



# CONNECT

THE MAGAZINE FROM THE GÉANT COMMUNITY | **ISSUE 16 JULY 2014**

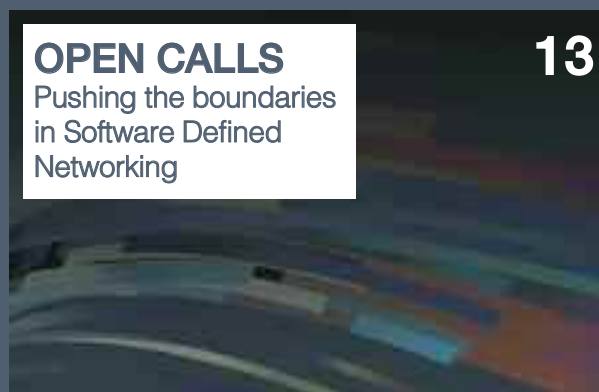
**NEW PHYSICS:**  
GÉANT'S GLOBAL  
LINKS SUPPORT  
JAPAN-BASED  
BELLE II  
EXPERIMENT

**EXCELLENT HAT TRICK:**  
GÉANT RECEIVES  
HIGHEST RATING FOR  
THIRD YEAR IN A ROW

**BOOSTING INNOVATION:**  
OPEN CALL PARTNERS  
PUSH THE BOUNDARIES  
IN SOFTWARE DEFINED  
NETWORKING

**ILLUSTRIS SIMULATION:**  
GÉANT HELPS WITH 13.8  
BILLION YEARS OF DATA

# CONTENTS



CONNECT is the quarterly magazine from the GÉANT community; highlighting key areas of interest, updates on the project and its vital work supporting European research and education. We give insights into the users who depend on the network, and the community that makes GÉANT what it is. We welcome feedback at **[connect@geant.net](mailto:connect@geant.net)**

Published by the GÉANT (GN3plus) project, under the NA2 Communications Activity Task 1 | **Editors: Paul Maurice (Task Leader) and Tamsin Henderson (Marketing Officer).**

**Hyperlinks:** CONNECT is produced as a digital magazine also made available in print. To view the digital edition and benefit from hyperlinks to further information, please see: **<http://connect.geant.net>**

For digital or printed subscriptions/unsubscriptions email **[connect@geant.net](mailto:connect@geant.net)**

Cover image © KEK 2014

**eduroam®** is a registered trademark of TERENA and all other brand, company and product names are trademarks of their respective owners.

## USERS

Illustris - The most complete simulation of our universe

08

## USERS

BELLE II – New Physics through collaboration

10

## COMMUNITY NEWS

Round up from our partners

34

## GLOBAL NEWS

News and updates from GÉANT's global partners

46

## ABOUT GÉANT

An at-a-glance guide to the GÉANT project

49

# WELCOME FROM THE EDITORS

**W**e launch the summer issue of CONNECT with the great news that the GÉANT project has for the third year running been rated 'Excellent'. This coveted grade was unanimously awarded by an independent panel at this year's European Commission review in Brussels. Congratulations once again to everybody in the project! You can read the full story on page 3.

### AMAZING STORIES OF COLLABORATION

The number of exciting collaborative projects we can report on seems to be consistently growing as high-speed networks increase in speed and capacity to support data driven science. Our cover story is yet another fantastic example. More than 570 physicists in 97 institutions from across 23 countries are working together on the BELLE II experiment which is searching for 'new physics'. What better way to demonstrate the

value of GÉANT and its NREN partners? High-speed global connectivity has never been more essential to the advancement of science.

On page 8, you'll learn about Illustris, the world's most comprehensive, detailed and accurate simulation of the universe. A mind-blowing achievement which will go on to support a whole host of cosmological experimentation and discovery.

### YOUR THOUGHTS

We thought it was about time to find out what you, our readers think about CONNECT. We asked you to be honest and tell us the good, the bad and the ugly. We had a great response, and thankfully, the majority of responses were highly positive! Turn to page 2 to find out how we plan to improve over coming issues. Thanks again to everybody who took part.



**Editors**  
Paul Maurice  
& Tamsin  
Henderson

### WHAT'S NEW?

In this issue, we're introducing a new section which will look a little deeper 'under the hood' (page 28) and we are continuing with our Open Call project partner showcase, (page 13), to introduce the people and projects that are such an important part of the GÉANT Innovation Programme. As the GÉANT project works to drive the internet of the future, these projects will bring in fresh ideas and support new users of the network.

We hope you enjoy this issue and we look forward to hearing from you via [connect@geant.net](mailto:connect@geant.net)

# CONNECT READER SURVEY

**WE ASKED YOU FOR YOUR THOUGHTS ON  
CONNECT AND YOU GAVE THEM TO US!**

## THE RESULTS ARE POSITIVE

72% of respondents view CONNECT online and 60% also read it in print. And from your comments it looks like we're doing a few things right!

**"I very much like the home stories and the insights into the workings of the GÉANT project."**

**"I like the Interviews with GÉANT people and stories about participation in events, project success stories, etc."**

**"Stories about how GÉANT changes things."**

Many of you regularly read CONNECT to gain valuable insight into the project. Well over half of respondents agree that the magazine is a useful way to communicate the project of which 24% strongly agree. (The others couldn't decide, but nobody disagreed!).

**"Favourite aspects include: the variety of topics and the interviews with individuals in the project particularly showing their personal side."**

## UNDERSTANDING THE GÉANT PROJECT

A whopping 88% of respondents understand more about the GÉANT project as a direct result of reading CONNECT.

**"I like the insights into the areas that I am least involved in, it helps to get an overview of where we are."**

You gave praise for offering a wide perspective on research and education networking, for case studies that make the story more relevant and for

highlighting the people, projects and research that you may never have heard of otherwise.

## DESIGN

We're happy to hear over 94% of respondents rate CONNECT as good or better. In fact 46% voted it 'very good' and 20% 'excellent'! Positive feedback for the overall layout and finish, reinforced with praise for quality, cover imagery and graphic design came out strongly.

**"Multicolour, multifaceted, informative, fresh, convincing!"**

A few people mentioned too many 'confusing colours', so in the future we're streamlining the colour coding and sticking to light backgrounds for easier reading.

Opinion was divided on the quality of the pages. Whilst some feel it is too glossy, others consider this to add weight to the GÉANT brand and help attract attention, particularly at industry events. Although we cannot please everyone, we will bear it in mind and always do our best to ensure there is substance behind the style.

## YOU WANT MORE PEOPLE

People love to read about people. Human interest gives a depth of insight we can all relate to. Many of you told us how much you enjoyed the people-based features, so it comes as no surprise that this was high on the list of things you asked for more of. We're introducing more 'day in the life' articles and Q&As. Could you be next? We'd love to hear from you!

**"Articles about people give a feeling of 'knowing' (the project) and those behind all the good work."**

**"Like to have more user stories and day to day life of people in the project."**



**Picture**  
Linda Mesch,  
Project Manager,  
GÉANT

## INTERESTS

While many commented on the good content and wide range of topics, some of you asked for more technical depth, focus on best practice, and educational stories to explain how services can assist in specific scenarios.

**"How about some educational material, something like 'Advisers' or 'the tip of the day?'"**

We will be introducing more technical content over the coming issues, with a dedicated section to address these areas. If you have an area you'd like to know more about, please email the editors.

## GETTING CONNECT OUT THERE

You told us you'd like more options for reading CONNECT. Currently, you can download it as a full PDF on the CONNECT home page ([connect.geant.net](http://connect.geant.net)) or view it in ISSUU to read booklet style.

Printed copies are available to anyone free of charge, and they are delivered to subscribers and NRENs every quarter. You can order copies on a regular basis or for specific events.

Many of our subscribers leave them in reception and communal areas or use them to attract customers at exhibitions.

**"CONNECT always flies off the shelves at industry exhibitions!"**

If you'd like to be added to our distribution list to receive a digital copy or if you'd like printed copies, we can help! Please drop us an email us at [connect@geant.net](mailto:connect@geant.net)

Thanks to all our loyal readers for all your great feedback. The survey is still open here:  
<https://www.surveymonkey.com/s/G5VF9H6>

# EXCELLENT HAT TRICK!

## EC AWARDS HIGHEST RATING TO GÉANT PROJECT FOR THIRD YEAR RUNNING

The GÉANT community celebrated in June as the European Commission delivered its verdict for the first year of GN3plus, which is the current iteration of the GÉANT project. This is the third year running that the GÉANT project has been awarded an 'Excellent' rating.

The independent panel took just half an hour to conclude the result, following a packed week of presentations representing all areas of the GÉANT project. An 'excellent' rating is highly sought after, with only 10 per cent of EC-funded projects reaching this grade. Niels Hersoug and Matthew Scott, Joint Project Managers, GÉANT, said:

**"Any project with new activities, new structures and new personnel was always going to be challenging, especially on the back of two previous consecutive 'Excellent' ratings. So we are delighted to have been recognised for maintaining a very high level of performance. It's clear that the combination and breadth of expertise being developed across this collaboration is very powerful and functioning more effectively and delivering better results than ever before."**

According to the reviewers, Year 1 of GN3plus was a well-managed project that demonstrated a good level of cooperation, innovation and flexibility. They gave particular praise to such areas as dissemination and outreach; Product Lifecycle Management; and the development, delivery and increased promotion of services.

Positive feedback was received for standardisation throughout the project, with a shift towards a more product-focused approach and for the projects overall ability to extend innovation through Open Calls.

Matthew Scott said:

**"Whatever role you play in this project please note that this really is a collective achievement and one that we hope you are all contributed to and one that we hope you are all justifiably very proud of. We have an ambitious and exciting year ahead as we prepare the way for GN4 [the proposed successor to GN3plus]. With the energy and dedication evident in the achievements of year 1, we should and can set our sights high."**

A two page document, 'The GÉANT Project (GN3plus) Year 1 Highlights' is available to download here:  
[www.geant.net/Resources/Media\\_Library](http://www.geant.net/Resources/Media_Library)

# GÉANT AND TERENA HONOUR RESEARCH AND EDUCATION NETWORKERS WITH 2014 COMMUNITY AWARDS



**GÉANT and TERENA present Community Awards to people who have shared their ideas, expertise and time in collaboration with the research and education networking community, recognising that such contributions are often provided voluntarily and through the good will of their employer.**

Jan Meijer (UNINETT, NO) and Stefan Winter (RESTENA, LU) received this year's Community Awards following open nominations and selection by a panel of judges. Karel Vietsch (late Secretary General of TERENA) was also, posthumously, awarded. Dorte Olesen (Technical University of Denmark), a former TERENA president and now chair of the GÉANT NREN Policy Committee, presented the awards on behalf of the judges during the closing plenary session of the TERENA Networking Conference (TNC2014) on Thursday 22 May.

Jan Meijer was lauded for sharing an idea that was discussed under his

chairmanship in the TERENA task force TF-Storage, and developed into the open-source FileSender software under Jan's leadership. This simple-to-use, federated, web-based application allows users to privately share large files through a trusted intermediary. FileSender is now deployed by almost 40 NRENs, institutions and other organisations around the world.  
[www.filesender.org](http://www.filesender.org)

Stefan Winter was honoured for helping develop eduroam® – the secure, world-wide roaming access service for research and education. With roles in GÉANT and the TERENA task force TF-MNM, Stefan led standardisation work, strove for federated solutions, and proposed and developed tools such as F-Ticks for statistics collection and CAT, the universal eduroam configuration tool. Almost 600 institutions have signed up to CAT, with 500,000 end users running a secure configuration that required no effort from them.  
<https://cat.eduroam.org/>

In May 2013 Karel Vietsch received Dutch royal recognition for his contributions to research and education networking, when he was appointed an Officer in the Order of Orange-Nassau. His work had influenced prominent Internet organisations and initiatives, and

**Words**  
Laura Durnford,  
Senior  
Communications  
Officer, TERENA

**Picture**  
From left to right,  
Valentino  
Cavalli, Stefan  
Winter, Dorte  
Olesen and Jan  
Meijer

Karel demonstrated his commitment to the community by leaving it a legacy in the form of the 'Vietsch Foundation', which aims to stimulate the community's work in future. The Community Award judges acknowledged Karel's extraordinary dedication by honouring him posthumously, after he passed away on 23 February 2014. For further information about the Vietsch Foundation, please contact Valentino Cavalli: [cavalli@terena.org](mailto:cavalli@terena.org)

## FURTHER INFORMATION

Details are available via  
<http://www.terena.org/about/people/awards/>

In addition to Dorte Olesen, the 2014 judges were:

Pierre Bruyère (Belnet, BE),  
TERENA President;

John Boland (HEAnet, IE),  
CEO of the TNC2014 host  
organisation;

Erik Huizer (SURFnet, NL),  
Chair of the TNC2014  
Programme Committee.



# E-INFRASTRUCTURE SUMMER WORKSHOPS SUPPORT EASTERN PARTNERSHIP DEVELOPMENT

**W**ith roles in the GÉANT project's tasks on Digital Inclusion, Campus Best Practices, and User Access and Applications, TERENA co-operated with CEENet, BREN and CSC-Funet to organise a series of workshops for NRENs and institutions from Eastern Partnership countries, with funding from EC Platform 4. The main objective is to transfer tools and knowledge, so these countries can join the growing global community of interconnected NRENs. Almost 50 people from ten Partnership and other Eastern European countries participated in the first workshops, which were held in Sofia, Bulgaria, from 16-20 June.

The first three days were aimed at staff from NOCs (Network Operation Centres) and featured a GÉANT Technical Workshop focused on network security training. Participants learned how to implement security policies, how to select and operate security tools needed in daily network management and how to operate

CSIRTs (Computer Security Incident Response Teams) in the GÉANT environment.

The following days included a half-day GÉANT Services Workshop on campus best practices in wireless networks. This was a 'crash course' covering the most important aspects of Wi-Fi wireless network deployment and included live demonstrations and the sharing of practical experiences, with a particular focus on the eduroam service. The final day-and-a-half was a federated identity technology workshop aimed at managers and IT leaders. The objective was to educate attendees on policy issues, business case and deployment options related to the development and support of pan-European and global identity e-infrastructures.

"As the Technical University of Sofia had just joined eduroam and the Sofia University was in the process of enabling eduroam, it really was a good time to get together and discuss best practices", said Jari Miettinen of CSC/Funet, who leads the Campus

Best Practices task. "The workshops provided a great opportunity for international multi-directional information exchange and community building. All the partners, their expertise and contributions are needed in the European co-operation."

Brook Schofield, the TERENA Project Development Officer with responsibilities in various project tasks, explained that "members of the Eastern Partnership and their neighbouring countries had not been involved in building the body of knowledge around identity federations, so these events compressed 10 years of experience to ensure their roadmap accelerates their participation in the global federation infrastructure."

Follow-up workshops to provide more in-depth technical training in all these areas are being organised. The first will align with the joint RoEduNet-RENAM conference in Chisinau, Moldova, on 11-13 September. To stay up to date with developments, see: [www.terena.org/activities/development-support/workshops/](http://www.terena.org/activities/development-support/workshops/)

**Words**  
Laura Durnford,  
Senior  
Communications  
Officer, TERENA

**Picture**  
Sofia, Bulgaria

# COORDINATING E-INFRASTRUCTURES ACROSS EUROPE

## NEW E-INFRASTRUCTURE COLLABORATION COMMITTEE TO ENSURE COLLABORATIVE OPPORTUNITIES ARE MAXIMISED

GÉANT's role as a key enabling e-infrastructure involves extensive collaboration with other European partners. Now, in a move to ensure collaborative opportunities in Horizon2020 with other e-infrastructures are coherently investigated and coordinated with the planning of GN4 (the proposed next-generation of GÉANT project), the E-infrastructure Collaboration Committee (EICC) has been formed, with members having experience not only in networking, but also in computing, storage and cloud activities.

Therefore the role of the EICC – who will work closely with the GN4 Working Group, the group working on the

proposal for the next-generation of GÉANT project – is to look further into where Horizon2020 calls invite collaboration between different publicly funded e-infrastructures in Europe. Where concrete calls are found, the EICC should ensure coordination between such project proposals and the relevant activities in the proposed next-generation GÉANT project, such that overlap is avoided and activities are complementing each other under the common umbrella of the GÉANT strategy for the areas in question. It is therefore anticipated that the activities within that project would be linked as closely as possible with the collaborative opportunities.

**Words**  
**Paul Maurice,**  
**Senior**  
**Communications**  
**Officer, DANTE**

The appointed members of the EICC are as follows:

- Jan Gruntorad (Chair, CESNET)
- Valentino Cavalli (TERENA)
- Marco Paganoni (GARR)
- Simon Leinen (SWITCH)
- Josva Kleist (NORDUnet)
- Marko Bonac (ARNES)
- Ivan Maric (Srce-CARnet)

Dorte Olesen, Chair of the NREN PC and GN4 Working Group, adds, "I am delighted the EICC has been formed with so many outstanding members of our community volunteering to be part of this valuable work. I believe this area is crucial for the coming years. A special thank you goes to the Chair, Jan Gruntorad, who has taken up this challenging task."

# EGI AND GÉANT SYMPOSIUM ON FEDERATED COMMUNITY CLOUD SERVICES FOR E-SCIENCE



In September, as part of EGI's Conference on Challenges and Solutions for Big Data Processing, EGI and GÉANT are jointly organizing a two-day Symposium on federated cloud services to support the European Research Area.

The Symposium takes place from 25 to 26 September 2014 at the Amsterdam Science Park in the Netherlands and is focused at:

- User communities with cloud service requirements
- Community and commercial cloud providers and integrators
- Cloud technologists.

GÉANT and EGI are inviting cloud providers, integrators of community clouds offerings, cloud specialists, cloud users and other stakeholders from the research and education community to participate by submitting proposals for presentations and workshops in the following tracks:

1. **AAI:** authentication and authorization requirements for cloud tools and services, cloud storage and other user facing services dealing with privacy as well as management of data access to sensitive data.
2. **Data analysis platforms:** user community requirements for platforms needed to execute workflows, requirements for underpinning IaaS services.
3. **Storage and data transfer:** use cases and requirements for cloud storage services including federated storage, data replication and transfer.
4. **Resource placement:** use cases and requirements for policy-based resource placement in order to submit workloads to clouds hosting specific datasets, adhering to security policies and regulations and supporting specific SLAs.
5. **User-facing services:** services that cloud providers and more broadly e-infrastructures should provide to their users, such as user-friendly

tools to manage the allocated resources, to access aggregated information about resources availability, resource usage or platforms available for deployment.

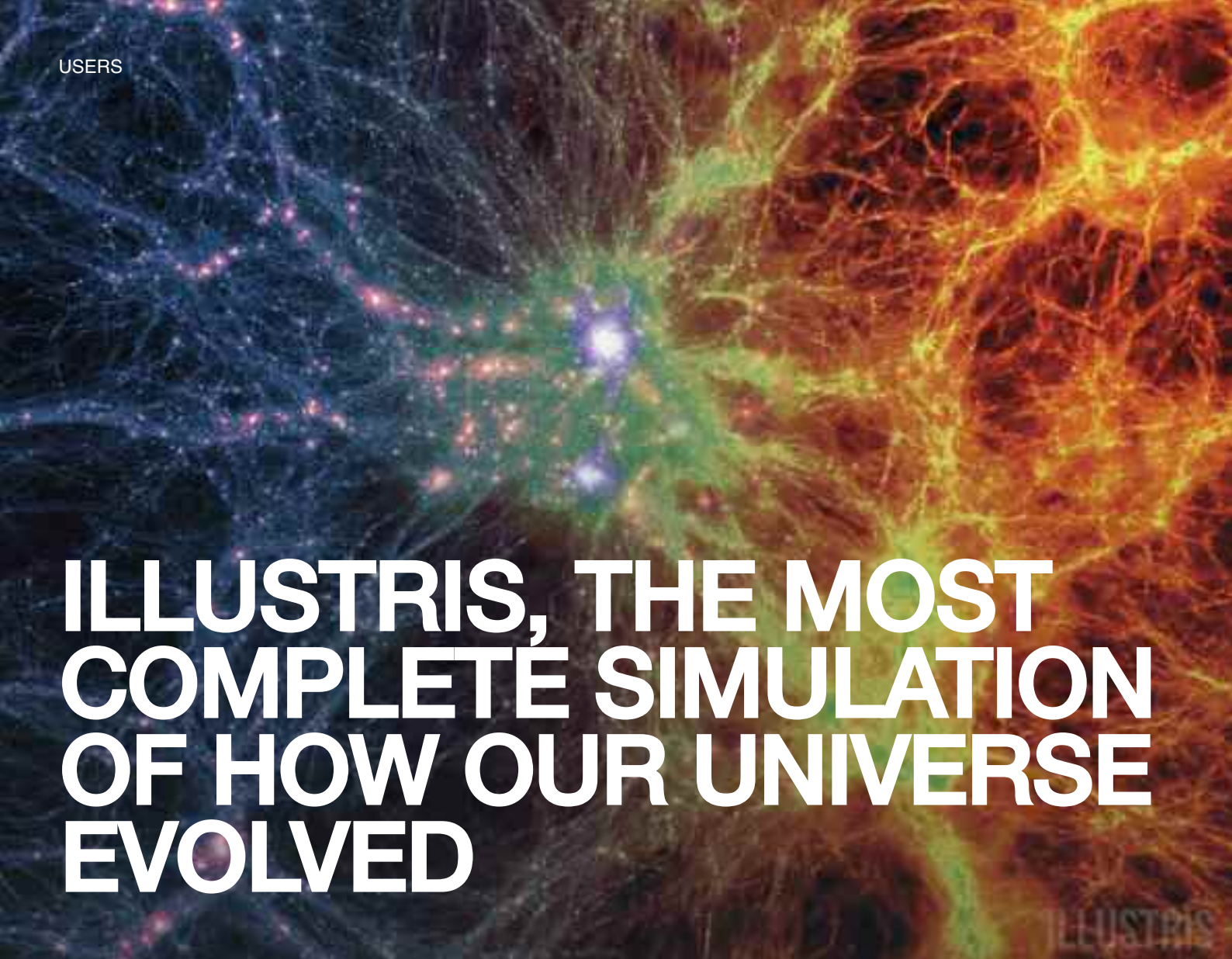
6. **Network services:** use cases and requirements for software-defined networks, bandwidth on demand, virtual private networks and other advanced network services.

The deadline for submission of abstracts is 19 August 2014 and successful applicants will be notified by 29th August.

Registration for the symposium is free but spaces are limited so early registration is recommended.

**Words**  
Karl Meyer,  
Product  
Marketing and  
Communications  
Officer

For more details on the symposium, registration and submission of proposals visit:  
<https://indico.egi.eu/indico/conferenceDisplay.py?ovw=True&confid=2160>



# ILLUSTRIS, THE MOST COMPLETE SIMULATION OF HOW OUR UNIVERSE EVOLVED

In May this year, scientists collaborating in the US, Germany, and the UK announced they had created the most complete simulation of how the universe evolved.

The Illustris project is a time-lapse simulation, which traces the history of the universe, as we know it, starting soon after the Big Bang right through to the present day. It captures 13.8 billion years of evolution and is the most extensive and comprehensive physical model of the universe we have yet seen.

Cosmologists have been creating computer models of the universe for over two decades. Only now has a true simulation like this been possible due to the immense computing power and massive bandwidth required to handle the vast amounts of data.

To put this spectacular achievement into perspective, it would take a single state-of-the-art desktop computer more than 2,000 years to run the simulation.

Today, supercomputers and the high-capacity GÉANT network made this possible in just three months.

Bringing together ten researchers from three different countries, Illustris demonstrates how powerful, high-speed bandwidth is removing the boundaries of today's internet and accelerating global scientific discovery.

CONNECT spoke to Professor Volker Springel from the Heidelberg Institute for Theoretical Studies, to find out a little more about the project.

## IN A NUTSHELL WHAT IS ILLUSTRIS?

The Illustris project is a massive cosmological simulation, which shows a cubic chunk of the universe in unprecedented fidelity. It measures 350 million light-years on each side and contains more than 40,000 well-resolved galaxies.

## HOW DOES IT DIFFER FROM PREVIOUS SIMULATIONS?

Unlike previous simulations, where the result is a rough approximation of what astronomers see, Illustris comes up with a universe much like the real one. Many of the simulated galaxies match the galaxies in the real universe, which confirms the standard theory of cosmology.

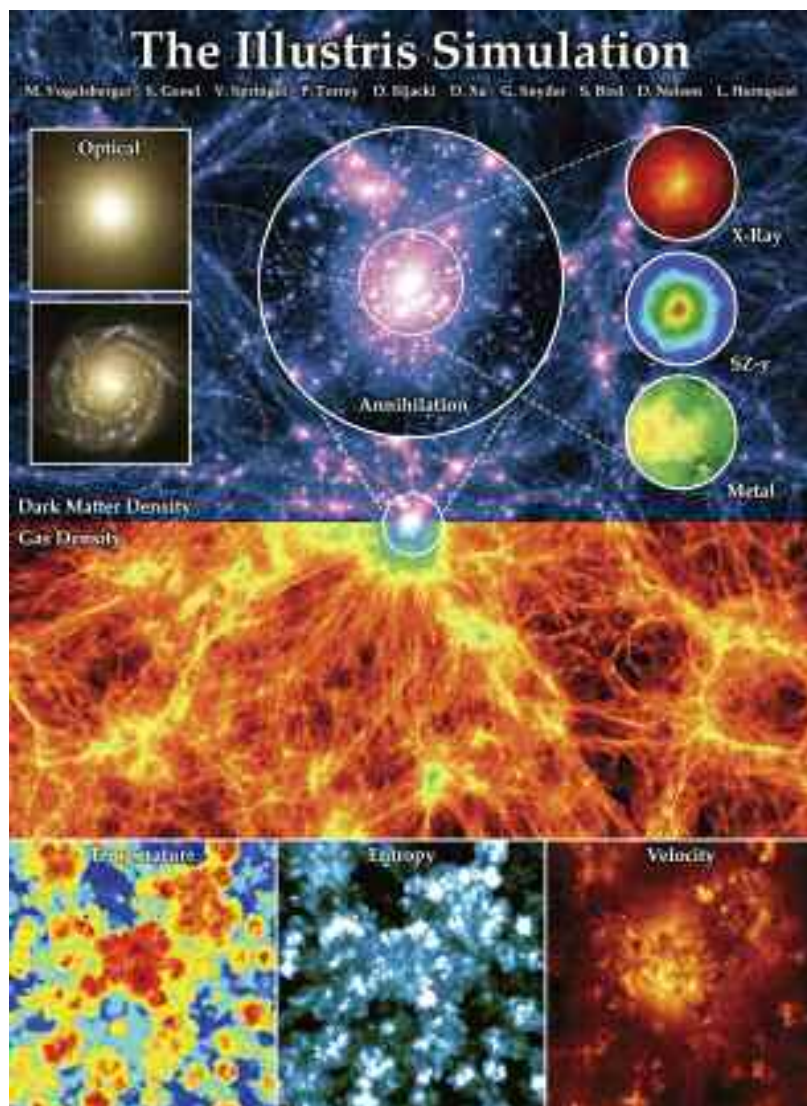
It also demonstrates how the first galaxies formed around clumps of the mysterious substance, 'dark matter', backing the theory that dark matter is the scaffold on which the visible universe is hanging.

## Words and Interview

Tamsin Henderson, GÉANT

## Images

Illustris Simulation



## WHAT'S THE PURPOSE OF THE PROJECT?

Galaxy formation is one of the most important unsolved problems in cosmology today. Illustris help us to better understand how stars and galaxies form.

It provides important insights into the rate at which certain types of galaxies develop and helps cosmologists learn more about the 'dark energy' that we believe is powering the continued acceleration of the universe.

## HOW CAN THIS INFORMATION BE USED?

According to co-author Shy Genel of Harvard University: "Telescopes, such as Hubble show us what far-off galaxies looked like millions or billions of years ago, because those galaxies are millions or billions of light-years away. A main benefit of Illustris is that it lets researchers see what those galaxies might have looked like at various points in time. Like a time machine, we can go

forward and backward in time. We can pause the simulation and zoom into a single galaxy or galaxy cluster to see what's really going on."

These findings could be used to fine-tune experiments performed with space-based telescopes. The project will provide a test bed for emerging theories of what the universe is made of, helping organisations such as The European Space Agency, and its planned spacecraft EUCLID, which is due to launch in 2020 to measure the acceleration of the universe.

## HOW ON EARTH DID YOU ACHIEVE THIS?

We began by entering details of what the Universe was like shortly after the Big Bang, then developed a computer program encapsulating the main theories of cosmology. After this, we let the program run. Of course in order to do this we needed to assemble a talented team in cosmology and astrophysics from around the world.

As you can imagine, as well as connecting ten different researchers situated in different continents, a project of this scope also requires access to vast computing resources. We used several months of computing time at multiple computing centres. For instance, we used 20 million core hours on the PRACE HPC resources in France and Germany, including the CURIE supercomputer at CEA/France and the SuperMUC at the Leibniz Computing Centre, Germany.

## WHY ARE HIGH-SPEED NETWORKS SO IMPORTANT?

With so much data and so many researchers needing to collaborate seamlessly, reliable and high-capacity bandwidth was critical. GÉANT and its NREN (National Research and Education Network) partners, in this case Janet in the UK, RENATER in France and DFN in Germany, provided the fast, reliable and convenient 500Gbps bandwidth that helped us realise the most ambitious project of this kind seen thus far.

Find out more and explore the simulation for yourself here:  
[www.illustris-project.org](http://www.illustris-project.org)

## WHO IS INVOLVED?

### Europe:

- Heidelberg Institute for Theoretical Studies, Germany
- Zentrum für Astronomie der Universität Heidelberg, Germany
- Kavli Institute for Cosmology, Cambridge, UK
- Institute of Astronomy, Cambridge, UK

### U.S:

- Massachusetts Institute of Technology
- Harvard University
- The Space Telescope Science Institute
- The Institute for Advanced Study

Special thanks to Audrey Gerber, IUCC-Inter-University Computation Center, for her help in researching this article.

# BELLE II EXPERIMENT BENEFITS FROM GÉANT'S GLOBAL LINKS

Copyright KEK 2014. Images are the property of KEK and must not be reproduced without express permission from KEK

The area of particle physics has been well served by GÉANT and other international research and education networks for many years. The Large Hadron Collider at CERN is surely the best known in this area of physics, and has done much to raise the profile of electrons, protons and neutrons. But what about the complementary BELLE II experiment, part of a rapidly growing community in Japan that is prompting many to see this part of the world as a future centre of experimental physics.

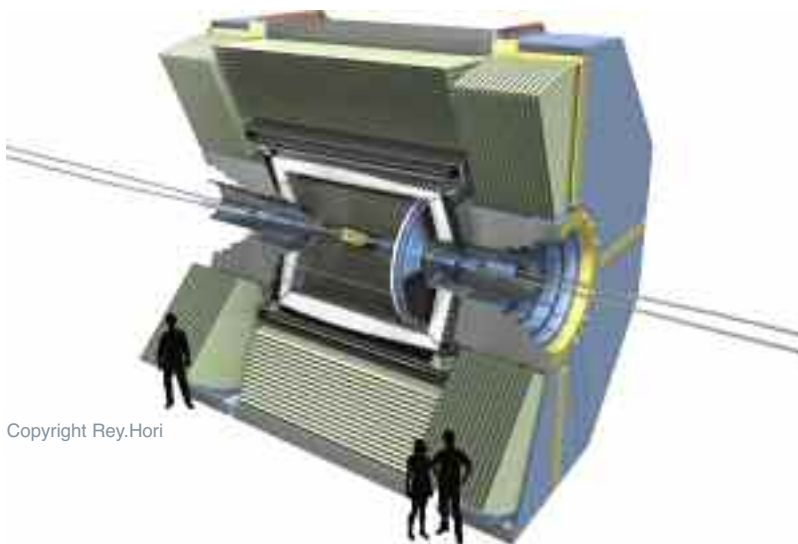
CONNECT spoke to Vincenzo Capone, GÉANT and Takanori Hara of KEK, to understand more about this experiment and its potential impact on GÉANT's global connectivity.



## WHAT IS BELLE II, AND WHAT DOES IT HOPE TO ACHIEVE?

The BELLE II experiment deals with the project of an asymmetric-energy electron-positron ( $e^+e^-$ ) collider, named SuperKEKB, and focused on the so-called “flavour physics” which searches for New Physics by precise measurements of the interactions involving the various quark families (“flavours”). It is the continuation of the former BELLE experiment (and in a similar track to other experiments like BaBar) that had the same objectives but used a previous collider facility (KEKB).

The ultimate goal is to understand the reasons of the actual form of the universe, based on the assumption that while at the time of the Big Bang there were equal amounts of matter and anti-



Copyright Rey.Hori

matter, today only matter remains. This could be explained by the CP violation, which is an extremely small violation of the symmetry between matter and anti-matter in nature; with a perfect symmetry, for every particle created during the Big Bang the relative anti-particle should have been created too, and while a particle and an anti-particle ends annihilating each other with the production of pure energy, without the CP violation our universe wouldn't exist as we know it.

The research pursued by BELLE and BELLE II is devoted to detecting the broken symmetry theory predicted three decades earlier by the 2008 Nobel Prize winners Kobayashi and Maskawa.

## WHERE IS IT BASED, AND WHO ARE THE PARTNERS?

The experiment facility is located in an area near Tsukuba (40 min. from Tokyo), at the KEK Institute, that also hosts the computing equipment needed to store the raw data produced by the detectors. The BELLE II Collaboration is constituted of more than 570 physicists from 97 institutions across 23 countries. Amongst the participating countries, Germany, Italy and Slovenia play a key role in the computing infrastructure of the experiment.

## WHY DOES BELLE II NEED HIGH SPEED CONNECTIVITY?

One of the most important figures of merit for a particle collider is its luminosity, which stands for the number of particle collisions that occur every time the beams collide. It is in turn related to the number of events that will be collected and available for the

physics analysis. A higher luminosity means that the researchers will have a higher number of “good” events on which to base their observation, and also that far more experiment data will be collected. High statistics samples allow for precise results, and in this sense BELLE II will collect an unprecedented amount of data for an  $e^+e^-$  collider. The peak luminosity of SuperKEKB is expected to reach  $8 \times 10^{36} \text{ cm}^{-2}\text{s}^{-1}$ , and the expected data production of the detector is rated at approximately 25 Petabytes per year (over 25 million Gigabytes). The experiment will have a distributed computing system that will make use of grid computing facilities, so the bandwidth between the computing sites needs to be sufficient to accommodate this huge amount of data movement.

## WHERE WILL THE DATA GO TO, AND WILL IT INVOLVE OTHER INTERNATIONAL NETWORKS?

A “mirror” site for the main computing facility in Japan is located at Pacific Northwest National Laboratory (PNNL) in Richland (State of Washington, USA), that will host the same raw data and will reprocess them, transforming them into the so-called mDST (physics-analysis-oriented compact dataset made from raw data). These data will then be transferred to a number of sites in Germany (40% - DESY, GridKa), Italy (40% - CNAF, ReCaS and other INFN sites in Italy) and Slovenia (20% - SIGNET), that collectively constitute the Tier-1 computing facility for the reprocessing of data. The subsequent analysis of the reprocessed data will be performed on a currently unknown number of worldwide-spread sites.

### Words

Paul Maurice interviewed Vincenzo Capone of GÉANT's pan-European user liaison team; and Takanori Hara of KEK.

### Pictures

Illustration (left) and image (far left) show the BELLE II detector. All images are the property of KEK and must not be reproduced without express permission from KEK.



Copyright KEK 2014. Images are the property of KEK and must not be reproduced without express permission from KEK



Copyright KEK 2014. Images are the property of KEK and must not be reproduced without express permission from KEK

## WHAT CHALLENGES ARE THERE IN PROVIDING THIS CONNECTIVITY?

The GÉANT connectivity needed for the BELLE II experiment is basically in two main directions, to North America and to Japan. Currently the available bandwidth to North America is more than sufficient to accommodate the experiment's data traffic, however the connectivity to Japan is in a less-than-ideal state, due to the distance and the relative costs. At the moment, the 10G connection with SINET4, the Japanese NREN that connects KEK, goes via North America, to benefit from GÉANT's direct peering in New York, but the very long distance on that route leads to relatively high latency, which has the effect of reducing the maximum achievable bandwidth to well below 10G. Promisingly however, there are high expectations of greatly improving, over the next 1-2 years, the quality and bandwidth of eastward connections from GÉANT to Japan, that will not only provide tangible benefits to the BELLE II experiment, but also to a big number of other scientific collaborations between Europe and Japan.

## HOW IS GÉANT WELL POSITIONED TO OFFER THIS?

GÉANT peers directly with ESNet (Energy Sciences Network, that connects PNNL) and SINET4 (Science Information NETWORK, that connects KEK) thereby offering the ideal position to provide sufficient and reliable

connectivity to both the North American and Japanese sites for the BELLE II European partners, who are of course connected to GÉANT via their national NRENs. GÉANT's high speed links with the world's other major international research and education networks will also benefit the BELLE II worldwide user community, enabling them to access the analysis data stored at the European distributed Tier 1 sites.

## WHAT DOES GÉANT PROVIDE TO BELLE II?

GÉANT's support to the experiment has been provided in two areas:

- A perfSONAR-based solution has been tested to provide network monitoring, with five sites currently running a perfSONAR measurement point and work ongoing to establish a Measurement Archive and User Interface at PNNL, aimed at building a BELLE II dedicated network weather-map based on perfSONAR.
- Coordination and support for a BELLE II Data Challenge using the ANA-100G trans-Atlantic link: the combined efforts of GÉANT, ESNet, GARR (Italian NREN) and DFN (German NREN) have resulted in an international testbed infrastructure being set up to measure the achievable data rates, simulating the movement of a day's worth of raw data production (approximately 25 Terabytes) from PNNL to three European sites: Italy's INFN-Napoli and INFN-CNAF, and Germany's Karlsruhe Institute of Technology

(KIT). The activity has been spread across two timeframes, 12-15 May and 10-20 June, and has helped the BELLE II computing team to identify network throughput, as well as address any last-mile configuration issues.

## WHAT IS THE TIMELINE FOR BELLE II? WHEN WILL EXPERIMENTS START?

The schedule sees the commissioning of the collider starting in 2015; the data taking starting in 2017 and peak luminosity (maximum data-taking rate) expected in 2021.

**"GÉANT is proud to be working closely with another truly global collaborative project that is looking at the big questions behind the creation of the universe. We anticipate a strong and productive relationship that will not only drive forward scientific discovery, but will also help to promote stronger connectivity and links with Japan, for the benefit of all research and education users."**

Vincenzo Capone.

# GÉANT AND THE SDN REVOLUTION

Software Defined Networks are one of the hottest research topics over the past three years. The benefits SDN can bring to internet networking - speed, agility, flexibility, improved security, lowered costs - and the potential it has to radically alter the networking landscape make this a cornerstone of networking innovation. Indeed, SDN is one of the three pillars in the virtualisation revolution (compute, storage, and network virtualisation); without SDN, it is not possible to fully exploit the enormous potential of cloud technology.

**O**n the institutional front, there is firm recognition of the key enabling quality of Software Defined Networks. In the US, the National Science Foundation has instituted a specific line of funding for these activities with its CC\*IE (Campus Cyberinfrastructure – Infrastructure, Innovation and Engineering) program.

In the EU, the European Commission has established as a priority in its 'Future Networks' funding objective "Internet architectures enabling innovation in network virtualisation, specifically through programmability of network functions and protocols."

GÉANT has a fundamental role in the evolution of this technology; its OpenFlow facility, deployed over the world-class production infrastructure, is increasingly popular with Europe's innovators, including the teams from the Open Call projects. Six of these projects focus specifically on SDN research, while others use it to develop new-gen applications and other innovative services.

GÉANT's own research teams in this area are working on laying the grounds for new capabilities and services, as well as new service models for GÉANT and the NRENs. The areas covered include green networking, multi-domain SDN, SDN-driven security, SDN capabilities to support the Cloud, and various related activities to support the integration of the network with compute and storage resources. In addition, the GÉANT research teams work closely with the Open Call projects.

We present here three Open Call projects that work on diverse developmental aspects of SDN, from implementing the technology at a carrier grade in IP backbones to optimising data flows dynamically, to creating a user friendly service for researchers to directly harness the power of SDN-enabled virtual networks; plus one project in the Applications area that uses SDN to provide specialised caching of Video-on-Demand services to improve quality while reducing costs.

**"You really want to have networks that are designed for friction-free science."**

Eric Boyd, Internet2

**"All together that could mean a world that is fully connected. Seamless networks, merging fixed and mobile. Virtual networks defined by software. Connected devices that talk directly to each other. Constant connectivity for every European, everyone able to stay informed and empowered instantly, anytime, anywhere. Downloading and uploading from their locker in the cloud."**

Neelie Kroes, Future Internet Assembly, Athens, 18 March 2014

**"One of the key drivers was to basically shatter that black box ecosystem and create an environment with smaller, more modular components that people could mix and match; by decoupling the control plane from the data plane you can have intense competition amongst the switch vendors, and competition among the controller vendors, or partnerships; basically, by breaking up these back boxes into smaller subcomponents, it allows a faster innovation cycle."**

Eric Boyd, Internet2

## Words

Diana Cresti,  
GARR

# COCO

## ON DEMAND COMMUNITY CONNECTION SERVICE FOR ESCIENCE COLLABORATION

The increasing interconnectedness of research communities on a global scale is pushing the demand for custom virtual networks. Researchers want to be able to share resources, such as Virtual Machines, storage, microscopes and other facilities, by setting up private and secure virtual networks to fit their specific needs.

Currently, only technical experts have the required knowledge to manually set up these virtual networks. But SDN and NaaS (Network-as-a-Service) service models can facilitate eScience communities in the creation and management of virtual networks.

The CoCo project is building a proof-of-concept for a service that brings the power of SDN to the fingertips of researchers, allowing them to create their own virtual network without having to rely on experts. The CoCo service - short for 'Community Connect' - is based on the

OpenFlow programmable network infrastructure, and will be accessible through a simple and easy to use web interface; it will allow users to create on-demand virtual private multi-domain, multipoint data/network instances, interconnecting laptops, virtual machines, storage, instruments and other eScience resources.

The project is a joint effort between SURFnet, the Dutch NREN, and the Dutch research organisation TNO. The team held a workshop in January of this year to establish some core use cases from the direct input of the research community, yielding two high level use cases: DNA sequencing as a Service and Shared Electron Microscope. These will provide the template for ongoing collaboration with the user communities to ensure the efficacy and usability of the service.

# CEOVDS

## VIDEO ON (INCREASINGLY HIGH) DEMAND

The rapidly growing popularity of Video on Demand (VoD) services is a major challenge for network capacity. Often, this huge amount of content is delivered across the same channels multiple times, resulting in unnecessary stress on the network. To mitigate this, an intelligent network should be able to 'know' when identical content is being delivered repeatedly, and react by implementing an appropriate service to reduce identical transmissions, such as caching. Enter OpenCache, the service being developed by CEOVDS.

The CEOVDS project is managed by the School of Computing and Communications at Lancaster University and has gained the attention of mainstream media such as Computer Business Review.

OpenCache uses OpenFlow to optimise important VoD delivery metrics, such as buffering time, throughput, and video quality, to reduce the impact of repeated delivery of identical content over the network, thus reducing the cost of delivery to the network operator.

The university had already developed a prototype architecture, the precursor of OpenCache, to provide OpenFlow-enabled VoD caching at a single physical site. With the CEOVDS project, the team has access to the GÉANT OpenFlow facility, where the service is being extended to run across multiple sites.

This innovation is expected to significantly reduce VoD service costs for network operators.

# DYNPAC

## DYNAMIC PATH COMPUTATION TO IMPROVE QUALITY OF SERVICE (QOS)

A fundamental benefit that SDN (Software Defined Networking) has over classic IP connectivity is the potential to greatly improve network efficiency by regulating traffic flow in response to the status of the network at any given time. This is the area addressed by the DyNPac project, which is working on an OpenFlow solution that uses dynamic path computation algorithms to shape traffic in a QoS-aware manner and based on real time information about the network.

DyNPac is run by the I2T Research Group from the University of the Basque Country, a team that has extensive experience in OpenFlow technologies as well as telecommunications service management and working with the Spanish and Basque NRENs.

"We want to take advantage of the characteristics of OpenFlow" says Eduardo Jacob, project coordinator "in the sense of being able to define the flows by disaggregating the original flow in several smaller flows, reacting to the state of the network; this means that we are able to monitor the network and as a response to the actual state disaggregate traffic, route it in different parts of the network, and aggregate it again at the exit of the network. This will give us the possibility to have a better use of the network, because we will have better control of the capacity used, so it will be interesting from the economical point of view. This also benefits those applications related to security."

# DREAMER

## SDN – COMING TO A NETWORK NEAR YOU!

What does it take to evolve the current IP backbone to SDN (Software Defined Networking)? This question is at the core of the work being carried out by the DREAMER project, which is developing a solution based on a thorough study of the actual operational requirements of an NREN.

DREAMER brings together three partners: the Italian research organizations CNIT and CREATE-NET, and the Italian NREN, GARR, which contributes – among other things - the operational requirements.

"The project is about evolving the current IP backbone network towards SDN, by meeting carrier-grade requirements," says Stefano Salsano, coordinator of the project. "For this purpose the project will enhance the existing open source platform – we want to have an open

approach – so we want to evolve this platform adding this new capability."

DREAMER takes an evolutionary approach whereby the SDN functionality in the backbone nodes operates in parallel with (existing) IP routing protocols. To this end, the team designed and is currently testing a hybrid IP/SDN node called OSHI – Open Source Hybrid IP/SDN - developed entirely with Open Source components.

In June of this year, the project organised a workshop for experts in the application of SDN technology, where it gave a demonstration of the new prototype. The event, and the attendees, are part of a larger context of collaborative work by the IEEE SDN community.

# COULD DATA SONIFICATION DELIVER WHILE-YOU-WAIT CANCER DIAGNOSIS?

*Converting cell data into sounds could enable GPs to make instant, non-invasive cancer diagnoses during a routine check-up. This could significantly reduce the agonising weeks of waiting for test results. Government waiting time targets currently specify that there should be no more than 2 months wait between an urgent GP referral for suspected cancer and starting treatment.*

The preliminary study was launched earlier this year at the 20th International Conference on Auditory Display. It is a collaboration between GÉANT; Birmingham City University and the University of Central Lancashire.

The novel method could also help surgeons perform faster, more accurate treatment on cancer patients undergoing life-saving surgery.

Domenico Vicinanza, Product Manager at GÉANT was the researcher responsible for the sonification. He said:

**“Part of my role at GÉANT is to explore new ways for representing data and discovery through the use of high-speed networks. This study is no exception and a great opportunity to assist with such a potentially life-enhancing project that addresses one of society's biggest challenges”.**

## WHAT COULD THIS MEAN FOR CANCER DIAGNOSTICS?

### INSTANT DIAGNOSIS

Traditional diagnosis might involve taking a biopsy, sending it to the lab and waiting for the results. It can take weeks and even months. In the future, GPs could use audio feedback devices to diagnose certain types of cancer on the spot by scanning a patient to detect specific sound signals. With instant medical feedback, a GP can make a fast, more confident diagnosis - without time-consuming or uncomfortable tests or scans - and react immediately.

### FASTER, MORE EFFECTIVE SURGERY

When removing cancerous tissues, even a small amount left behind can be dangerous. By listening to data in a patient's body via an audio diagnostic tool or probe, a surgeon is more likely to spot remaining cancerous cells than by visual inspection alone. This provides another layer of assistance and leaves the surgeon's eyes free to focus on the operation. This is likely to reduce surgery time and improve the probability of all cancerous tissue being removed from the body.

## WHY DATA SONIFICATION?

This shows that data sonification – where data is conveyed as audio signals as opposed to visual illustrations such as graphs – can improve standard techniques currently used in biomedical spectroscopy analysis.

Current spectroscopy methods involve firing light from a laser into cells and observing how it reacts. However, analysing the results and determining healthy cells from cancer cells involves looking through large datasets by eye, which is time consuming and difficult. The study found that by classifying this data into audio signals, it is easier to differentiate between different types of cell, improving accuracy and allowing researchers to search through large volumes of data very quickly.

Ryan Stables, a researcher for the School of Digital Media Technology in Birmingham who lead the study said:

**“This method of identifying cancerous cells is similar to that of using a metal detector. It allows you to identify the characteristics of cancer in real-time, which we hope could have life-changing implications for patients through the development of better diagnostic tools.**

**We are now looking at using different types of data and are hopeful the research could be used for treating other physical diseases, not just cancer.”**

Domenico Vicinanza, added:

**From a practical point of view, listening to a single sound for a prolonged period of time can be pretty hard on the ears, so I was keen to ensure the sounds were bearable and perceptually interesting.”**



## WHAT'S NEXT?

Ryan Stables said:

**“The next step for the project is to start analysing different types of data (cell types, tissue samples, etc.). Our current goal is to start developing the hardware for the Raman spectroscopy-based probe over the next few months. We’ve just taken a PhD student on in this area, and they’re currently looking at methods for creating non-intrusive auditory feedback during high-pressure situations such as surgery.”**



## WHAT IS DATA SONIFICATION?

Domenico Vicinanza explains data sonification - watch the video here:

**[www.geant.net/sonification\\_video](http://www.geant.net/sonification_video)**



# PRODUCT LIFECYCLE MANAGEMENT

## - TAKING GÉANT FORWARD TO MEET THE CHALLENGES AHEAD

GÉANT Product Manager Domenico Vicinanza explains how Product Lifecycle Management (PLM) benefits GÉANT and the R&E Community.

### DOMENICO, PLM HAS BEEN IMPLEMENTED FOR OVER A YEAR NOW – HOW HAS IT IMPROVED THE EXPERIENCE OF THE GÉANT DEVELOPMENT TEAMS?

The biggest benefit has been in providing a clear, predictable structure to product development. Developers and task leaders understand the process of turning a concept into a production service and know what steps are needed. Activity leaders can much more easily monitor progress and can help secure and allocate resources much more easily.

### DOESN'T THE NEED FOR “GATES” BETWEEN THE CONCEPT, PILOT AND PRODUCTION STAGES RESTRICT DEVELOPERS?

Not at all. By dividing development into clear stages both the development teams and users understand how a service transitions from pilot into production and what is expected of the service.

### SO HOW DO NRENS AND USERS BENEFIT?

Before it was hard for users to understand the status of the service they were using. Now users can understand that a production service, just like a commercial service, will have firm SLAs [Service Level Agreements], defined implementation and support procedures and they can have confidence that the service is stable and suitable for their project. This increased confidence is vital for researchers who rely on our network and services on a day-to-day basis.

### ARE USERS INVOLVED IN PLM?

User input is vital to the success of the PLM and GÉANT as a whole. At the very beginning of any development each product needs both a Value Proposition and a Business Case so it is very clear why we are developing the service and can show that the investment will benefit the end users. Throughout the development we can refer to these to ensure that we are always working to support the users and give them the services they need and asked for and are providing value for money.

### WHAT HAPPENS ONCE A SERVICE HAS BEEN DELIVERED?

This is the essence of lifecycle management and Product Management. It is essential that GÉANT doesn't ignore services once they have been launched and that they are continually monitored to make sure they are still fit for purpose.

As an example we received valuable feedback from the NRENs about how they wanted perfSONAR to change and we have been able to use that feedback to help redesign the service to become part of an enhanced global perfSONAR which incorporates the best elements of perfSONAR MDM [the European version of the service] and perfSONAR PS [the North American version of the service]. As technology develops and users' needs continue to grow, it is vital we keep the GÉANT products up-to-date and offer our users, both NRENs and the wider community, great service and great value for money.

**Interview**  
Karl Meyer,  
Product  
Marketing and  
Communications  
Officer.



# EDUGAIN SUPPORTING INTERNATIONAL COLLABORATION FOR EDUCATION



Sabita Behari works for SURFnet as a Product Manager, but is also involved in several innovation teams. Her role in the Virtual Campus Hub (VCH) project was to be the coordinator within SURFnet and the contact for Technical University Eindhoven, the Dutch participant in the project. Here she explains how eduGAIN has helped the VCH project.

## WHAT IS YOUR RELATIONSHIP IN THE LONGER TERM WITH EDUGAIN?

When I started my first job at SURFnet (at SURFfederatie, since fully integrated with SURFconext) I really liked the idea of federations but was surprised that federations didn't connect to other countries – although that was being worked on. When eduGAIN then came into production, we tried to encourage Service Providers (SPs) with the possibilities of eduGAIN. We then became really excited that we could support a project like VCH so as to make full use of eduGAIN when it entered production.

## WHAT IS VCH AND WHAT ARE ITS GOALS?

The VCH is a project that was started by four institutions from four different European countries – The Netherlands, Denmark, Italy and Sweden. These institutions are all technical universities that offer similar programs, but they shared a common problem: a relatively low number of students for particular programs in each country. As part of this, they wanted to see if it was possible to offer a virtual platform where the students and teachers could get in contact with each other, collaborate online, maybe videoconference, share documents, follow web lectures – there was even talk of using online laboratories from a distance, so they wanted a seamless collaborative working space.

## SO HOW DID YOU SUPPORT VCH AND THEIR NEEDS?

The institutions were very excited to learn about eduGAIN in this context. Their initial focus had understandably been on the educational aspects but very quickly they realized the technical challenges were an equally big task. How do you give users access to all these online applications? That's when the Dutch university (Eindhoven) asked SURFnet to help, and we introduced them to the world of NRENs, federations and eduGAIN. To date, VCH has run as a pilot project and all the universities involved are happy with the results. The laboratories need some further work, but we were able to get several applications online and available for everyone. Later this year, they will look into how to move the project to a production environment, and how it could open new doors in education.

### Words

Laura Durnford,  
Senior  
Communications  
Officer, TERENA  
interviews Sabita  
Behari, SURFnet

### Picture

Sabita Behari

## WHAT WERE THE MAIN CHALLENGES IN CONNECTING EDUCATIONAL INSTITUTIONS?

Firstly, whilst our contacts were heavily involved with the educational content and the user experience from the student and teacher perspectives, their understanding of the technical challenges was limited. So our job was to teach them about the possibilities and how it could work. Second, not all the educational institutions were an IdP (identity provider) – and for you to be able to use eduGAIN you first need to be an IdP with your own federation in your own country. Whereas every country has a federation, not all institutions are members of that federation. So the universities had to be set up as part of their country federation, albeit occasionally as guest members – but that will be addressed when the VCH pilot moves into production. Finally, there were many legal conditions that need to be abided by – for example when services are provided by one country not only to their members, but to members from other countries as well. Whilst these conditions are not unique to educational users, their need for the highest data protection is critical – particularly when the universities are involved in research – and the collaborative environments must remain carefully controlled.

## HOW DOES EDUGAIN PROVIDE A SOLUTION?

eduGAIN provides the vital framework, functionality and technical support to connect separate federations into one confederation, or inter-federation, enabling the various institutions to work together. It does the same job as a local federation in that it connects IdPs and SPs and connects users with online services and it does all of that on an international level. So theoretically, eduGAIN makes it possible for a user to make use of an online service offered by another federation or IdP anywhere in the world.

An important part of this is the legal framework, effectively a Code of Conduct, to which SPs can agree and which institutions can trust. This is a key part of eduGAIN.

The value is very clear. If institutions want to work together internationally, they simply have to connect through their local federation – typically well known to them.

## WHAT ALTERNATIVES ARE THERE TO EDUGAIN?

Is there a good alternative for eduGAIN? Probably not! I guess some commercial products offer similar benefits. As our institutions are all part of the local federations that are usually operated by NRENs, in other words specifically for R&E, they would be unlikely to use commercial products. If it wasn't for eduGAIN they would probably have had to make a lot more technical connections one on one. I really don't see any other way to address their challenges, except for maybe just using one big suite of one service provider, but that's usually not what they want. So no, there's not a good alternative to eduGAIN.

## WHAT VALUE DOES EDUGAIN OFFER FEDERATIONS?

It's very useful for SURFconext to be part of eduGAIN because we see that a lot of our institutions are collaborating more and more not only with each other, but on an international level with students and researchers from around the world. Not having eduGAIN would mean we would have to figure out case by case how to help them, but now there is a single solution for all of them.

## HOW WOULD YOU LIKE TO SEE EDUGAIN DEVELOP IN FUTURE?

I would like to see even more IdPs and federations connected to eduGAIN. In particular having more Service Providers connected to eduGAIN would help a lot, simply because then you could view the services already available. Also it would be great to have a global solution for guest users. Whilst we are here for the research and education community, these people also work with other people from commercial companies, from government, and it would be very helpful if there was a global solution for helping these guest users to connect to our community in an easy way.

*Sabita Sehari was talking to Laura Durnford, Senior Communications Officer, TERENA. The full video interview will shortly be available at [www.youtube.com/GEANTtv](http://www.youtube.com/GEANTtv)*

## WHAT IS EDUGAIN?

The eduGAIN service enables the interconnection of identity federations around the world, simplifying access to content, services and resources for the global research and education community. eduGAIN enables the trustworthy exchange of information related to identity, authentication and authorisation (AAI). Through eduGAIN, identity providers offer a greater range of services to their users, delivered by multiple federations in a truly collaborative environment; service providers offer their services to users in different federations, increasing their target market; and users seamlessly benefit from the wider range of services.

# CAMPUS BEST PRACTICE JUST GOT EVEN BETTER!

Last month the Campus Best Practice team launched a brand new website to help users find and download the full range of Campus Best Practice materials and also get involved in the workshops and community activities.



TERENA and Dante have worked together to combine the resources of the CBP group into one easy to use site which will make it easier for NRENs and campus IT staff to find help and resources they need.

The CBP materials can be found at <http://services.geant.net/cbp>



# NEW PERFSONAR IS INTERNATIONAL EFFORT TACKLING GLOBAL MONITORING CHALLENGE

## perfSONAR

**P**erfSONAR MDM and perfSONAR PS are two different implementations of an original shared idea, which have recently been integrated into one platform. We caught up with Domenico Vicinanza, Network Services Product Manager at GÉANT to ask him about the many benefits this will deliver to users.

### PLEASE EXPLAIN A BIT ABOUT PERFSONAR

The infrastructure and associated services of perfSONAR simplify network troubleshooting making it easier to solve end-to-end performance problems. perfSONAR enables network performance monitoring using measurement beacons and archives that talk to each other using a standard protocol.

### WHY BRING THE TWO TOGETHER?

The resulting convergence of the platforms is now even more flexible, robust and sustainable in supporting its

users. User could be students working via local campus networks to scientists collaborating on international projects, so interoperability is vital. Essentially, it removes scope for confusion and fragmentation and increases efficiency for all.

### WHAT'S THE HISTORY OF PERFSONAR?

Since its inception 10 years ago, MDM and PS have followed different paths, meeting the needs of local user communities in the USA and Europe. This led to a set of two, mostly incompatible sets of tools and packages.

In March 2010, to respond to an increasingly international research community, we began work under a collaboration framework called DICE – along with Internet2, CANARIE and ESnet.

The result was a set of more effective and sustainable monitoring functionalities able to interoperate between perfSONAR MDM and PS infrastructures. It removed the demanding tasks of constant alignment of components and the need to duplicate functionalities.

### HOW DID YOU GO ABOUT CONVERGING THE TWO?

At the end of 2013, GÉANT, Internet2, Indiana University and ESnet, started working on a different approach. Using experience gained in the previous work, we selected the best components from MDM and PS for delivering a consistent high quality experience to users and bundled them into a commonly branded and jointly released platform.

This first operational prototype was successfully demonstrated at TNC2014. It included four measurement points, two in the US, Washington and New York, and two in Europe, Frankfurt and Amsterdam.

### WHAT DOES THE FUTURE HOLD?

In the coming months we will be working together again to consolidate the support structures, training, documentation and software delivery for the new 'converged perfSONAR.'

Find out more:

[perfsonar-info@geant.net](mailto:perfsonar-info@geant.net)

<http://services.geant.net/perfsonar/Pages/Home.aspx>

# GREEN NETWORKING WORKSHOP

## - BUILDING COMPETENCE IN ENVIRONMENTAL SUSTAINABILITY

**T**he GÉANT Green Team is dedicated to showing how NRENs can use green ICT to support sustainability. On 15-16 September, the Green Team will be hosting a workshop in Budapest to help NRENs build sustainable work practices and develop a greater understanding of the environmental impact of ICT.

The purpose of this workshop is to:

- Build competency in sustainable work practices.
- Demonstrate best practice guidelines to aid business implementation.
- Provide greater understanding of the impact of energy consumption in lifecycle costing when selecting equipment.
- Learn and share progress in environmental policy and practice from academic and research institutions.



GRNET (the Greek NREN) will also be presenting their ECO2METER online tool that NRENs can use to report their Greenhouse Gases emissions.

Many teams will also be presenting posters demonstrating their latest research in greening ICT.

The workshop is intended primarily for NREN participants, both operational and management, ICT and facilities management personnel in higher education institutions, and for environmental agents and decision-makers.

For more details on the workshop and to register, visit

<http://www.terena.org/activities/green-workshop/ws3/>



# Q&A WITH IVANA GOLUB

Ivana Golub of Croatian NREN CARNet leads the GÉANT Activity that deals with Network Support Services (SA4). CONNECT spoke to Ivana to learn more about the work in this area, and what it means for the millions of users who rely on GÉANT.

## HOW LONG HAVE YOU BEEN PART OF GÉANT, AND HAS YOUR ROLE ALWAYS BEEN IN THIS AREA?

I joined the GÉANT community during the GÉANT2 project (which ran 2004-2009) as part of the Service Activity involved with End-to-End Quality of Service and the Joint Research Activity working on Performance Measurement and Monitoring.

In GÉANT (GN3 2009-2013), I was part of the Joint Research Activity working on Future Network - Federated Network Architecture, after which I joined the Service Activity for Network Build and Operations – part of the planning team.

Finally in August 2012, I applied for the Activity Leadership position for the GÉANT (GN3plus) Service Activity Network Support Services (SA4), since when I have been actively involved in this area.

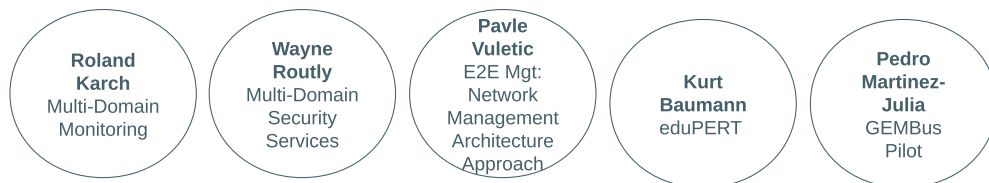
## WHAT IS YOUR AREA OF RESPONSIBILITY?

In the GÉANT project, my role as the activity leader is to empower the tasks in their assignments when needed, coordinate activities between the tasks, from and towards the other project teams. The Activity Leader has to possess expert knowledge in the fields, as well as management and leadership capabilities to create an environment for the successful delivery of high quality results.

In CARNET, my role as the Assistant CEO for Network infrastructure is to lead and coordinate all activities related to building, operating, maintaining and managing the CARNET network and network services. With this two-fold role, I am bringing the NREN view to SA4 as well as GÉANT experience to CARNET everyday work.

## WHAT DOES NETWORK SUPPORT SERVICES DO FOR THE NRENS AND THEIR USERS?

Network Support Services looks at the multi-domain aspects of network monitoring and security. We see it as providing the glue that bonds together individual NRENs' related services into a global infrastructure. This area develops and offers tools such as perfSONAR (together with US partners including ESnet and Internet2) for CMon in the area of network monitoring, and penetration testing, Firewall on Demand and NfQuery in the area of multi-domain security.



We also coordinate the eduPERT community and address performance-related topics, including end-to-end user services, infrastructure services or the infrastructure itself by providing the communication platform, including on-line and face-to-face meetings and presentations, training and workshops, active portal and knowledge base and more.

We also provide support for developers in the GÉANT project through secure code training for developers, and secure code audits and penetration testing for production services.

Our work in the area of End-to-End Management (Network Management Architecture Approach) has started with analysis of the existing processes, services and tools in the area of Network Support Services taking into consideration relevant industry standards, thus focusing primarily on the internal aspects of the GÉANT project. Still, the main focus is in offering services to the GÉANT community users through the optimisation, continuity and possible integration of existing solutions and the development of missing pieces if needed.

## WHAT DO YOU SEE AS THE MAIN OBJECTIVES AND CHALLENGES IN YOUR ROLE AS ACTIVITY LEADER?

My main objectives – and at the same time challenges – are to gather together and work with the team in a confident, trusty and working environment around the pre-defined goals and tasks towards user-oriented, recognised, useful and used services.

Team members come from several countries, bringing to the teams different views, experiences and knowledge, all of which gives a new dimension and great benefits to the project. Orchestrating that with the defined objectives, goals, time-line and with the work of other teams in different activities is an interesting and valuable experience.

## IN TERMS OF NETWORK SUPPORT SERVICES, WHAT AREAS WOULD YOU LIKE TO SEE INCLUDED IN FUTURE PROJECTS?

I'd like to see a multi-domain view on infrastructure, services, cooperation, and many other areas, as well as in all lifecycle phases. It can help to strengthen the communication between individual domains, to provide additional information that might not be available for single-domain view, for trends analysis, etc.

From the area of current Network Support Services activity, benefits can be seen in the continuation of work in the areas of multi-domain monitoring, security, operations...

I believe it is the networking of expert groups that brings special strength to the project and the community, and this trend is increasing in GÉANT. Cooperation, collaboration, knowledge and experience sharing create a beautiful synergy that helps the project and people in it to grow even faster. Hopefully there will be more!

## Interview

Paul Maurice,  
Senior  
Communications  
Officer, DANTE

## WHAT DO YOU ENJOY MOST ABOUT YOUR WORK?

The opportunity for continuous learning, dynamics, diversity, and working with great and interesting people from our community.

## LAST MOVIE YOU WATCHED?

Cartoons, over and over again!

## WHAT BOOK ARE YOU READING?

Just finished "The naive and the sentimental novelist" by Orhan Pamuk, now reading "The seven daughters of Eve" by Brian Sykes.

## WHERE WAS YOUR LAST HOLIDAY?

Summer holidays I always spend in Croatia in a small place at the Adriatic coast.

## WHAT'S IN YOUR MUSIC LIBRARY?

Depeche Mode, Zaz, Pink, Adele, Vaya Con Dios, Croatian artists, and many more

## WHAT DO YOU DO FOR DOWNTIME?

Enjoying the time with my family. The best way to enrich the day!

# TECHNICAL INSIGHT

## GÉANT perfSONAR MDM-BASED CIRCUIT MONITORING IN A MULTIDOMAIN ENVIRONMENT

### ABSTRACT

Global research collaborations today require reliable and secure dedicated network connections to facilitate data communications between collaborating partners. To deal with the deluge of data, dedicated connections are needed to transport data in a highly efficient manner. Managing such links, which often cross multiple administrative domains with heterogeneous infrastructure, poses many compelling research challenges, one of which is interdomain network monitoring. In this article, a multidomain circuit monitoring system, CMon, is introduced. Using some services of GÉANT perfSONAR MDM, CMon is able to provide end-to-end circuit monitoring services with great flexibility, extensibility, and vendor independence, regardless of the underlying circuit provisioning systems. The architecture of CMon, by using measurement federations, can adapt to either changes in the circuit provisioning system or expansion of network size.

### INTRODUCTION

Researchers are increasingly collaborating on projects, exchanging data, and innovating at the forefront of their fields in different parts of the world. Networking and communications technologies have been assisting such activities for decades. However, the traditional method of data service is to use IP service and accept whatever performance is obtainable across multiple network domains or to construct a dedicated network with dedicated capacity designed only for specific performance requirements.

However, users are requiring data services that can provide higher guaranteed bandwidth with less jitter than traditional IP connections, and greater flexibility than static dedicated layer 2 (L2) point-to-point connections (circuits). The service should allow users to request a circuit with a specific set of parameters (bandwidth, maximum transmission unit (MTU), delay, ingress and egress virtual local area network [VLAN] identifiers, etc.) for a desired duration (from hours to months). Such an automated dynamic multidomain

circuit provisioning service is called multidomain bandwidth-on-demand service (BoD). There are different circuit provisioning systems (CPSS) supporting the same BoD service or having the same purpose, such as Automated Bandwidth Allocation Across Heterogeneous Networks (AutoBAHN) [1], On-Demand Secure Circuits and Advance Reservation System (OSCARS) [2], and others [3, 4]. A multidomain circuit consists of several segments, for which each domain is responsible. Even if the circuit is provisioned by the same tool, the underlying technologies used for provisioning each segment can be different, such as L2 multiprotocol label switching (MPLS) virtual private networks (VPNs), generic framing procedure (GFP) over synchronous digital hierarchy (SDH), or Ethernet over MPLS.

In order to provide a complete data service, performance needs to be effectively monitored. However, it is generally challenging to monitor the performance of such dynamically provisioned multidomain circuits for viewing, analysis, diagnosing, and troubleshooting because of the various technologies used in different domains, collaboration challenges, policy issues, and so on. Many monitoring architectures [5–7] have not considered the heterogeneity of different domains. The work in [8] considered the heterogeneity, but there is no holistic view on the service chain.

Related work in this area has also been done at the Czech Republic's National Research and Education Network (CESNET) with the development of a monitoring tool for photonic services called CzechLight Monitor, or CLMon [9]. CzechLight Monitor conducts Simple Network Management Protocol (SNMP)-based monitoring of CzechLight devices and is capable of using in- and out-of band remote access. In its first version, CLMon was not vendor-independent and could only be used to monitor CzechLight devices; CESNET is currently working on a new development of CLMon that also includes monitoring of Cisco optical elements.

To the best of the authors' knowledge, current CPSS either lack monitoring ability, where the system

Reproduced from IEEE Communications Magazine, Vol 52, No. 5

### Words and Interview

Hao Yu, Feng Liu, Susanne Naegele-Jackson, Tangui Coulouarn, Trupti Kulkarni, Josva Kleist, Wolfgang Hommel, and Lars Dittmann

cannot realize a broken circuit unless notified by users, or rely on primitive methods to locate system faults in a multidomain environment (e.g., by calling or sending emails to the next domain on the circuit chain). These are undoubtedly inefficient and unacceptable for BoD service.

To tackle these problems of multidomain circuit performance monitoring, a multidomain circuit monitoring system (CMon) is built, using services provided by Performance Focused Service Oriented Network Monitoring Architecture (perfSONAR) [10], which is a unified service platform for multidomain network performance monitoring used where a set of services deliver performance measurements in a federated environment. With the diversity of monitoring technologies between different domains taken into account, CMon utilizes perfSONAR services to provide circuit monitoring data through a web portal in order to achieve the most flexibility, extensibility, compatibility and vendor independency. perfSONAR services include active and passive measurements. An active measurement for circuit monitoring requires a measurement node to send test packets in a specific pattern from one end of the circuit path to the other in order to estimate the condition of the traversed path by analyzing the received test packets. Passive measurements for circuit monitoring demand network equipment to be constantly monitored in order to determine the traffic condition. Different measurement methods should be used for different metrics. For instance, to measure the latency of a certain circuit, test packets must be sent. In contrast, measurement of, for example, bandwidth usage can be implemented by monitoring the transmitted traffic volume on a specific interface. These two methods jointly contribute to the multidomain circuit monitoring service.

Therefore, we discuss the architecture and design of CMon in this article. We first describe the background, including perfSONAR and the automated circuit provisioning service, BoD, and the tool, AutoBAHN. After that, we depict CMon architecture and design in a nutshell. Finally, we conclude the article.

## BACKGROUND

CMon is a system that processes notifications from CPSs, fetches monitoring data from domains, and splices different segments' performance to show for the whole circuit. Such an architecture gives CMon great flexibility, extensibility, and simplicity. This section briefly describes the BoD service and the perfSONAR architecture.

## BANDWIDTH-ON-DEMAND SERVICE AND AUTOBAHN

The GÉANT3 BoD is an end-to-end (E2E), point-to-point connectivity (circuit) service for data transport. It allows users to create dedicated dynamic circuits with specified bandwidth and duration. The service is designed for situations where high volumes of data have to be transported in the networks between two known endpoints and/or where a dedicated circuit is required. It is intended for relatively short-term use, ranging from several minutes up to several months with no change in basic configuration, while static circuits usually have a very long life cycle.

The novelty of the approach consists of conceiving a multidomain service, which stretches over different networks administered by different entities, and multi-platform, not using a single software but relying on standards and/or agreements between different co-providers.

Today, the service is used by big data science users and also different projects that are mostly interested in aspects other than just bandwidth. In particular, the BoD service is used by applications in order to get dedicated connectivity. For example, the following research projects have started to use the service: NEXPreS (radio astronomy), AutoKNF (high energy physics), Bonfire (testbeds), and Mantychore; while several projects intend to do so. It confirms the progress observed in other networks for user-controlled traffic. As indicated above, the BoD service also targets network managers who want an automated solution to set up multidomain or single-domain connections.

As one of the CPSs, AutoBAHN was developed and piloted within the GÉANT2 project (2005–2009). It was conceived from the beginning to be used in a multidomain environment where domains use different technologies to provide circuits.

Within the GÉANT3 project (2009–2013), AutoBAHN was further developed to support the tool-agnostic multidomain BoD service for a number of national research and education networks (NRENs) in the GÉANT

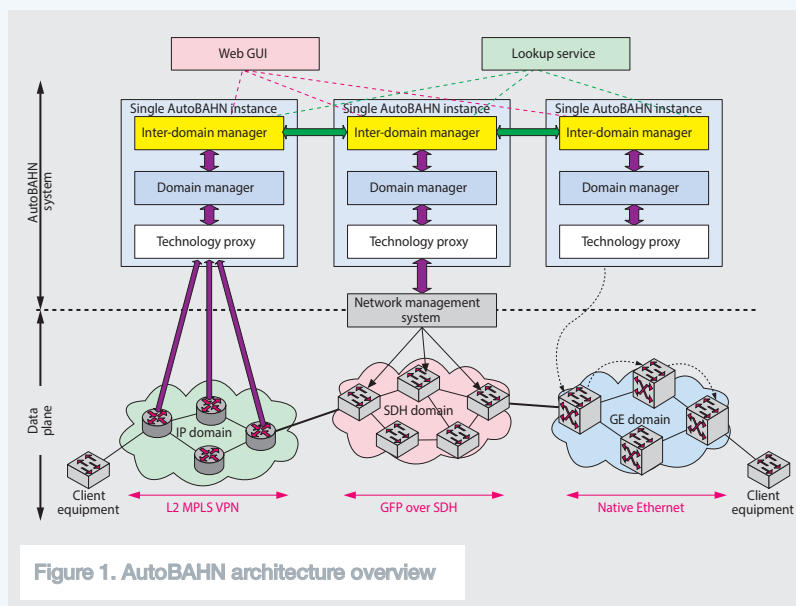


Figure 1. AutoBAHN architecture overview

community. In most implementations, AutoBAHN uses Common Network Information Service (cNIS) for topology information. AutoBAHN is composed of three modules:

- **Interdomain manager (IDM):** Responsible for the interdomain operation of circuit reservation on behalf of a domain
- **Domain manager (DM):** Abstracts the information provided by cNIS and transmits it to the IDM; also required to manage intra-domain resources
- **Technology proxy (TP):** Specialized components with the technology-specific capability to configure the heterogeneous underlying networks

Figure 1 [1] presents the interactions between the basic AutoBAHN modules, including a lookup service (LS) used for abstract topology exchange between IDM, and TPs.

It is far from enough to provide connectivity service without being able to monitor performance. In the operation of the BoD service, a monitoring system based on a standard perfSONAR implementation, CMon, will be provided to users to track the end-to-end availability of the circuits provisioned by one or different CPSs.

## THE PERFSOANAR PLATFORM

perfSONAR is a framework for multidomain network performance monitoring. The web-services-based infrastructure was developed by several international partners from Internet2, ESNet, and the GÉANT2/GÉANT3 projects with the purpose of providing network administrators with easy access

to cross-domain performance information and facilitating the management of advanced networks. The design of the architecture was set up to be well prepared for new metrics and extensions, and to automate processing of measurement data whenever possible. For this reason perfSONAR was divided into three components with different service modules:

- A data services component, where measurement points (MPs) collect data through active and passive measurement tools, and store the data in a measurement archive (MA)
- An infrastructure services component where authorization and information services are provided, which also include topology information and a home lookup service (hLS) that can identify all registered perfSONAR services such as MAs or MPs
- An analysis and visualization service component with graphical user interfaces (GUIs), network operations center (NOC) alarms, and web visualization services for the collected measurement data

For use in a multidomain environment, the perfSONAR services can be globally federated. This requires synchronization of all involved hLS with a global lookup service (gLS) and the availability of global topology information collected from intra-domain MAs into an inter-domain aggregated (abstract) topology measurement archive (MA(at)), as shown in Fig. 2. The perfSONAR framework not only provides a reliable source for raw monitoring data for upper-layer network management services; it also defines a set of standardized protocols that facilitates deployments of federated network measurement infrastructures.

# CIRCUIT MONITORING SYSTEM

Data transportation from one research institute to another sometimes needs a dedicated L2 circuit instead of an IP route. A circuit, consisting of different connection methods, can be provisioned across multiple domains by an automated provisioning system with on-demand parameters, such as duration and bandwidth. Due to the dynamic resource allocation mechanism used by CPSs and the potential expansion of the NREN community, CMon is required to be flexible and extensible in order to adapt to any change in the underlying CPSs. In this section, first the requirements are analyzed, and then the system architecture and design are described.

## SYSTEM REQUIREMENT ANALYSIS

The CMon system intends to make monitoring information aggregation across domains not only feasible, but also easy and fast. To this end, it is designed with the properties of flexibility, security, simplicity, controllability, and transparency in mind. In this section these considerations and the principal design philosophies behind CMon are discussed briefly. These requirements serve as guidelines in both the design and implementation stages of CMon.

### Flexibility

One of the differences between dynamic and static circuits is their life cycle duration. To monitor dynamically created circuits, configuration and information retrieval processes need to be adapted aptly to changing situations. For example, once a circuit is established, a corresponding monitoring page should be created dynamically. Nevertheless, for static circuits, due to their long life cycle and relatively stable routing paths, a less automated reconfiguration process could be adequate. However, for dynamic circuits with frequent changes and short life cycles, manual configuration and adaptation would be difficult, if not impossible. Therefore, the creation and adaption of dynamic circuits should be done without heavy human intervention to reduce the overhead and increase efficiency.

### Security

Security is paramount in the design of CMon. NRENs in Europe mostly have rather strict data protection policies or even laws by which they must abide. Operational information such as monitoring data regarding devices such

as core routers and switches are generally considered to be sensitive information that have to be sufficiently protected against any unauthorized access and potential interceptions as they are sent over networks. CMon has to consider and evidently provide the following security features before NRENs are ready to provide data:

- **Authentication of data sources:** Sources of monitoring data must be rigorously authenticated in order to guarantee genuineness.
- **Access control of monitoring data with authorization:** This ensures that only authorized personnel/devices have access to the data. It is optional for operators to implement based on their own policies.
- **Secure communication channel for monitoring data:** All communications between a data gathering client and a CMon server must be through encrypted channels.

### Simplicity

One of the important lessons learned from a previous deployment and operation of an interdomain monitoring application [11] is that everything should be kept as simple as possible for users. Simplicity must be catered to for the complete life cycle of the monitoring system. The following considerations are made:

- **Easy installation and configuration:** For example, all dependencies should be resolved automatically by installation, and configuration should also be automated wherever possible.
- **Simple maintenance:** Software updates and patches should be prepared and distributed without extra overhead to the users. Moreover, potential system disruption must be kept to a minimum during maintenance.

### Controllability and Transparency

Once an administrator introduces a new management system that is required by an multi-domain project such as GÉANT, they may want to know what actually happens in the background once the system is operational and whether the introduction of the new application causes any new security risk in their administered infrastructure. Moreover, operators have to ensure that the monitoring information collected and transmitted over the networks to the external application does not conflict with any information policy from their own organizations. Such knowledge enables operators to gain transparency on what data is actually communicated between data collecting and data aggregating entities.

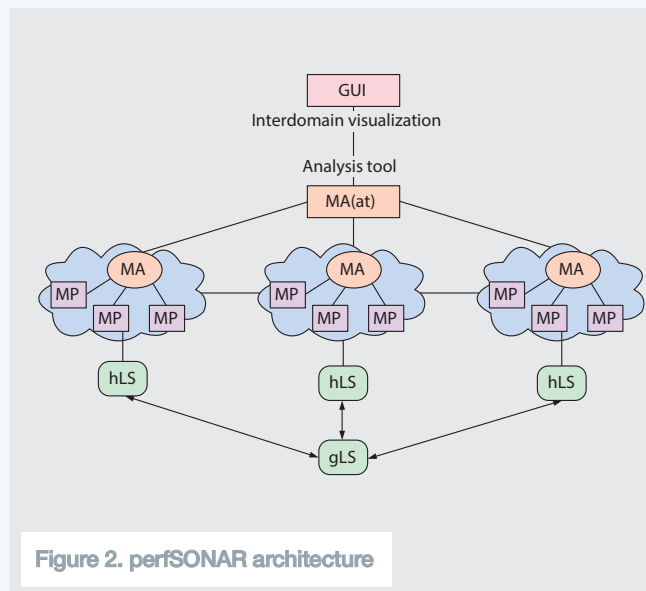


Figure 2. perfSONAR architecture

According to the experiences gained during past deployments of interdomain applications [11], most target users wish to remain in control of management data flows throughout the life cycle of a circuit. It is thus desired that, at a technical level, administrators should be capable of controlling the data flow in a more active way.

### Multimodal Accessibility

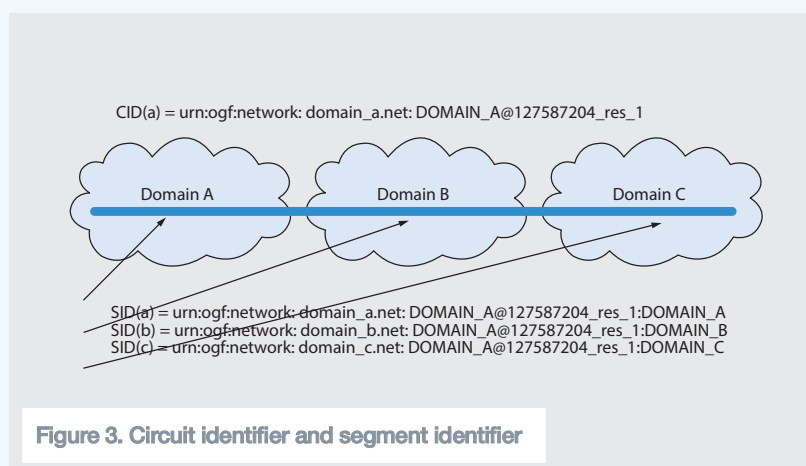
The system should enable its users to access their desired data in different ways. This not only allows users to have different interfaces to access the application, such as either through web-based methods or command line interface (CLI); it also provides users with feasibility to integrate the software into their own applications (e.g., with their own home-brewed network management scripts). Since each access model has its own advantages and disadvantages, choices should be given to users to select the access model that is most suited to their needs.

## CIRCUIT DESCRIPTION

Circuit naming and description is an important issue in a multidomain environment because identification uniqueness must be ensured. This section presents a circuit description mechanism using the four elements listed below.

### Circuit Identifier

A circuit identifier (CID) uniquely identifies a circuit. With the CID, clients can look up information about the circuit in a circuit registration database. The format of this identifier is a universal resource name (URN) of the Global Lambda Integrated Facility (GLIF) naming format containing a domain name part and a domain-specific part, shown as follows:



**GLOBAL-CID =**  
 urn:ogf:network:<source-domain>:<local-part>  
 <local-part> = <source-domain-ID>@<timestamp>\_res\_<sequence-number>

### Circuit Descriptor

A circuit descriptor is used by a provisioning system to track the reservation in all involved domains. It contains circuit information, such as bandwidth, source, destination, duration, and other like information related to the circuit.

### Segment Identifier

A segment identifier (SID) uniquely identifies a circuit segment, which is usually provisioned by a domain. Like the CID, clients can look up information about the segment in a circuit registration database. The format of this identifier is also a URN of the GLIF naming format containing a domain name part and a domain-specific part, shown as follows:

**GLOBAL-SID =**  
 urn:ogf:network:<domain-name>:<local-part>  
 <local-part> = <source-domain-ID>@<timestamp>\_res\_<sequence-number>:<domain-ID>

### Segment Descriptor

A segment descriptor contains a sequence of network elements selected for the reservation within a domain. It contains information of a circuit segment, including bandwidth, ingress port, and egress port. Figure 3 depicts an example of a circuit consisting of three segments. According to the format described previously, the CID is:

urn:ogf:network:domain\_a.net:DOMAIN\_A@127587204\_res\_1

and the SIDs are, respectively:

urn:ogf:network:domain\_a.net:DOMAIN\_A@127587204\_res\_1:DOMAIN\_A  
 urn:ogf:network:domain\_b.net:DOMAIN\_A@127587204\_res\_1:DOMAIN\_B  
 urn:ogf:network:domain\_c.net:DOMAIN\_A@127587204\_res\_1:DOMAIN\_C

## CIRCUIT MONITORING ARCHITECTURE

For static circuits, where the configuration rarely or never changes, a simple static monitoring architecture is enough. However, when circuits are provisioned dynamically, the topology or resources of a circuit connecting two end nodes may not always be the same after being reestablished. Different ports or even different network nodes may be used, even if the two ends remain unchanged. As a result, the addresses of corresponding measuring probes and databases will be different. The architecture, therefore, should be able to handle the changes dynamically.

CMon is designed to utilize services of perfSONAR to implement a flexible and extensible solution for multidomain circuit monitoring. But this principle should not impede the development and deployment of CMon in non-perfSONAR domains. Part of CMon directly interacts with the underlying CPS. This is due to the fact that some CPSs are not integrated with the perfSONAR platform as proposed in [12]. In this case, a middle layer between the CMon and the CPS is required. Part of CMon directly interacts with data plane devices, where perfSONAR is not covered.

A holistic view of the CMon architecture is shown in Fig. 4, consisting of three groups of functions: circuit provisioning functions from CPS, network monitoring functions from perfSONAR, and circuit monitoring functions from CMon.

### Circuit Provisioning Functions

A domain can have a different circuit provisioning system from the others (e.g., OSCARS, AutoBAHN, and OpenNSA [13]), using the Network Service Interface (NSI) protocol. However, regardless of the differences between provisioning systems, three elements are crucial from the circuit monitoring perspective:

- The interdomain provider agent (IPA) provides interdomain-technology-agnostic functionality. It receives and processes high-level BoD reservation requests from users and other IPAs.
- The provider agent (PA) is responsible for intra-domain functionality. It receives the BoD reservation requests from the IPA, searches for a proper path within the domain, and handles signaling to/from the data plane.
- The network resource manager (NRM) owns a particular set of transport resources and is responsible for authorizing and managing the use of these resources.

## Network Monitoring Functions

perfSONAR has several functions that are used by CMon (i.e., MA and LS) already described.

### Circuit Monitoring Functions

For circuit monitoring, additional functions are required that focus on binding the monitoring service to the underlying circuit provisioning system to ensure that data measurements, as well as circuit reservation and termination information, is collected. These tasks are provided by:

- CMon Headquarters (HQ) is the function responsible for gluing the circuit provisioning system and the network monitoring system, and gathering the measurement data of circuits. As mentioned previously, an extra layer, CMon-CPS, is introduced between CMon and the CPS. Although such cross-layer architecture limits the flexibility of the system, it is a relatively quick way to implement circuit monitoring. Considering future evolution, two sub-functions are created so that they can be separated easily, allowing the system to convert to a layered structure in the future. These two sub-functions are:
  - HQ-monitoring manager (HQ-MM) is responsible for collecting and storing measurement data from either CMon agents (AGTs) or MAs.
  - HQ-integration function (HQ-IF) is responsible for interfacing with the CPS to fetch circuits' establishment and teardown information. Also, this function registers itself in the LS so that it can be searched by other perfSONAR parties.
- AGT is responsible for gathering monitoring data from either an MA or already existing monitoring proxies and sending the data in a formatted XML file to HQ periodically. SNMP traps from the data plane should also be handled directly by the AGT.

## COMMUNICATION PROTOCOL

Based on the architecture described, the communication workflow of different functions is further presented in this section.

The whole circuit monitoring process is divided into three phases: circuit notification, circuit monitoring, and circuit termination. In addition to the monitoring procedures, all services (e.g., MA and AGT) should constantly maintain their registrations in the hLS in their own domain.

### Circuit Notification Phase

The circuit notification phase starts from the time a circuit request is initiated until the circuit is successfully established and ready to carry traffic. In this phase, the circuit metadata (circuit descriptor and segment descriptor), described earlier, are generated, and the HQ must receive it in order to fetch the measurement data later on in the circuit monitoring phase.

Each IPA sends the circuit descriptor and the segment descriptor in a circuit request message (CRM) to the HQ with establishment information. (Information is pushed to the HQ by the IPA.) The HQ contacts the hLS and uses the information contained in the segment descriptor to obtain the addresses of the AGT that is available in the domain, and relevant to the monitored circuit and its parameters. Upon receiving the addresses of the AGTs, the HQ sends begin commands to the AGTs in each domain, and each AGT responds with a 200 OK message.

### Circuit Monitoring Phase

The circuit monitoring phase starts from the time the circuit is successfully established and the AGT in each domain is ready to collect measurement data until a circuit termination command is initiated either manually or automatically in the CPS. In this phase, live and history measurement data are provided.

After confirming the successful reception of the begin command, each AGT begins to periodically fetch monitoring data from the local system (i.e., either the third-party monitoring proxy or the local MA, or directly from the devices). Alternatively, SNMP traps can be set up in the data plane so that a network failure event can immediately be reported to the AGT and further forwarded to the HQ to raise alarms.

### Circuit Termination Phase

An established circuit should be able to be terminated manually or automatically when the reservation time has passed. Either way, the IPA should send a circuit termination message (CTM) to the HQ, indicating that the circuit is no longer valid or active.

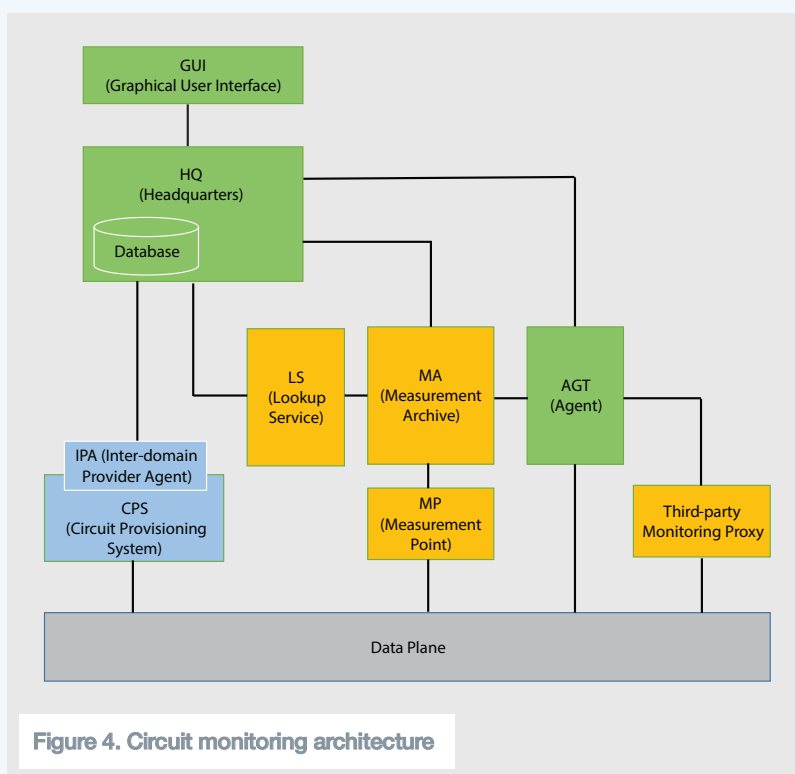


Figure 4. Circuit monitoring architecture

Each IPA sends a CTM containing necessary circuit and segment descriptors information to the HQ with termination information. (Information is pushed to the HQ by the IPA.) The HQ responds to each IPA with a 200 OK message. The HQ sends an end command to each AGT related to the circuit to stop fetching the monitoring data of this circuit.

## DESIGN AND IMPLEMENTATION

This section focuses on the software design and implementation of CMon and the current development status.

### Software Design

Functionalities of CMon can be logically categorized into three layers: presentation/rendering, business logic, and information exchange. As illustrated in Fig. 5, all major functionalities and information flows are organized at these three layers, listed below.

### Presentation/Rendering

It is responsible for rendering monitoring data in user-friendly and easy-to-comprehend ways. In Fig. 5, a web-based front-end is taken as an example for the representation of aggregated monitoring data so that users can get access to their desired data with a web browser. Administrators of the interdomain monitoring service are also capable of configuring and modifying necessary system parameters through this layer. A CLI is provided as

an integral part of the CMon system. Multiple ways of presentation data meet the multimodal accessibility requirement discussed earlier.

### Business Logic

The core part of CMon is the business logic layer, which performs actual data processing and storage operations. It controls scheduled queries of distributed monitoring data. As explained earlier, once a circuit is created, a corresponding monitoring data object must be created on the fly so that users can access information almost instantly.

To serve this purpose, CMon computes a set of nodes through which the established circuit traverses, and configures the individual metadata for each circuit (e.g., pulling intervals for query scheduling). Once a circuit is terminated, its corresponding monitoring data objects are automatically deactivated so that no related data will be further pulled from the participating nodes. This design approach considers the flexibility requirement stated earlier.

### Information Exchange

Information exchange prepares incoming and outgoing data into proper formats that can be comprehended by external data acquiring entities. These include queries and results exchanged between CMon and distributed data collecting entities (e.g., MA/MP). Moreover, a communication manager (noted as CommManager in Fig. 5) is responsible for conducting communications with distributed data collecting entities with the prepared data.

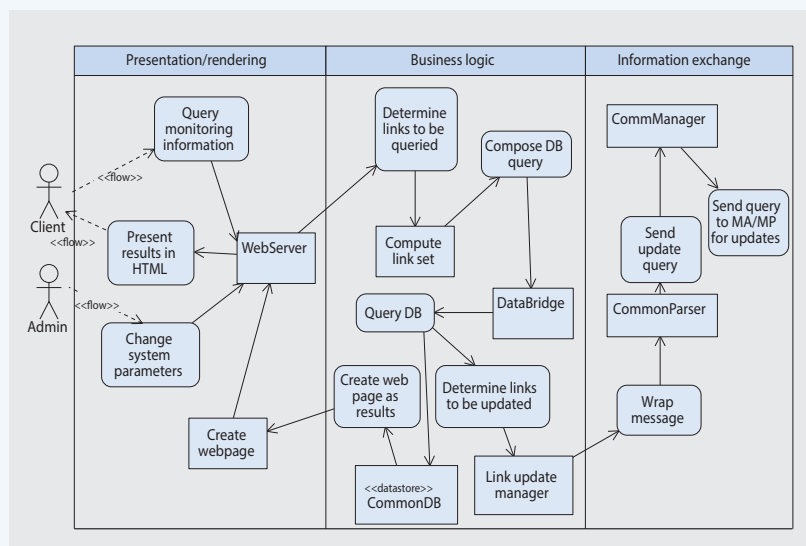


Figure 5. Dynamic view of CMon

The implementation of CMon also includes a lightweight data collecting agent, AGT, which can be applied independent from the MA. With this implementation, administrators at a local NREN can easily register their data collecting agents with the central CMon server (i.e. HQ) and remain in full control of monitoring data flow. This complementary implementation makes CMon itself more flexible, independent, and self-contained, while it continues to support the perfSONAR MA/MP. This design addresses the simplicity and controllability requirements mentioned earlier.

Note that all data communications between participating components are encrypted and authenticated using digitally signed certificates as required.

## Implementation and Current Development Status

The CMon system is currently implemented with Python for its simplicity, flexibility, and rich libraries. With those properties the system development efforts can be focused on the business logics and can be done in a highly efficient fashion. Communication between distributed subsystems uses JavaScript object notation (JSON)-based data objects, in which all queries, data exchanges, and remote procedure calls (RPCs) are encapsulated and transmitted over networks. As previously stated, data exchanges are all encrypted to ensure security.

In the background, a JSON-based database is used for the persistent storage of monitoring data. For the server to store monitoring data obtained from distributed monitoring entities, very little processing effort is required since all data is transported over networks in the JSON format.

Acquisition of monitoring data is realized by calls of remote procedures published by servers in forms of stubs. In the actual implementations, both data acquisition sites (HQ and AGT) and data providing sites (MA/MP) publish their essential functions as RPC stubs, which can be called by the other party without revealing implementation details. For example, a data acquisition site can pull monitoring data from various data collecting sites by parameterized calling of the proper stubs to query desired SNMP data on the remote devices.

## CONCLUSION

This article has introduced a multidomain circuit monitoring system, CMon, using services of GÉANT Performance Focused Service Oriented Network Monitoring Architecture Multidomain Monitoring (perfSONAR MDM). The architecture provides the best flexibility and extensibility to adapt to either further changes in the circuit provisioning systems or the expansion of the NREN community. As an on-demand circuit is provisioned, a notification message including circuit metadata is sent to CMon from the CPS. Furthermore, CMon looks up the addresses of the measurement probes related to the provisioned circuit (i.e., AGTs and MAs) in the hLS. Once the addresses are obtained, CMon begins to query the probes for measurement data, and then presents the data to its users and network administrators. By using measurement federations, circuit monitoring in a multidomain environment thus becomes efficient and beneficial to its users. The future research and development plan will focus on areas such as more approachable user interfaces, data verification and access control, and multi-HQ scalability.

## REFERENCES

- [1] J. Lukasik, "Autobahn Overview," 2011, <http://geant3.archive.geant.net/service/autobahn/Resources/Pages/Resources.aspx>.
- [2] C. Guok et al., "Intra and interdomain Circuit Provisioning Using the Oscars Reservation System," 3rd Int'l. Conf. Broadband Commun., Networks and Systems, 2006, Oct. 2006.
- [3] J. Tanaka et al., "Field Demonstration of Dynamic Circuit Provisioning by Web Services Interface Proxy for Lambda and Ethernet Based Administrative Domains," Commun. and Photonics Conf. and Exhibition, Asia, Dec. 2010.
- [4] D. Colle et al., "Enabling High Availability over Multiple Optical Networks," IEEE Commun. Mag., vol. 46, 2008, pp. 120–26.
- [5] E. Boschi et al., "Intermon: An Architecture for Inter-Domain Monitoring, Modelling and Simulation," NETWORKING '05, Jan. 2005.
- [6] P. Morand et al., "Final Specification of Protocols and Algorithms for Inter-Domain SLS Management and Traffic Engineering for QoS-Based IP Service Delivery," Del. D1.3, MESCAL, June 2005.
- [7] A. Mehaoua et al., "Service-Driven Inter-Domain QoS Monitoring System for Large-Scale IP and DVB Networks," Comp. Commun., vol. 29, 2006, pp. 1687–95.
- [8] A. Belghith et al., "Proposal for the Configuration of Multi-Domain Network Monitoring Architecture," 2011 Int'l. Conf. Info. Networking, Jan. 2011.
- [9] J. V. M. Karasek, J. Radil, "Optical Amplifiers in Czechlight 2," [www.ces.net/events/20050516/](http://www.ces.net/events/20050516/).
- [10] J. Zurawski and A. Brown, "personar Introduction," Feb. 2011, <http://www.internet2.edu/workshops/npw/materials/WJT2011/20110202-NPW-ps-Introduction.pdf>.
- [11] M. Yampolskiy and M. K. Hamm, "Management of Multidomain End-to-End Links — A Federated Approach for the Pan-European Research Network GÉANT 2," 10th IFIP/IEEE Int'l. Symp. IEEE Integrated Network Management, 2007, IM'07, 2007, pp. 189–98.
- [12] J. Gutkowski, R. Lapacz, and J. Lukasik, "Autobahn and personar Integration, Circuit Monitoring," Apr. 2011, <http://www.geant.net/MediaCentre/MediaLibrary/MediaLibrary/AutoBAHN-perfSONAR-integration-spec-1.0.pdf>.
- [13] OpenNSA, 2013, [github.com/jeroenh/OpenNSA](https://github.com/jeroenh/OpenNSA)

## BIOGRAPHIES

**HAO YU** (haoyu@fotonik.dtu.dk) received M.Sc. and Ph.D. degrees from the Technical University of Denmark, in 2007 and 2011, respectively. He is currently working as a post-doc at the Technical University of Denmark. His research interests include interdomain network management, software-defined networking, future Internet architecture, multicast for high-speed switches, traffic management in carrier Ethernet, the control plane for next generation networks (NGN), IPTV service, and related applications in IMS and NGN.

**FENG LIU** (feng.liu@lrz.de) is a senior researcher at Leibniz Supercomputing Centre (LRZ) of the Bavarian Academy of Sciences and Humanities, Munich, Germany. He received his Ph.D. in computer science from Ludwig-Maximilians-Universität München (LMU) and his M.S. (Dipl. - Inf.) from TU Clausthal, Germany. His research interests include inter-domain network management systems, SDN, cloud computing, and network virtualization technologies. He is also interested in applying data mining, machine learning, and other AI techniques to network management.

**SUSANNE NAEGELE-JACKSON** (susanne.naegele-jackson@fau.de) graduated with an M.Sc. in computer science from Western Kentucky University and the University of Ulm, Germany. She received her Ph.D. (Dr.-Ing.) from the University of Erlangen-Nuremberg in 2006 and has worked at the Regional Computing Center of the University of Erlangen-Nuremberg since 1998 on a variety of national and international research projects such as GTB, Uni-TV, VIOLA, MUPBED, EGEE-III, GN3, FEDERICA, NOVI, and GN3plus.

**TANGUI COULOUARN** (tanguy@fotonik.dtu.dk), Ph.D., works at the Technical University of Denmark for the Danish e-Infrastructure Cooperation (DeIC). He manages the GÉANT Bandwidth-on-Demand Service co-offered by several NRENs at the European level.

**TRUPTI KULKARNI** (trupti.kulkarni@dante.net) joined DANTE in April 2009. She is a senior software engineer, and has been responsible for design, development, and maintenance of various applications used for inventory management and monitoring of the GÉANT network. She has a Bachelor's degree in computer science and engineering.

**WOLFGANG HOMMEL** (wolfgang.hommel@lrz.de) is head of the communication networks planning group at the Leibniz Supercomputing Centre of the Bavarian Academy of Sciences and Humanities. He studied computer science at Technische Universität München and has a Ph.D. as well as a postdoctoral lecture qualification from Ludwig-Maximilians-Universität, Munich, Germany. His research, for which he was granted the Karl Thiemig Foundation's Young Academics Award in 2011, focuses on network management in complex large-scale and interorganizational scenarios.

**JOSVA KLEIST** (kleist@nordunet.net) holds a Ph.D. and M.Sc. in computer science, and is coordinating the design and implementation of NORDUnet development projects, including NORDUnet activities within the GÉANT projects. He joined NORDUnet in 2006 and worked as an NDGF software coordinator until the end of 2010, and was one of the main drivers behind the Nordic distributed WLCG Tier-1. He came to NORDUnet from Aalborg University, where he held a position as associate professor in computer science.

**LARS DITTMANN** (ladit@fotonik.dtu.dk) received his M.Sc.E.E. and Ph.D. from the Technical University of Denmark (DTU) in 1988 and 1994. He is a professor at DTU within the area of integrated network. He is leading a research group on network technology and service platforms, and is also the cluster leader (defining the overall research strategy) for about 85 researchers in the area of communication technology.

# THE 2014 ARNES CONFERENCE

## – AN EXCHANGE OF KNOWLEDGE AND IDEAS

Maja Vreča has worked at Arnes since 1995. She currently she works head of user support and as a team member of the Safer Internet Center SAFE-SI.



New ways of teaching proposed by the European Commission through the Opening Up Education initiative are introducing numerous new approaches, both from the perspective of using technology in education and to the concept of teaching itself. The main goal of this initiative is to provide learning environments and content that will be available to all. At this year's ARNES Conference, which took place in Kranjska Gora on 28 May 2014, we have thus focused on solutions that facilitate the open exchange of knowledge.

The event was an opportunity to host experts in various fields closely related to the educational process. At the keynote, we introduced a Norwegian pilot model for secure e-testing of knowledge which has seen the participation of all Norwegian universities. Special attention was also given to e-education at Slovenian universities.

In line with these trends, the conference continued with a presentation on Massive Open Online

Courses (MOOCs), which have been bringing education to all that desire it, both in Europe and beyond. We had the honour of hosting a representative of one of the leading European higher education environments, iversiti.org, who explained the MOOC platform of Europe's largest provider of free massive online education from a technical perspective. We also had the opportunity to see how these kinds of courses work in Croatia and what is being done in this field in Slovenia.

The next sessions delved into the current challenges of the entire education and research vertical in Slovenia. We introduced various solutions which can assist the user in everyday tasks and some content for the technically most demanding attendees – people who view advanced information and communications technology as a personal challenge.

This year's ARNES Conference, which was once again successfully held within the framework of the SIRikt international multiconference, is over, but new challenges and new ideas already await at the autumn Network of Knowledge Conference.





# EDUROAM EXTENDS CONNECTIVITY TO NHS

## HEALTHCARE STUDENTS NOW BENEFIT FROM BANDWIDTH 'IN THE FIELD'

Ed Wincott, eduroam(UK) service manager at Janet, part of Jisc, which provides eduroam national services in the UK

**S**tudents studying medicine, dentistry, nursing and clinical researchers spend a significant time in hospitals and on-site in NHS services. Although nearly all UK universities use Jisc supported eduroam® for guest network access, clinical students and researchers can miss out on easy connectivity when “in the field”. In fact, the NHS has typically less bandwidth available and more limited user access.

In large cities where the big teaching hospitals are often very close to the partner university campus, the locally agreed solution has often been to extend the university eduroam footprint through the hospital's wireless network. Both the authentication and resulting network access traffic is routed through a local firewalled link from the hospital to the partner university.

There are some hospitals that are more distant from a main university campus so a local link to support eduroam is not cost effective. The University of Bristol found an alternative approach to extending the eduroam footprint. They managed the authentication process on behalf of Weston-Super-Mare hospital (via a tunnel between the national NHS network N3 and Jisc's education and research network Janet) while the hospital provided the connection to the internet. After a successful pilot year, this model is now being explored by



similar hospitals with their university partners.

The advantages of eduroam to the health service community are clear. The South London and Maudsley NHS Foundation Trust, part of the King's Health Partners Academic Health Science Centre, has joined the eduroam federation in its own right. This approach could be used by other NHS organisations as a way of providing the

“visited service” and, if policy allows, possibly a home service too (currently only those users involved in research and education are eligible).

The benefits of extending eduroam connectivity to NHS premises is a vital step to ensuring that UK clinical students and researchers can continue to benefit from a high-speed, reliable connection, wherever they study.



# GÉANT REACHES A GLOBAL AUDIENCE THROUGH TNC2014

During this year's TERENA Networking Conference (TNC2014), as in previous years, GÉANT sponsored a 'distributed workshop': sixteen presentations on a variety of topics related to the project were embedded in the conference sessions. With TNC attracting ever more participants from around the world, these GÉANT presentations truly reached a global audience.



**I**n line with the theme of TNC2014 - 'Networking with the world' - participation by individuals and organisations from outside Europe was the highest yet. More than 660 people from 55 countries attended the event in Dublin from 19-22 May. 18 percent of speakers and around 45 percent of participants were from world regions outside Europe. Remote participation also increased compared with previous years, with almost 3,000 people around the world viewing live session streams online.

TNC is the largest and most prestigious European research and education networking conference, and participants include decision makers, network specialists and managers from all major European networking and research organisations, universities, worldwide sister institutions and industry representatives. Through keynote speeches by renowned

specialists, many parallel sessions, lightning talks, cutting-edge demonstrations and numerous side meetings, TNC presents an overview of the latest developments in research and education networking, both in technical fields and in the areas of application and management.

## Topics without boundaries

Every year, TNC is packed with sessions that discuss a wide variety of topics that are relevant to research and education (networking) around the world. At TNC2014, keynote speakers Jelmer Evers (UniC, NL), Tracy Futhey (Duke University, USA) and Lord David Puttnam (UK) called on the TNC2014 participants to engage with the challenges and requirements related to technology in education and learning, while Barend Mons (Netherlands Bioinformatics Centre, NL) called for data stewardship to be included in future research projects, Stephen Farrell (Trinity College Dublin, IE) issued a call to arms against pervasive monitoring, and Martyn Dade-Robertson (Newcastle University, UK) presented data art. Other topics included 'the global university', cloud services and federated identity for research and education.

## Cross-continental significance

The growth in TNC's cross-continental attraction is evident from the fact that, for the past two years, the research and education networking organisation for eastern and southern Africa - UbuntuNet Alliance - has proactively sought to send representatives from national R&E networking organisations to the conference. The TNC2014 delegates therefore included network engineers from RENU (Uganda) and MoRENet (Mozambique). "The chemistry of person to person contact is the strongest glue of any community of practice," explained Tusu Tusubira, CEO of UbuntuNet. "TNC is literally a global human cross-roads where our upcoming engineers and researchers can build such bonds with people who are passionate about the practice of research and education networking and its advancement as well as the consequent human development opportunities and benefits it entails."

ASREN (Arab States Research and Education Network) made an announcement at TNC2014 that the first Points of Presence (PoPs) in the pan-Arab network had been opened, in London and Fujairah, in cooperation with the EUMEDCONNECT3 project. Yousef Torman (ASREN) and Ahmed Dabbagh (Khalifa University) chose to disclose the news at TNC because "at ASREN, we count on TNC as one of the most important venues for networking among experts, researchers, networkers, technologists and scientists from all over the world."

## GÉANT presence

Among the highest rated TNC2014 sessions were 5-minute 'lightning talks' and a session about advanced networking. The former included presentations about the GÉANT Green Team's Shared Environmental Sustainability Policy Template for NRENs and an overview of the Federation-as-a-Service solution to lowering the technology barrier for NRENs and other interested groups in building their Identity federation and using the eduGAIN service. The advanced networking session included an introduction to CoCo, the Community Connection service, which is one of the GÉANT Open Call projects running from October 2013 until April 2015.

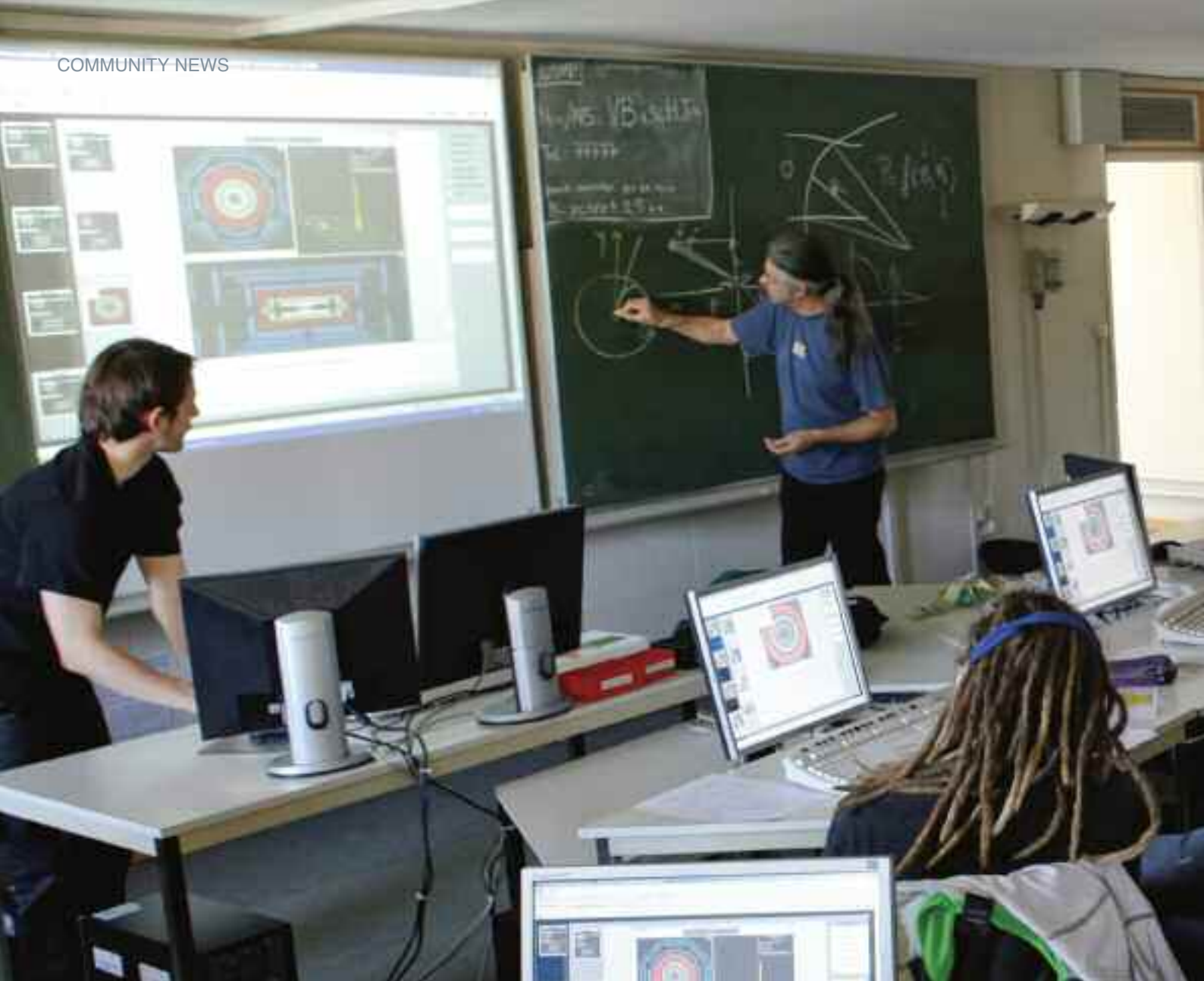
## Further information

TNC2014 was organised by TERENA and hosted by HEAnet, Ireland's national education and research network. More about TERENA: [www.terena.org](http://www.terena.org)  
More about HEAnet: [www.heanet.ie](http://www.heanet.ie)

TNC2014 slides and papers can be downloaded by clicking on the relevant session via: <http://tnc2014.terena.org/schedule>. Archived session video streams and video interviews with keynote speakers are available on [www.youtube.com/user/TERENATube/tnc2014](http://www.youtube.com/user/TERENATube/tnc2014).

TNC2015 will be hosted by FCT-FCCN in Porto, Portugal from 15-18 June 2015: <https://tnc2015.terena.org>.

**Words**  
Laura Durnford,  
Senior  
Communications  
Officer, TERENA



# CERN PROVIDES SINGLE LOGIN TO RESEARCH INSTITUTIONS THROUGH SWITCHaai AND EDUGAIN

LARGE SCALE RESEARCH COLLABORATIONS WILL BENEFIT FROM SIMPLIFIED ACCESS TO ONLINE SERVICES



CERN is now using SWITCHaai to simplify access to online services. SWITCH's standardised authentication process allows certain CERN members of personnel to use the online services of affiliated research institutions and universities more easily. The Authentication and Authorisation Infrastructure (AAI) connects researchers around the world with a single login.

The AAI login is available at almost all Swiss universities. It has clearly enhanced Switzerland's standing as a research location by improving process efficiency. CERN recently signed an agreement with SWITCH this month to use SWITCHaai. "International collaboration plays an essential role in our scientific activities," says Frédéric Hemmer, head of CERN IT department. "Joining the SWITCHaai federation is an important step as our community will be able to connect in

an easier way to our services and resources thanks to the use of a single set of access credentials."

## A single login for global access

The cooperation with SWITCH links the world-leading research centre's employees up to eduGAIN, the interederation service provided as part of the pan-European GÉANT project. This means that CERN collaborators all over the world can access CERN's online services using their home institution's login account. In addition, certain CERN members of personnel can access selected services provided by other institutions via the national AAI federations participating in eduGAIN. "SWITCH is convinced that federated identity is highly beneficial to the sort of large-scale scientific collaborations and projects that have been typical in particle physics over the past decades," says Christoph Witzig, Head of Central ICT Providers, the SWITCH unit responsible for identification services in the Swiss higher education sector. "SWITCH is delighted by CERN's decision to join the SWITCHaai Federation and looks forward to working with it in this area."

## SWITCHaai: straightforward and efficient

All members of the AAI Federation, including major universities, universities of applied sciences and other educational institutions, use the same standard to validate access to their password-protected services and resources. With a single user name and password, the institution's AAI login, users can access a range of e-learning systems and web applications provided by all participating universities in Switzerland. This reduces the administrative workload for the universities and enables them to make their teaching content available to a broader academic audience. Similar infrastructures are being developed around the world.

## About SWITCHaai

SWITCH service giving university members access to various e-learning systems and web applications provided by all participating universities in Switzerland using a single user name and login belonging to their university. Some 390,000 users at 55 participating institutions can use more than 770 services registered with SWITCHaai.

**Picture**  
Researchers  
at CERN

# GLOBAL NEWS

**By Tom Fryer, Senior International Relations Officer, DANTE and Helga Spitaler, Senior Communications Officer, DANTE**



## NEW R&E NETWORK HUB FOR THE GULF REGION TO BE LAUNCHED IN FUJAIRAH, UAE



**A**s announced at TNC2014 a new R&E internet exchange point is being established in UAE at Fujairah by the local NREN Ankabut and ASREN (the Arab regional R&E networking organisation), expected to be operational Q4 2014.

Known as 'Arabian Global Educational Open Exchange' (AGE-

OX), the PoP is likely to see New York University's remote site in UAE as its first user. Following a survey conducted in 2013 by the International Relations team, DANTE is aware that many European universities have remote campuses in UAE and is gauging the interest with the GÉANT community in R&E connectivity from

**Words**  
**Helga Spitaler,**  
**Senior**  
**Communications**  
**Officer, DANTE**

Europe to AGE-OX. Currently there is no such connectivity in place between GÉANT and UAE.

Please contact David West at [david.west@dante.net](mailto:david.west@dante.net) if you are aware of any user institutions with remote campuses in UAE (e.g. Dubai, Abu Dhabi)

The ORIENTplus project maintains and develops research and education links between GÉANT and China. Here is a visualisation of the facts, figures and impact of the project, which provides essential bandwidth for all collaborating European and Chinese researchers.



**ORIENTplus connects 25% of the world population with 35% of global GDP**



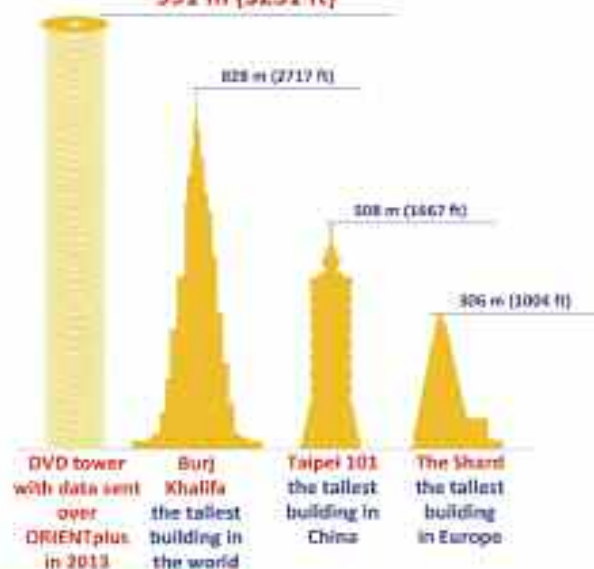
**ORIENTplus serves 4.8 million researchers and 51 million tertiary students in China and Europe**



**ORIENTplus is a 12,000 km link over which 3,882 TB of data were transferred in 2013**

**Total link expenditure of €4M = 5 cents / 4 jiao per ORIENTplus user over 4 years**

991 m (3251 ft)



1/15 bottle of water



1/30 litre of fuel



27 seconds of a cinema movie



12 seconds of a musical download



2 pages of an online book



[www.orientplus.eu](http://www.orientplus.eu)

The ORIENTplus project is jointly funded by the European Commission, the European IWM partners and the Chinese government.

This document has been produced with the assistance of the European Union. The contents of this document are the sole responsibility of GÉANT and can in no way reflect the views of the European Union.



# CLARA RECOGNISES KEY PLAYERS IN FOUNDING OF REDCLARA

**O**n 10th June 2003 in Valle de Bravo, Mexico, the statutes for the CLARA (Latin American Cooperation for Advanced Networks) organisation were signed, and with it the success story of the Latin American R&E network, RedCLARA, took root. Eleven years later, in May 2014, the RedCLARA community returned to Mexico, this time to Cancun with its azure-coloured waters for its annual TICAL (Latin America ICT) conference and RedCLARA meetings. In the closing session of the TICAL conference, which this year saw a record participation of over 400

people, the audience was taken back eleven years to the beginnings of RedCLARA and public recognition was given to the people who worked tirelessly in 2003 to make RedCLARA a reality. Among those recognised and presented with a framed photo from the statutes-signing meeting, was DANTE and GÉANT's Cathrin Stöver, who was project manager of the first EC-co-funded ALICE (Latin America Interconnected with Europe) project. Though unable to attend in person, Cathrin expressed her gratitude through a message to the audience, and congratulated RedCLARA on its successes.

The other individuals recognised were: Ida Holz (RAU, Uruguay), Luis Furlán (RAGIE, Guatemala), Nelson Simoes (RNP, Brazil), Rafael Ibarra (RAICES, El Salvador), Carlos Casasús (CUDI, Mexico), Florencio Utreras (CLARA, Latin America), Mario Campolargo (European Commission), Elena Villar Pascual (European Commission).

**Words**  
Tom Fryer,  
Senior  
International  
Relations Officer,  
DANTE

For more information on  
RedCLARA, visit  
[www.redclara.net](http://www.redclara.net)

# GLOBAL SERVICE COLLABORATION: RAISED PROFILE AT INTERNATIONAL MEETINGS



**R**esearch collaboration is increasingly global in nature and the fact that GÉANT's connectivity to other world regions has grown apace in recent years is a reflection of this. For instance, since March 2012, GÉANT's global links for production IP traffic have increased by 50% from just under 73Gbps to just over 110Gbps, the most recent increase in capacity resulting from a doubling of capacity to RedCLARA in Latin America with a new link of 5Gbps.

However, connectivity alone is not sufficient to provide for the needs of research groups spread around the globe. Services such as eduroam® and eduGAIN are increasing their global reach, enabling wider access to connectivity and on-line services. Tools such as perfSONAR enable networking engineers to identify where performance issues lie so that they can be resolved as quickly as possible, improving the reliability of the network. Bandwidth on demand makes it possible to provision the required capacity as and when it is needed.

Users however require additional tools and services which enable them

to carry out their day-to-day work more efficiently and easily. Tools such as cost-effective and user-friendly web-conferencing and other real-time collaboration tools are highly desirable, as are file storage and transfer tools.

As a result efforts are being made to provide such tools for end users, in some cases by individual universities, in others by NRENs and regional networks. In order to make best use of resources and expertise, significant efforts already exist to co-develop standards and make tools available, examples include the EC-funded ELCIRA (Europe Latin America Collaborative e-Infrastructure for Research Activities), and focus groups of the CEO Forum such as the Global Video Alliance and Global Service Delivery groups.

This increased global interest in sharing experiences and tools, and working together on standards and implementations, has been reflected at three recent international R&E networking events. The TNC2014 in Dublin in June this year saw a panel discussion entitled "Global Collaboration Makes Us Stronger" involving representatives from the

**Words**  
**Tom Fryer,**  
**Senior**  
**International**  
**Relations Officer,**  
**DANTE**

GÉANT, HEAnet, RNP (the Brazilian NREN) the TEIN Community and the UbuntuNet Alliance, chaired by Anna Hunsinger of Internet2. A week later in Cancún, Mexico, RedCLARA's annual TICAL conference for ICT directors of Latin American universities enjoyed a panel session with Niels Hersoug (GÉANT), Florencio Utreras (RedCLARA) and Shelton Waggener (Internet2) who discussed the future of NRENs and how the R&E networking community will need to interact in order to meet the future service needs of all. The theme continued at the UbuntuNet Alliance meeting held in Entebbe, Uganda, at the beginning of July with a session devoted to shared services.

It would be difficult to summarise in a few lines the many thoughts shared in these discussions, but one concept did seem to arise time and again from many of the participants, and that is that there is a strong need for networks around the world to share not only their experiences with services, but also to explore ways and discuss how services and collaboration tools can be shared and made available to user groups across the world.



# FIFA WORLD CUP IN 8K: LARGE SPORTING EVENTS TRIGGERING NETWORK RESEARCH

**B**etween June 14th and July 13th 2014, while the soccer balls were rolling in Brazilian stadiums, Research & Education networks played an important role in providing public viewing of live TV images of the FIFA World Cup in 8K resolution (7680 x 4320 pixels) in Japan. The huge distance between Brazil and Japan, half a world apart, sets new challenges for streaming digital images spanning multiple domains over long-distance networks.

The project is led by the Japanese public television company, NHK, which since their coverage of the 2012 London Olympic Games is experimenting with and improving its new 8K streaming technology (branded "Super Hi-Vision" or SHV). NHK technology is currently able to compress SHV video flows at 60 frames per second to 300Mbps IP format. The same video in an uncompressed fashion would require almost 24 Gbps to be streamed. The current state of the art of digital

**Words**  
Leandro Ciuffo  
and Michael  
Stanton, RNP,  
Brazil Hisao  
Uose and  
Tatsuya Fujii,  
NTT Innovation  
Labs, Japan  
Shinichi  
Sakaida, NHK  
Labs, Japan

television media prevents 8K signals from being transmitted over long distances. This is why this project depended on the technological support of NTT Network Innovation Labs (Nippon Telegraph and Telephone Corp.), RNP (Brazil's R&E network) and other research networks in Latin America, the USA and Japan.

Altogether, 9 matches were selected by NHK for live streaming in 8K, starting with the first Japan game (Japan vs. Ivory Coast in Recife on June 14th) and concluding the show



## SUPER HIGH VISION DEMONSTRATION IN NUMBERS

**9** World Cup matches streamed live in 8K to **7** viewing sites in Japan and Rio

**275** inches (6,30m x 3,63m) was the size of the screen in the main PV site in Rio

**22.2** audio channels distributed in **33** loudspeakers

**5** redundant network routes were configured between Rio and Tokyo to stream the video flows

**400** Mb/s was the required bandwidth

**24** Gb/s would be necessary to stream uncompressed 8K images at 60fps

8K resolution (7,680 x 4,320 pixels) is **16** times Full-HD, or 4 times 4K

with the World Cup final between Argentina and Germany in Rio de Janeiro on July 13th. The selection of games took into consideration the logistics of moving the NHK outside broadcast vehicle containing the 8K capture and editing equipment between the hosting cities in Brazil.

All matches were first streamed to the FIFA's International Broadcast Center (IBC), regardless the location of the stadium. The IBC was located in the Riocentro – a big conference and exposition centre in Rio de Janeiro – and the FIFA communications network that interconnects all stadiums to the IBC was provided by the Brazilian telecommunications company, Telebras.

From the IBC, the 8K signal was streamed to the RNP Point of Presence (PoP) in Rio, using RNP's own metropolitan network. From there, it was streamed to Tokyo using three of the five redundant international routes that have been configured, as shown in the map.

To create a secure communications path suitable for 8K video transmission over multiple IP networks, NTT applied a very powerful forward error correction (LDGM-FEC) technology using a block size of 150,000 packets with 20% redundancy combined with the multi-

path transmission scheme. Those added redundancies can eliminate errors such as black-out or block artifacts on the screen, even when all paths but one are disconnected and the loss of 20,000 successive packets occurs in the remaining path.

The games in 8K were streamed live to 7 viewing sites, 4 in Japan, in the cities of Tokyo, Yokohama, Osaka and Tokushima, and 3 in Rio, at the IBC, the Sofitel hotel (one of those used by FIFA) and the auditorium of the Brazilian Centre for Physics Research (CBPF). This latter venue hosted viewing sessions organised in cooperation with the Brazilian broadcaster TV Globo. Selected audiences of students, researchers, professors, authorities and representatives from press and industry were invited to attend both pre-recorded and live sessions. In addition to the 8K video, the invited audiences enjoyed the Super Hi-Vision's 22.2 channel 3D sound system.

The pre-recorded public screening sessions were organised to demonstrate SHV technology. Each 30 minute session displayed a selection of assorted 8K contents, including Rio's carnival, a Japanese fashion show and World Cup highlights. Altogether, more than 900 viewers attended the technological demonstrations at the CBPF venue in Rio.

## WORLD CUP 2014 GAMES STREAMED IN 8K:

14th June  
Ivory Coast 2-1 Japan  
Venue: Recife

16th June  
Ghana 1-2 USA  
Venue: Natal

19th June  
Japan 0-0 Greece  
Venue: Natal

23rd June  
Cameroon 1-4 Brazil  
Venue: Brasilia

28th June  
Brazil 1-1 Chile  
Venue: Belo Horizonte

30th June  
France 2-0 Nigeria  
Venue: Brasilia

5th July  
Argentina 1-0 Belgium  
Venue: Brasilia

8th July  
Brazil 1-7 Germany  
Venue: Belo Horizonte

13th July  
Germany 1-0 Argentina  
Venue: Rio de Janeiro



# UBUNTUNET HIGH SPEED R&E NETWORK COMMISSIONED



UbuntuNet Alliance, the research and education network for Eastern and Southern Africa; and DANTE, the operator of GÉANT, the pan-European research and education network, announced in July the commissioning of the UbuntuNet network, the regional high-speed Internet network connecting researchers, educators and students in Eastern and Southern Africa to their peers in the region and to Europe.

The African research and education community has for far too long carried the burden of slow Internet connectivity which has consequently widened the gap between the continent's researchers and their peers globally. The establishment of national research and education networks (NRENs), the regional UbuntuNet Alliance, and the kick-off of AfricaConnect are milestones transforming the research and education landscape on the continent.

**"Through the collaboration with GÉANT, the UbuntuNet network is boosting EU-African collaboration, bringing research and educational opportunities unprecedented in Africa. The implications for socio-economic development go far beyond anything we could have dreamed of before, putting African research on the map and transforming the lives of millions. I am very proud that GÉANT is the first R&E network to connect to Africa!"**

Cathrin Stöver, Chief International Relations Officer, DANTE

A major immediate impact of the network is that connectivity costs have dropped from a regional monthly average of \$4,000 per 1 Mbp/s to \$135 per 1 Mbp/s – a 97% cost reduction in just four years! This shows that the progress of rolling out the UbuntuNet network has unfolded at an impressively good pace and Chief Executive Officer of UbuntuNet Alliance, Eng. Dr Tusu Tusubira does not hide his joy at this amiable stride in promoting research and education networking in the region:

"We are delivering international and regional bandwidth to NRENs in these counties at a consolidated price of \$135 per megabit per second per month. I find this exciting, because at last, we have eliminated one barrier to regional participation in global research and education collaboration," Said Dr Tusubira.

The lowered cost of bandwidth and greater network resiliency is helping all sorts of research. For example, the new UbuntuNet circuit between Dar es Salaam and Lusaka is expected to contribute significantly to improved health research in bioinformatics in Zambia.

Impressively, through the AfricaConnect project, more countries have been connected to the UbuntuNet network than initially envisaged. The Alliance is grateful for the assistance rendered by the European Commission in helping to scale-up rollout of the regional component of the UbuntuNet network. These strides would also not have been possible without the partnerships and rapport between DANTE, UbuntuNet Alliance, WACREN and respective partner NRENs.

AfricaConnect has birthed a more resilient and secure high-speed network that offers greater connectivity between African countries, as well as high-speed links to the pan-European GÉANT. Economically, the UbuntuNet network is gradually pushing countries in Eastern and Southern Africa towards realizing the MDGs through improved ICT.

**Words**  
Joe Kimaili,  
Technical  
Manager,  
UbuntuNet  
Alliance

**For more information, visit:**

UbuntuNet Alliance  
[www.ubuntunet.net](http://www.ubuntunet.net)

AfricaConnect  
[www.africaconnect.eu](http://www.africaconnect.eu)

# COFFEE BREAK Q&A

Each quarter we invite a GÉANT project participant to tell us a bit about their role at GÉANT and themselves. Grab yourself a coffee and enjoy!



## NAME:

Remco Poortinga – van Wijnen

## JOB TITLE AND ORGANISATION:

Team lead Collaboration Platforms at SURFnet

## TELL US ABOUT YOUR ROLE ON THE GÉANT PROJECT

I'm currently Acting Activity Leader for GN3plus JRA3 - Identity and Trust technologies for GÉANT services. Stefan Winter from RESTENA and I filled in for Licia Florio during her parental leave. Around that time the whole Open Calls process started as well, and

we kept the resulting Technical Coordinator role when Licia returned. I remained as acting/backup AL since Licia had a lot of other responsibilities that were difficult to combine time-wise; which also meant I represented JRA3 at the year 1 review in June.

## WHAT'S THE BEST BIT ABOUT YOUR JOB?

Working with all the smart, enthusiastic and fun people from various organisations all across Europe on interesting and relevant topics. It's interesting to see similar topics popping up at various places nearly simultaneously and noting the similarities and differences in how they are addressed.

## FAVOURITE FILM?

The Adventures of Priscilla, Queen of the Desert (1994)

## READING ANYTHING INTERESTING?

I just finished reading all the Detective Erlendur novels by Indriðason, highly recommended. A more serious novel that I read almost in one go and really impressed me was The Kite Runner by Khaled Hosseini.

## GOT ANY HOBBIES? TELL US ALL!

I like to tinker with all kinds of devices, must be my background in electrical engineering and the total lack of soldering irons in my daily work. My latest bigish project was refurbishing a 20+ years old (Quick Mill) espresso machine. Of course I also replaced the bimetallic thermostat with a self built electronic version, meaning the water temperature for brewing espresso now varies less than 5 °C (instead of more than 20 °C); I even convinced myself it tastes better now.

**Picture**  
Photo by  
Andreas Åkre  
Solberg

<https://www.flickr.com/photos/andreassolberg/14091924411/>.  
License at  
<https://creativecommons.org/licenses/by-nc-sa/2.0/>



Until a few years ago I was quite active in designing and building solid-state audio amplifiers (using transistors only, since integrated circuits tend to do all kinds of nasty stuff to the sound). Unfortunately I can't really find the time to do that anymore, so for now I stick to tinkering with existing devices.

### LAST MEAL?

Cod with tomato, cheese and Italian herbs/spices from the oven, combined with a simple salad. Super easy to make but tasty: Put the cod in a buttered oven dish. Sprinkle with some lemon juice. Lay slices of tomato on top and put salt and spices on those, followed by grated cheese. Put in the oven for 20 minutes or so on 180 °C.

### TOP THREE ALBUMS OF ALL TIME?

Difficult, there is a lot of very good music around and I am quite a musical omnivore. But if I think of the albums that I keep returning to, then this must be my top three:

1. Pink Floyd - The Final Cut
2. The Beatles - Sgt. Pepper's Lonely Hearts Club Band
3. Front 242 - Front by Front

At home the (internet) radio is mostly tuned to Classic FM UK. Classical music is the only type of music my husband and I both like. We listen to the UK version of Classic FM

### FAVOURITE MODE OF TRANSPORT?

Train for my daily commute from Arnhem to Utrecht and back. SURFnet is located right next to the train station – in the same building – and also very generously provides a public transport card to all its employees, so taking the train to work is a no-brainer really.

Privately I love our Citroën C5 because of its hydropneumatic suspension. Our last 5 cars have been Citroën models (BX, XM, Xantia and 2x C5). We started driving them because the used models are usually dirt cheap, but fell in love with the way they drive.

They have stiffened the suspension in successive models unfortunately, so it's not the magic carpet ride it used to be. Still far better than most alternatives though.

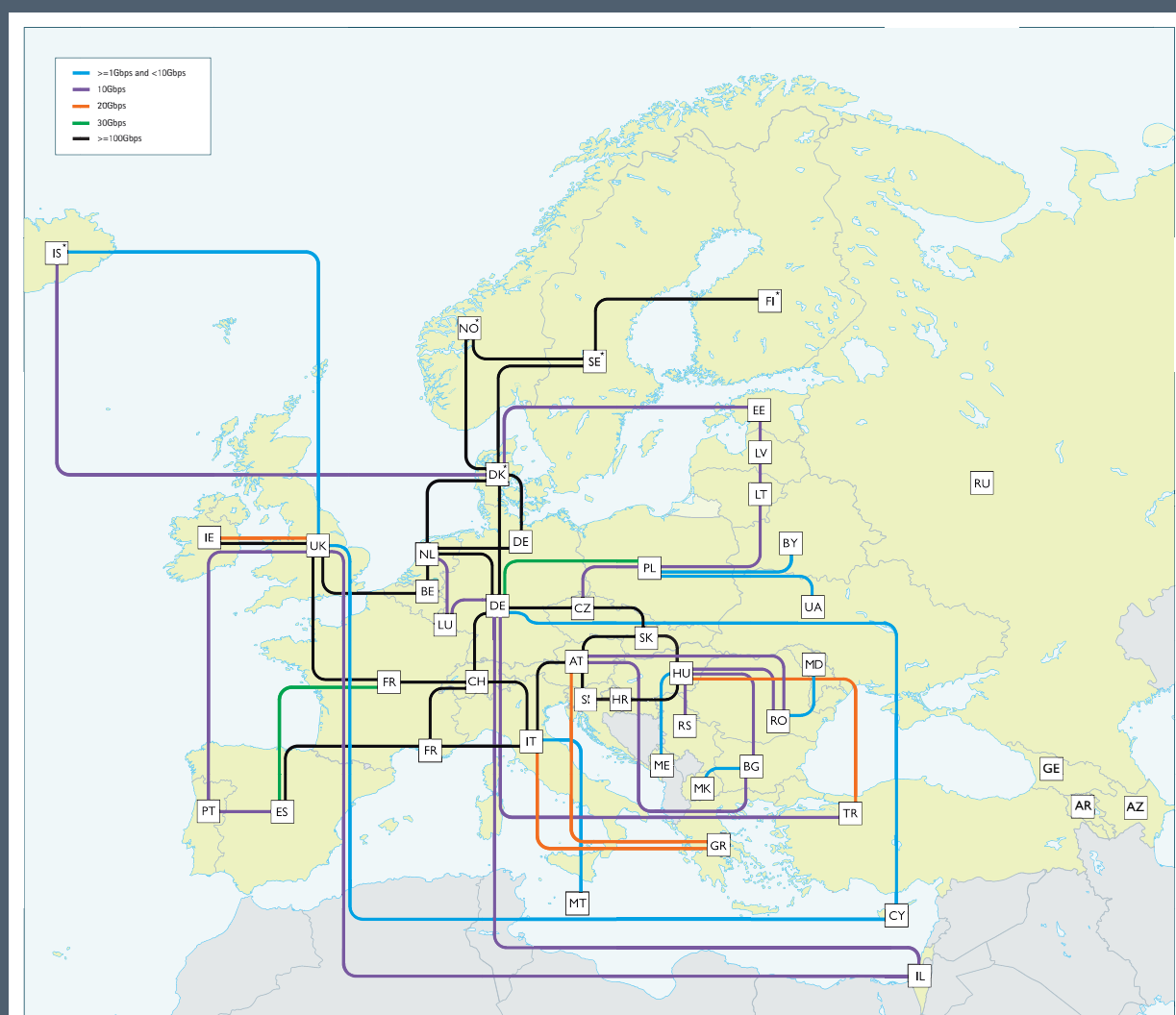
### A MEMORABLE EXPERIENCE YOU'LL NEVER FORGET OR SOMETHING ABOUT YOU THAT NOBODY KNOWS?

My husband and I participated in the Amsterdam Canal Parade last year, on a boat with some 50 people on it. And while watching the parade is already great fun, being on a boat in the parade itself is a different experience altogether. Especially passing under the first bridge and entering the canals, the sides and bridges absolutely packed with thousands of people all cheering and clapping; an exhilarating experience I will never forget.

# ABOUT GÉANT: AN AT-A-GLANCE GUIDE

GÉANT is the pan-European research and education network that interconnects Europe's National Research and Education Networks (NRENs). Together we connect over 50 million users at 10,000 institutions, supporting research in areas such as energy, the environment, space, health and medicine.

## EUROPE'S RESEARCH AND EDUCATION DATA NETWORK



GÉANT connectivity as at January 2014. GÉANT is operated by DANTE on behalf of Europe's NRENs.

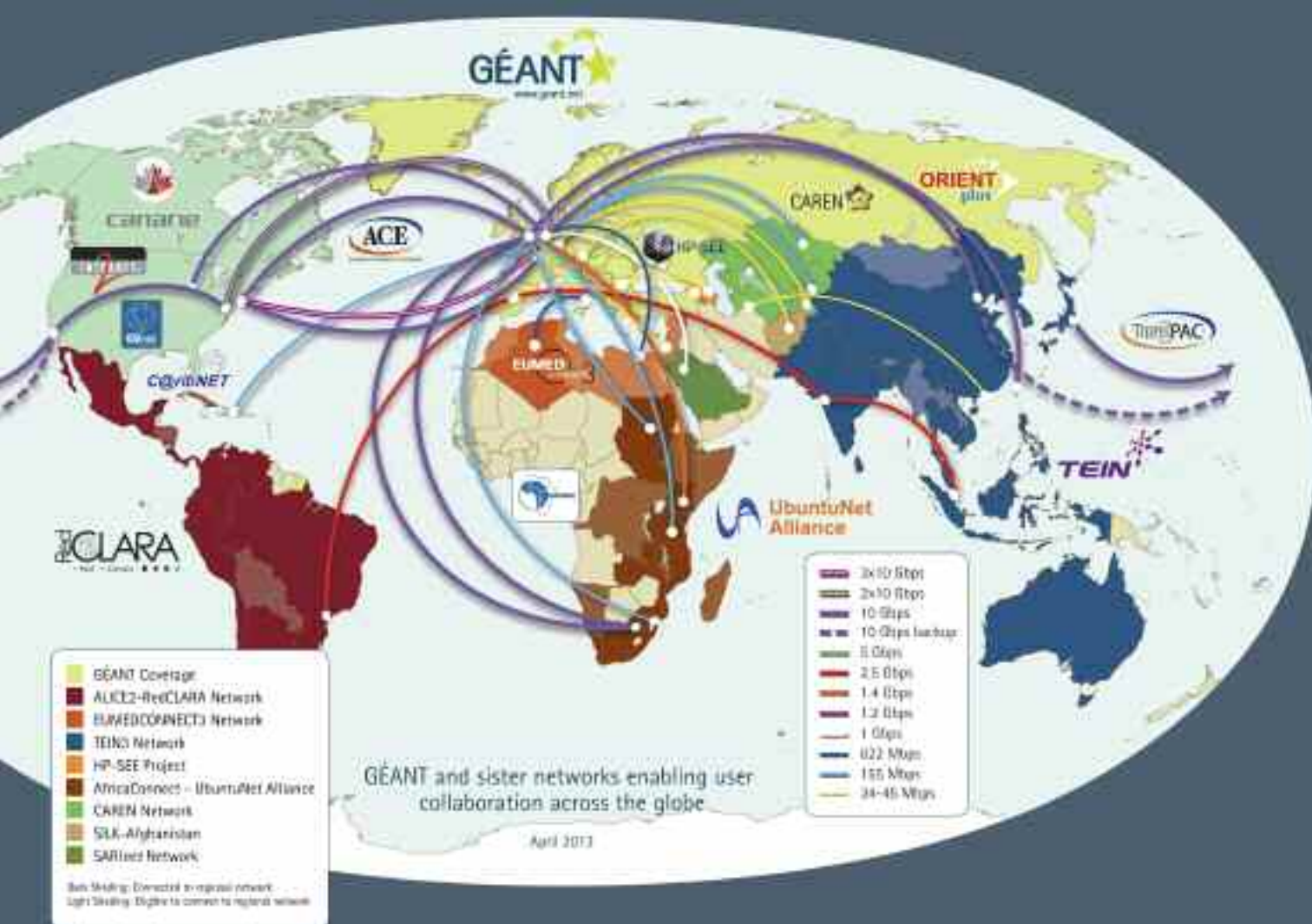
|               |                   |             |             |            |               |                     |                |            |             |                   |
|---------------|-------------------|-------------|-------------|------------|---------------|---------------------|----------------|------------|-------------|-------------------|
| AR Armenia    | BG Bulgaria       | DE Germany  | FI Finland* | HR Croatia | IS Iceland*   | LV Latvia           | NL Netherlands | RO Romania | SE Sweden*  | TR Turkey         |
| AT Austria    | CH Switzerland    | DK Denmark* | FR France   | HU Hungary | IT Italy      | ME Montenegro       | NO Norway*     | RS Serbia  | SI Slovenia | UK United Kingdom |
| AZ Azerbaijan | CY Cyprus         | EE Estonia  | GE Georgia  | IE Ireland | LT Lithuania  | MK F.Y.R. Macedonia | PL Poland      | BY Belarus | MD Moldova  | UA Ukraine        |
| BE Belgium    | CZ Czech Republic | ES Spain    | GR Greece   | IL Israel  | LU Luxembourg | MT Malta            | PT Portugal    | RU Russia  | SK Slovakia |                   |

\*Connections between these countries are part of NORDUnet (the Nordic regional network)



## AT THE HEART OF GLOBAL RESEARCH NETWORKING

The GÉANT network has extensive links to other world regions through collaboration with further networks, including those in North and Latin America, the Balkans, the Mediterranean, Black Sea, South Africa, Central and Eastern Asia.



## JOIN THE CONVERSATION



[www.geant.net](http://www.geant.net)



[www.facebook.com/GEANTnetwork](https://www.facebook.com/GEANTnetwork)



[www.twitter.com/GEANTnews](https://www.twitter.com/GEANTnews)



[www.youtube.com/GEANTtv](https://www.youtube.com/GEANTtv)

# SERVICES

## ENHANCING YOUR EXPERIENCE OF THE NETWORK

The GÉANT project delivers innovative services to enhance users' experience of the network. We're here to support you with a portfolio of advanced connectivity, network support and access services, designed to meet the needs of NRENs, institutions, researchers and students. Discover more here: <http://www.geant.net/Services/Pages/home.aspx>

|                                      |                           |                                                                                                                                         |
|--------------------------------------|---------------------------|-----------------------------------------------------------------------------------------------------------------------------------------|
| <b>Networking Services</b>           | GÉANT IP                  | Core IP connectivity between NRENs. Cost effective, reliable, open and independent.                                                     |
|                                      | GÉANT Plus                | Layer2 point-to-point connectivity. Assured bandwidth, secure.                                                                          |
|                                      | GÉANT Lambda              | Layer2 ultra-high capacity point-to-point connections for demanding applications                                                        |
|                                      | GÉANT Peering             | Layer3 IP interconnectivity with 3rd party providers.                                                                                   |
|                                      | GÉANT Open                | Flexible, open Layer2 interconnectivity between organisations                                                                           |
|                                      | GÉANT L3 VPN              | Logical virtual IP networking – ideal for one-to-many or many-to-many connectivity.                                                     |
|                                      | GÉANT Bandwidth on Demand | Flexible “on-demand” layer2 connections to provide high performance networking                                                          |
|                                      | GÉANT OpenFlow Facility   | A flexible testbed facility to help develop new networking services.                                                                    |
| <b>User Application Services</b>     | eduroam®                  | National and International wi-fi roaming. Secure, simple and global.                                                                    |
|                                      | eduCONF                   | An easy to use directory of VC facilities across Europe.                                                                                |
|                                      | eduGAIN                   | Federated AAI services offering assured, simple single sign-on.                                                                         |
| <b>Tools and Management Services</b> | perfSONAR                 | Multi-domain monitoring service. Enabling NREN NOCs and PERTs to collaborate in providing seamless network performance for their users. |
|                                      | eduPERT                   | Federated Performance Enhancement Response Teams - helping network users get the best performance from their connections.               |
|                                      | eduPKI                    | Supporting service developers by helping manage digital certificates.                                                                   |

# THE GÉANT INNOVATION PROGRAMME

## SHAPING THE INTERNET OF THE FUTURE

Part of GÉANT's role is pushing the boundaries of networking technology to shape the internet of the future. The GÉANT Innovation Programme exists to develop an advanced portfolio of technologies, to develop into services, tools and network capabilities for tomorrow's researchers.

Here are just a few ways the GÉANT Innovation Programme is driving discovery in networking technology.

### RESEARCH PROGRAMMES

The research elements of the GÉANT project focus on three core areas:

- Network architectures for Horizon 2020
- Technology testing for advanced applications
- Identity and trust technologies

By being technology and supplier neutral, these research activities contribute greatly to thought leadership in networking services across Europe.

### STANDARDS

The use of standards and information from standards bodies are essential to the development of GÉANT services to ensure interoperability with services of other networking organisations. Members of the GÉANT project have leadership roles in the OGF (Open Grid Forum) and IETF (Internet Engineering Task Force) standards organisations and make significant contributions to the formation of standards.

### TESTBEDS

"Testbeds as a Service" provides two types of testbed capabilities to support the network research community. Dynamic Packet Network Testbed Service supports upper layer network research, and the Dark Fibre Testbed provides photonic layer long haul facilities for testing novel optical/photonic technologies in the field.

### OPEN CALL

The Open Call projects bring in fresh ideas and support new uses of the network. €3.3m is being invested into 21 independent projects for research into advanced networking technologies. In support of the Horizon 2020 aims, each project is aligned to one of the GÉANT Joint Research Activities. The four subject areas are:

- **Applications and Tools** – supporting advanced research activities and projects.
- **Authentication** – helping support secure end-to-end authentication of systems and people.
- **Network Architecture and Optical Projects** – studying future networking systems.
- **SDN** - exploring Software Defined Networking potential to meet new networking demands.

### ASPIRE FORESIGHT STUDY

ASPIRE (A Study on the Prospect of the Internet for Research and Education) provides recommendations to policy and decision makers on topics likely to have a significant impact for the future of research and education (R&E) networking. For instance:

- The adoption of cloud services
- The integration of mobile services into NRENs service portfolios
- Middleware and managing data and knowledge in a data-rich world
- The future role of NRENs

The final report can be downloaded from the TERENA website:  
[www.terena.org/publications](http://www.terena.org/publications)



[www.geant.net](http://www.geant.net)

