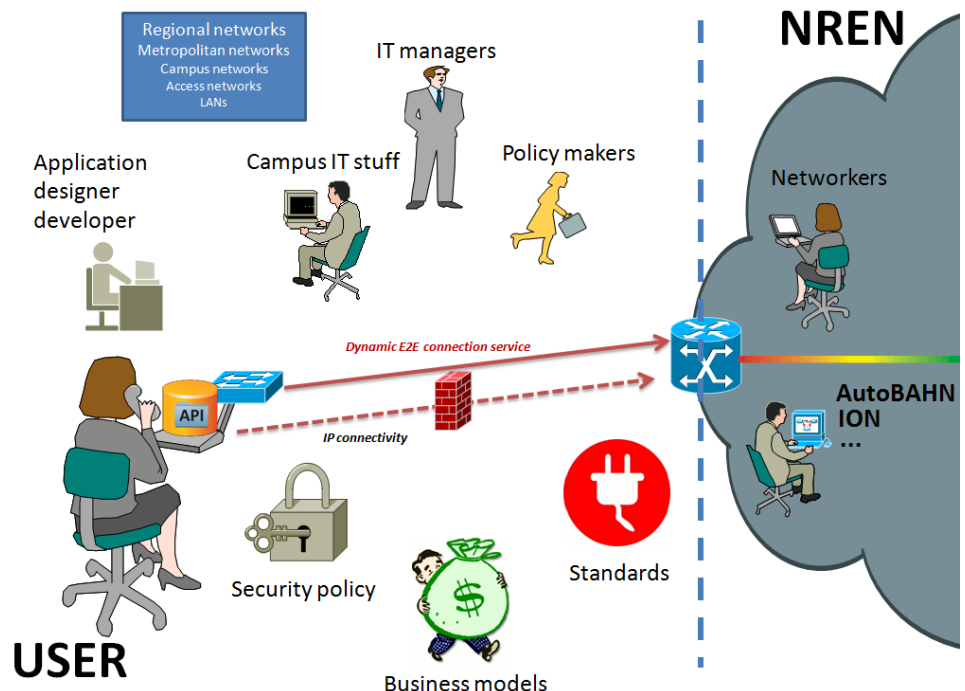
Strategy for better community support and liaisons

As NRENs become more and more service oriented and E2E dynamic connection services become part of their production service portfolio the promotion of these services and the support of user communities are getting more and more important. In a highly multi-domain, multi-level, and global research networking environment simple questions like 'who is the provider' or 'who is the customer' are not trivial to answer. Customers (not necessarily end-users; e.g., University IT departments), providers (not necessarily NRENs; e.g., Research projects), as well as scientific application developers, designers, regional, metropolitan and campus network operators, policy makers, etc. must come together in order to define and understand the overall service architecture, responsibilities, policies, and help working out appropriate business models for E2E services. The gradual involvement of commercials into the negotiations is essential.

- The TERENA E2E activity must be focused on community support and built on co-ordinations and liaisons with all the global peer groups possible (GÉENT, Interner2, APAN...).
- Technical developments and standardisation efforts must be kept under their natural domains (NRENs, OGF, IETF...) and TERENA E2E activity must harvest as many information as it can in order to facilitate knowledge sharing and to transfer that knowledge towards user communities.
- The user community support must be based on engagement with NREN community support managers and key service architects.
- This engagement must potentially be extended to campus IT departments, security officers, and policy makers, where it is possible.
- Both the technical development and the service promotion components of the activity must be harmonised and delivered in synergy with the peer groups (e.g., GN3 AutoBAHN and BoD pilot, GLIF NSI plugfest, or GN3 Partner Service Promotion, Internet2 ION service promotion).
- Industry trends, such as 100Gb< transmission and Next Generation Optical Access (NGOA) solutions, must be seriously considered.

Structure of the activity

Starting from 2011, the TERENA E2E activity is going to be more campus and end-site oriented, demand-driven, flexible container (i.e. co-ordinated set of sub-activities) that ensures the efficient information sharing and long term sustainability of the community efforts in E2E networking. It aims at investigating the emerging technical and non-technical issues, challenges of E2E dynamic connection services/architectures on- and off-campus, and identifying, proposing potential community support activities (in form of tutorials, workshops, trainings, collection of technical documentations, use cases, business models, recommendations for campus policy makers, security officers, etc.) in order to cope with these challenges.



Scope of the TERENA E2E activity

The activity is going to liaise with various peer groups (GÉANT, Internet2, APAN, GLIF, DICE, OGF, IETF, etc.) and transfer the knowledge towards the target customer groups via NREN community support managers, key service architects, where possible campus IT managers, information and/or security officers, and ‘ambassadors.’

Activities proposed for 2012/2013 (input to TERENA’s activity plan)

The following events are proposed to be organised within the TERENA E2E activity container in 2012/2013. The list contains 2 campus and 2 NREN oriented events strictly related to each other in an iterative way. The campus workshop on lightpath services has the highest priority that can provide feedback to the appropriate E2E service architecture design of NRENs. The necessary training for NREN people is then essential to materialise the benefits of dynamic lightpath services in end-user research projects that can deliver the use cases and refine the business models at the end.

Event	Type	Target audience	Aim	Liaison and support	Schedule
Lightpath Services Workshop for Campuses	Workshop / Tutorial	-Campuses -End-site networkers -University IT administrators -Researchers	Raise awareness and transfer knowledge about E2E connection services to campuses	-GLIF Campus Networking TF -GN3 SA2, NA3 and PSP -Internet2 - NRENs	First half of 2012

Pilot Project Ideas on E2E Service Architecture Design	Contest and/or Unconference	-NRENS -Research institutes	Collect and pilot potential solutions for E2E service architecture design issues aiming at standardisation	-OGF-NSI -NRENS	Second half of 2012
Train the Trainers on Lightpath Services	Tutorial / Training	-NRENS - 'community support managers' -Service architects	Train competent NREN people on how to position, promote and deliver E2E connection services	-GN3 SA2, JRA2, NA3 -NRENS	First half of 2013
End-user Research Project Ideas/Experiences demanding E2E lightpath	Contest and/or Unconference	- Campus 'ambassadors' -Research institutes	Collect use cases and potential business models Learning by doing	-NRENS	Second half of 2013

Summary of events planned in 2012/2013

References

[1] Minutes of TERENA Technical Committee Meeting, 25 February 2008, TERENA Office, Amsterdam
<http://www.terena.org/about/ttc/minutes/20080225-v2-ttc-mins.pdf>

[2] TERENA E2E Provisioning Activity website at <http://www.terena.org/activities/e2e/>

[3] TERENA E2E Expert Group Wiki page (restricted) <https://confluence.terena.org/display/e2e/>

[4] TERENA WORKSHOPS End-to-End Provisioning infosheet
<http://www.terena.org/activities/e2e/20100512-infosheet-e2e.pdf>

[5] TERENA News Item http://www.terena.org/news/fullstory.php?news_id=2348

[6] TERENA News Item http://www.terena.org/news/fullstory.php?news_id=2498

[7] TERENA News Item http://www.terena.org/news/fullstory.php?news_id=2525

[8] End-to-End Service Provisioning Series infosheet
<http://www.terena.org/activities/e2e/20110510-infosheet-e2e.pdf>

- [9] TERENA News Item http://www.terena.org/news/fullstory.php?news_id=2753
- [10] P. Szegedi , “Campus Networking: End-to-End”, pp. 36, EUNIS 23-26 June 2009, Santiago de Compostela, Spain http://www.immagic.com/eLibrary/SOURCE/EUNIS_FR/C090625C/PROGRAM.doc
- [11] GÉANT3 WHITE PAPER, GN3 Proposal, Review Board, July 15, 2008
http://www.geant2.net/upload/pdf/GN3-08-034-GN3-White-Paper_20080808173508.pdf
- [12] 1st E2E Workshop on Establishing Lightpaths
<http://www.terena.org/activities/e2e/ws1/programme.html>
- [13] Report on the 1st E2E Provisioning Workshop
<http://www.terena.org/activities/e2e/ws1/slides/tsec-08-076-E2Ews-report-v2-final.pdf>
- [14] 2nd End to End Workshop on Provisioning E2E Services
<http://www.terena.org/activities/e2e/ws2/programme1.html>
- [15] TERENA Technical Committee Meeting minutes, 09 March 2009
<http://www.terena.org/about/ttc/minutes/20090309-v1-ttc-mins.pdf>
- [16] 3rd End-to-End Workshop on Applications and Services
<http://www.terena.org/activities/e2e/ws3/programme.html>
- [17] GN3 Partner Services Promotion activity <http://www.terena.org/activities/psp/>
- [18] SURFnet dynamic lightpath promotion video <http://www.youtube.com/watch?v=cAWrqtuBem0>
- [19] GLIF Technical Working Group meeting minutes, 24-25 February 2011, Hong Kong, China
<http://www.glif.is/meetings/2011/winter/Minutes-20110315-v2.pdf>
- [20] E2E service architecture verification BoF at TNC2011 <https://tnc2011.terena.org/core/event/14>
- [21] E2E service architecture verification BoF at NORDUnet Conference 2011
<http://www.terena.org/activities/e2e/NORDUnet2011/>
- [22] Internet2 Fall Member Meeting, session proposal
<http://events.internet2.edu/2011/fall-mm/agenda.cfm?go=session&id=10001955&event=1148>