GÉANT

CONNECT

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15 YEARS OF FILESENDER

THE GÉANT PROJECT HIGHLIGHTS

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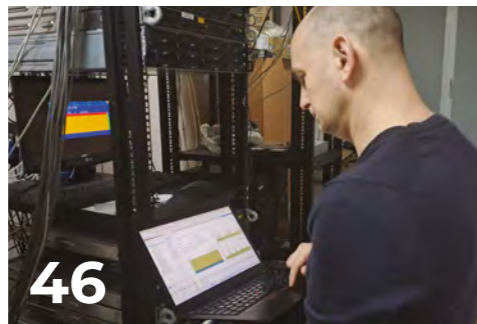
Editor's welcome

Welcome to this issue of CONNECT, and bienvenue à TNC24! If you're lucky enough to be here in Rennes, this week promises a packed programme of keynotes, sessions, workshops, side meetings, and the equally important social gatherings! Also, new and improved after its pilot last year is the Community Hub – be sure to look through the dedicated Hub programme and join in as much as you can. And, for those unable to be with us in person, we hope our online platform brings the conference to you, wherever you are.

When we put these magazines together, we always identify a theme to build the content around. What is our theme this time? How could it be anything other than this amazing community? TNC is where the community gathers, where we together engage with our diverse user communities and commercial partners. It's where we celebrate members of this community through the GÉANT Community Award and the Vietsch Foundation Medal of Honour. It's where we invite and welcome future talent to our community and where, through workshops, SIG meetings, ad-hoc chats in the coffee breaks, and the CEO Track we each embrace the global R&E community. So, what can you find in our magazine this time?

As with past TNC issues of CONNECT, we take a closer look behind the scenes and in our TNC section you can read interviews with our keynote speakers Professor Paul Iske and Doctor Nataliya Kosmyna; and you can meet our 2024 GÉANT Community Award winner Marina Adomeit of SUNET and this year's Vietsch Foundation Medal of Honour awardee Christian Grimm of DFN. We also take a closer look at two programmes that are a key part of TNC, the Future Talent Programme, and the Emerging NREN Programme. These outreach programmes highlight what makes this community – and its annual event – so special.

Our feature section shines a light on the incredible Large Hadron Collider Open Network Environment (LHCONE) that supports a vast community of scientists and projects, and our fascinating interview with CERN's Head of IT Enrica Porcari helps to explore how collaboration across scientific communities is only going to get stronger.

Elsewhere, you can learn how the first Security Days conference tackled key issues for the growing community of security professionals; how the GN5-IC1 project is charting GÉANT's intercontinental connectivity investments to best support the global R&E community - in what is a rapidly changing environment described in our opinion piece 'Five Hundred and Fifty Cables under the Seas'; and read about the latest national developments from our NREN members.

If you're in Rennes, be sure to visit all the exhibitor booths, meet the teams, visit the Community Hub, and fully engage with this wonderful community. Enjoy the issue, and the conference!

Paul Maurice, GÉANT

LHCONE – More than just a Boson

Virtually everyone knows about the discovery of the Higgs Boson by CERN and how LHCONE has supported that. But indeed, within the fields of physics, astrophysics and cosmology there are way more experiments that rely upon the LHCONE network. Here is an overview of the science collaborations that use LHCONE today.

Words: Karl Meyer, GÉANT

ATLAS - Pushing the frontiers of knowledge

ATLAS is a general-purpose particle physics experiment at the Large Hadron Collider (LHC) at CERN. It is designed to exploit the full discovery potential of the LHC, pushing the frontiers of scientific knowledge. ATLAS' exploration uses precision measurement to push the frontiers of knowledge by seeking answers to fundamental questions such as: What are the basic building blocks of matter? What are the fundamental forces of nature? What is dark matter made of?

ATLAS is the largest detector ever constructed for a particle collider: 46 metres long and 25 metres in diameter. Its construction pushed the limits of existing technology. ATLAS is designed to record the high-energy particle collisions of the LHC, which take place at a rate of over a billion interactions per second in the centre of the detector. More than 100 million sensitive electronics channels are used to record the particles produced by the collisions, which are then analysed by ATLAS scientists.

ATLAS is a collaboration of physicists, engineers, technicians, students and support staff from around the world. It is one of the largest collaborative efforts ever attempted in science, with over 5,500 members and almost 3,000 scientific authors. The success of ATLAS relies on the close collaboration of research teams located at CERN, and at member universities and laboratories worldwide.

atlas.cern

CMS – Compact Muon Solenoid

The CMS Collaboration brings together members of the particle physics community from across the globe in a quest to advance humanity's knowledge of the very basic laws of our universe. CMS has over 4,000 particle physicists, engineers, computer scientists, technicians and students from around 240 institutes and universities from more than 50 countries.

The collaboration operates and collects data from the Compact Muon Solenoid, one of the general-purpose particle detectors at CERN's LHC. Collaborators from all over the world helped design and fabricate components of the detector, which were brought to CERN for final assembly. Data collected by CMS are shared with several computing centres via the Worldwide LHC Computing Grid. From there, they are distributed to CMS institutions in over 40 countries for physics analysis. In keeping with CERN's commitment to open access for high-energy physics, the scientific results from CMS are shared openly with the world.

cms.cern

LHCb collaboration

LHCb is an experiment set up to explore what happened after the Big Bang that allowed matter to survive and build the universe we inhabit today. 13.8 billion years ago, the universe began with a bang. Crammed within an infinitely small space, energy coalesced to form equal quantities of matter and antimatter. But as the universe cooled and expanded, its composition changed. Just one second after the Big Bang, antimatter had all but disappeared, leaving matter to form everything that we see around us — from the stars and galaxies to the Earth and all life that it supports.

From the 10 million proton collisions every second, LHCb records the data from just 2,000. The job of choosing the most interesting collisions is carried out by an electronic trigger that performs an extremely rapid analysis of the signals from a few key parts of the detector. In just 4 millionths of a second the trigger must take a decision or data are lost. This is just one aspect of the computing challenges of LHCb. The amount of information recorded is around 10 gigabytes per second, enough to fill approximately 55,000 CDs per hour. Data from the experiment is then replicated throughout a network of more than 100 computing centres around the world. Tens of thousands of computers are able to analyse the data simultaneously, thanks to the global Grid computing infrastructure supported by the World LHC Computing Grid collaboration.

The LHCb is a truly international collaboration. About 1,400 scientists, engineers and technicians representing 86 different universities and laboratories from more than 18 countries are involved in the project.

lhcb.web.cern.ch

LHCONE – A model of network evolution in the 21st Century

One of the defining characteristics of these collaborations is the need to rapidly share huge volumes of data with hundreds of scientists around the world. For this the LHCONE network is ideally positioned. The LHCONE network overlay service is by far the largest multidomain service provided to the global Research and Education user community. It was created in response to the evolving needs of the LHC experiments and has grown from a small-scale technical exercise to today's global service. The LHCONE service is currently deployed by 40 national regional and intercontinental R&E network operators, connecting more than 150 sites, in four continents.

This network replaces the original hybrid private/shared topology initially developed in the late 1990s which rapidly became unfit to adapt to the changing profile of data processing in the community, which had shifted in response to both the increased data production of the LHC and the different ways this data was being used. The profoundly-changed computing model had the effect of bringing a lot more pressure on the network, not just in terms of traffic, but also the added capabilities required to allow for a more effective use of the increased capacity, primarily on the long-distance geographic links but also on the access links to the sites.

The answer to these new sets of requirements led to the LHC Open Network Environment (LHCONE) concept. Created at a workshop organised by Caltech and CERN in June 2010, and starting with a pilot with a small number of participating sites, LHCONE quickly grew organically to include the major LHC computing sites and the R&E network operators in all regions of the world.

As of today, LHCONE is implemented by 33 NRENs, four regional and three intercontinental RENs, spanning four continents (Europe, Asia, North and South America, Australia). Currently, over 150 sites are connected to LHCONE.

The use of the network has also been expanded from the original four LHC experiments to include all the experiments described here and many more. This widening of the scope allows the LHCONE infrastructure to be shared across a wider community, simplifying the operations of these other particle physics experiments and reducing duplication and costs for sites involved in multiple experiments.

LHCONE stands as a remarkable example of the benefits of international collaboration between NRENs and RRENs in order to support the rapidly-changing requirements of advanced research.

To find out more about the evolution of and technology behind the LHCONE network visit **connect.geant.org/ LHCONE**

ALICE (A Large Ion Collider Experiment)

ALICE is a detector dedicated to heavy-ion physics at the Large Hadron Collider (LHC). It is designed to study the physics of strongly interacting matter at extreme energy densities, where a phase of matter called quark-gluon plasma forms.

For part of each year the LHC provides collisions between lead ions, recreating in the laboratory conditions similar to those just after the Big Bang. Under these extreme conditions, protons and neutrons "melt", freeing the quarks from their bonds with the gluons. This is quark-gluon plasma. The ALICE collaboration studies the quark-gluon plasma as it expands and cools, observing how it progressively gives rise to the particles that constitute the matter of our universe today.

alice.cern

Belle II

In the Big Bang, matter and antimatter should have been created in equal amounts. But why is the universe today filled almost only with matter? Physicists attribute the different behaviour of matter and antimatter to the violation of the so-called CP symmetry. But the extent of the observed CP violation is not sufficient to explain the actual excess of matter in the universe. The Belle II experiment at the SuperKEKB accelerator in Japan aims to solve this great mystery of particle physics.

The Belle II collaboration consists of over 1,100 physicist and engineers from 122 institutions in 27 countries and relies upon the high performance networks of NRENs across the world to distribute and share the huge volumes of data produced.

belle2.jp

XENON

The XENON dark matter research project, operated at the Italian Gran Sasso National Laboratory, is a deep underground detector facility featuring experiments aiming to detect hypothetical dark matter particles. The experiments aim to detect particles in the form of weakly interacting massive particles (WIMPs) by looking for rare nuclear interactions in a liquid xenon target chamber.

Between 2006 and 2012, CERN has directed a beam of muon neutrinos from the CERN SPS accelerator to the Gran Sasso lab, 730Km away. These were detected by the OPERA and ICARUS detectors, in a study of neutrino oscillations which improved on the results of the Fermilab to MINOS experiment and demonstrate that neutrinos have mass.

xenonexperiment.org

Illustration:
Compact
Muon Solenoid
Detector

Pierre Auger Observatory

The Pierre Auger Observatory is located on the vast plain known as the Pampa Amarilla (yellow prairie) in western Argentina. It studies the highest-energy particles in the universe, which hit the Earth from all directions, so-called cosmic rays. Cosmic rays with low to moderate energies are well understood, while those with extremely high energies remain highly mysterious. By detecting and studying these rare particles, the Pierre Auger Observatory is tackling the enigmas of their origin and existence.

The Pierre Auger Collaboration includes over 500 scientists from Argentina, Australia, Belgium, Brazil, Columbia, The Czech Republic, France, Germany, Italy, Mexico, the Netherlands, Peru, Poland, Portugal, Romania, Slovenia, Spain, and the USA.

auger.org

Head of the Information Technology Department at CERN since 2021, Enrica Porcari leads a talented and enthusiastic team with whom she is pushing the boundaries of innovation and technology, focusing on serving not only CERN's IT requirements but also those of the larger scientific community. Before joining CERN, she managed the digital aspects of several international development projects. She was Chief Information Officer at the World Food Programme, where she played a key role in setting up the Fast IT and Telecommunications Emergency and Support Team to support global humanitarian operations.

We interviewed her to learn more about her career, her team's work and her take on the future of international collaboration within the high-energy physics community.

Interview by: Silvia Fiore, GÉANT

CONNECT Interview: Enrica Porcari, Head of Information Technology, CERN

Enrica, can you tell us more about what brought you to CERN? As you come from outside the world of high-energy physics, we are curious to know your story and how it led you to the Information Technology Department at CERN.

CERN is a very inclusive international research organisation and among the best-known in the world. Its success story is due to the contribution of thousands of people with many different profiles, and I am proud to be one of them. This year, CERN celebrates 70 years since its founding, a long and proud history of ensuring research in fundamental physics reaches society at large. A fascinating journey, a compelling story of science, innovation and impact.

From my end, when I joined CERN, I had already managed Information Technology (IT) teams in large international organisations for 30 years. The field I was coming from was that of the international humanitarian organisations, where I developed a deep understanding of the societal needs, so well described by the UN Sustainable Development Goals. Joining CERN was an unmissable opportunity for me, I could both support first-hand the great work of this Laboratory and its IT department to serve CERN's mission of fundamental research to understand the origin of the universe, and at the same time build ways and envision solutions that are, or will be, beneficial to society at large. A dream come true.

Science is our driving force at CERN, but it's not an ivory tower that keeps us away from the rest of society. A very good example are all our initiatives in the field of open science and the hundreds of software packages developed at CERN and shared with society. Just an example – it was recently announced that the World Health Organization (WHO) and CERN have collaborated to develop a robust risk assessment computer model for indoor airborne pathogen transmission based on tools developed for particle physics. The list of such initiatives is long.

In an online interview, you compared your work to that of "running a restaurant", meaning catering for the needs and requests of the clients while not bothering them with what happens behind the scenes, "in the kitchen". What does a typical day at work look like for you and your team?

We like what we do, and the IT department is proud to contribute to the tools and platforms the innovative physics research of CERN needs. We obviously serve CERN's internal computing needs but, very importantly, also serve collaboratively a growing community working in the larger scientific community. We have to work in sync with, and at times anticipating, the needs of our internal and external users – "the clients", if you will.

Article continues next page ⬎

Just like in a restaurant, these clients do not necessarily need to know the ingredients or ways the food is prepared in the kitchen, they just want to have a meal they like and want. There is no magic formula for that, just hard work and a mutual understanding of all people involved. Yes, in the IT Department, a huge effort goes into making sure that what we do matches what the research community needs, like a good chef would do to make their customers happy when they taste the food. To do so, we establish and everyday nurture strong collaborations with our own customers to make sure we continuously check progress, verify expectations, make them 'taste the food, before it is ready'. In that way, we are actually quite a unique and collaborative restaurant, where we also ensure the kitchen staff works as a team!

In September 2023, CERN passed the threshold of one million terabytes of disk space. These disks are primarily used to store the impressive amount of physics data produced by the LHC's experiments. HL-LHC, the upgrade of the LHC, is expected to generate even more data. How do you prepare for such a data deluge and the work that follows?

Dealing with huge amounts of data is our daily activity. We know already that what seemed like an incredible record and a challenge just a couple of years ago – the production of 1 PB of data – will soon be the amount of data that our storage facility will receive every day.

The recent successful outcome of the ALICE O2 project provided us with a useful preview of what we should expect from High Luminosity-LHC. Because of recent upgrades to the detector and also the data readout strategy, last Autumn, the ALICE experiment produced 50 PB over five weeks, generating up to 3.6 PB of data in a single day.

As I said, our mission is primarily to meet the needs of the scientific community managing the experiments. For them "failure" is not an option. Our teams collaborate constantly with the researchers, they innovate, they optimise. It's a daily effort, there is no miracle solution, it's pure human ingenuity and hard work. For ALICE O2, our teams set up a dedicated high-performance storage system consisting of approximately 12,000 hard disks across 126 servers with 100 GE network connectivity between the experiment – located in France – and the data centre – located in the main campus.

Besides CERN's two data centres – the one in the Prévessin campus was inaugurated last February – our community can also count on the vital role of the Worldwide LHC Computing Grid (WLCG). To date, there are around 160 WLCG sites in more than 40 countries. Collectively, in WLCG, we have a storage availability of more than 1 EB on disk and almost 2 EB on tape. The experiments use over 1M cores (processing units) from WLCG (on average at any given time). So, once again, dealing with the challenges is the result of a collaborative effort.

Created in response to the evolving needs of the LHC experiments, the Large Hadron Collider Open Network Environment (LHCONE) has proved to be the single most successful multidomain services provided by the global R&E network community, creating a closed and trusted environment, and enabling institutes and scientists around the world to participate in CERN's research. A remarkable example of the benefits of international collaboration within the high-energy physics community. How do you see this collaboration evolve in the future?

Past evolution of the LHCONE network has been driven by the needs of the LHC community— the improvements in connectivity between our partners in Asia are a good example. There is still a need to improve connectivity in less developed countries and address the needs of small sites, but I think evolution in the future will also reflect the growth in global "big data" science. Today, global R&E traffic is dominated by data from the LHC but we're soon going to be sharing those links with others, the SKAO community, for example. It's great to see how the LHCONE community has been preparing for this with initiatives such as SciTags that enables monitoring of the traffic flows from different communities. I'm also pleased to see that there will be a Global Science Network Forum at TNC24 which should help to ensure that other communities can benefit as much from close contact with the Global R&E networking community as we have at CERN.

Picture
Group photo of the CERN IT Department, which counts around 400 members

How do you envision the future of the IT Department and the evolution of the computing environment at CERN and beyond? What is the role of Education?

From my experience in technology management, I have learned that there is virtually no other field like Information Technology, in that it proves so difficult when one attempts to do forecasts about the way it will develop and the depth of its impact. Who would have known that back in the 90s CERN's innovative work on HTML would have grown into what is today's worldwide web, something everyone uses?

We work with Artificial Intelligence, Quantum Technologies, High-Performance computing, ultra-fast networks. This is the present. What will the future bring? I hope – and we are working for this to happen – that it will bring no new technology gaps. This is one of the reasons that pushed us, among others, to launch the Open Quantum Institute, an initiative that aims at envisioning how the quantum technologies can benefit society while they are being developed, not after. We also invest considerable resources in training future computer scientists. In 50 years of activity, we have organised more than 60 schools in 20 different countries. In 2024,

in addition to summer camps at CERN, we are running four different computing schools to provide early careers scientists with advanced learning in scientific computing and the opportunity to connect with other young scientists and engineers involved in particle physics or other sciences. And yes, the incurable optimist I am believes that tomorrow's world will be better. At CERN we have the motivation, the skills, and the tools to contribute to make it happen. And the IT department is an integral part of that effort.

![RENATER - CONNECTEUR DE SAVOIRS]

RENATER and the National Center for Scientific Research join CERN's 2024 Data Challenge
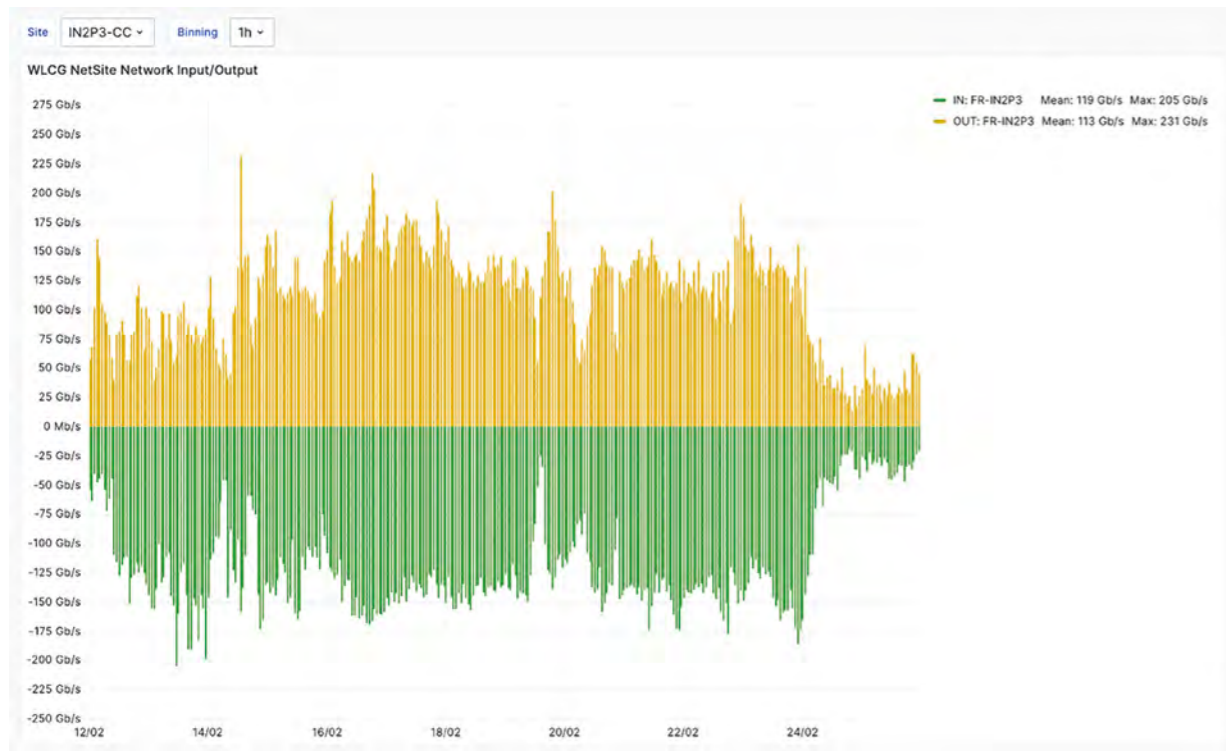
RENATER, the French National Research and Education Network operates a secure national and international connectivity network with the aim to promote the influence of national French research within international research projects.

Words: Boris Dintrans, CEO and Laurent Gydé, COO of RENATER

At the end of February 2024 during the 2024 Data Challenge (DC24), the European Organisation for Nuclear Research (CERN) ran an initial large-scale test which was carried out worldwide to validate the operation and size of the networks and software infrastructure to transfer the data produced of the future HL-LHC (High Luminosity Large Hadron Collider). In France, RENATER and the IN2P3 CNRS computing center have confirmed that the network infrastructure is capable of supporting the expected data rates.

Expected to deliver high-intensity beams from 2029, HL-LHC is the upgrade to the world's most powerful particle accelerator and will bring rich physics opportunities for CERN's global experiments. The LHC's data processing infrastructure is made up of almost two hundred sites spread across the planet and organised into several levels. At the center of this computing grid CERN distributes the data to fourteen international Tier 1 centers, which are in turn responsible for feeding a second tier (Tier 2) made up of around 160 sites spread across the globe. With the evolution of the LHC, it is essential to adapt the transfer capacities between the different sites of this computing infrastructure in order to absorb the considerable increase in data from the HL-LHC. The aim of DC24 across all the first-level sites was to validate the software and the performance of the data storage systems, and to test the various inter-site network links deployed around the world, whether they are dedicated to the LHCONE, the LHCOPN, or shared with other uses.

RENATER provides the network infrastructure to CC-IN2P3, a major player in scientific computing for the exploitation of data from major physics experiments and a Tier 1 site for the LHC. In order to guarantee the success of this data challenge, RENATER increased the CC-IN2P3 connectivity dedicated to the LHC from 200 to 400 Gbit/s at the beginning of 2024. RENATER's connectivity to the European GÉANT network has also been upgraded to a total capacity of 800 Gbit/s.

The observations of the network links during the exercise have shown sustained speeds of 200Gbit/s on LHCOPN and 200Gbit/s on LHCONE, in parallel and for several hours. This optimal use of the network links dedicated to the LHC experiments, which represented only 25% of the capacity to be reached by 2029 for the HL-LHC, is excellent news for the ramp-up of this infrastructure in the years to come.

Boris Dintrans, General Director of RENATER explained:

"RENATER has been serving the French scientific community and contributing to its influence for over 30 years. As part of the preparation of the computing infrastructures to process the future HL-LHC data, this data challenge has enabled us to validate with our colleagues from the CNRS the capacities and robustness of our network to best support this world-scale project."

"RENATER is thrilled to host, for the first time in its history, TNC in France and welcomes on its behalf all participants. By associating itself with TNC24, which contributes to promote technological innovation and to build an international community based on shared values, RENATER is demonstrating the proactive French contribution in the field of digital technology, innovation, education and research."

Boris Dintrans, RENATER CEO

AND AT LAST…
WE RENDEZVOUS IN RENNES FOR TNC24!

This week the international research and education community gathers in the picturesque city of Rennes, packed with historical sites, marvellous museums and futuristic buildings. GÉANT and TNC24 host RENATER are delighted to welcome you to the capital of Brittany! With its research-intensive university and thriving digital scene, Rennes is committed to structuring the European higher education area with a strong international orientation..

Words: Silvia Fiore, GÉANT

This coming together – this rendezvous – gives our community time to reconnect, to revitalise and to regain our balance. As we bring together different skills, we accomplish so much, and we thrive. We learn together, we support each other's work, we discuss our challenges, and we celebrate our success.

As TNC24 is already well underway, we hope you are enjoying the event, creating new connections and at the same time indulging in the local gastronomy in the city's quirky bistros and fine restaurants!

The TNC24 team has been busy working to deliver another unforgettable event. Scan this QR code to view the conference programme

TNC24 VENUE

Le Couvent des Jacobins is a 14th century former convent located in the heart of the historic centre of Rennes. The convent's church is dedicated to the worship of Our Lady of Good News and used to be an important place of pilgrimage. It was then assigned to the French Army during the Revolution in 1793. Today, the convent's historic premises belong to the city of Rennes and make an impressive location for hosting conferences and events. The Grand Auditorium can accommodate up to 1,200 people.

If you are interested in learning more about monastic life in the 14th century as well as the political, religious, and funeral rites of the time, and admire carved and painted decorations preserved during the recent renovation, join the guided tours organised by the venue.

GUIDED TOURS

June 11, 12 and 13 at 12:45 – 13:05 and 13:30 – 13:50. The meeting point is at the South Gallery 10 minutes before the tour start time to secure your space as numbers are limited.

The Community Hub

COMMUNITY HUB

At TNC23 we tested the idea of a Community Hub. It was a great success, and for TNC24 we've listened to your feedback and ideas and made it bigger and better! The Hub is an informal space, where participants can learn more about community-led initiatives, find and exchange ideas, solutions or assistance within the community, and at the same time be connected with global peers. It has its own dedicated space, located in the corner of the Exhibition Area on Level 1 of the conference venue.

This year, the Hub is part of the conference programme and it includes:

DEMONSTRATIONS
Researchers and developers will demo their innovations during the breaks.

ROUND TABLES
Join the walk-in sessions to learn about ongoing activities and initiatives in the community.

OPPORTUNITY CORNER
A bulletin board where you can leave a project brochure, a flyer promoting a service, or a post-it note with an idea or a question.

Visit the TNC24 website at **tnc24.geant.org**

CONNECT INTERVIEW:
PROFESSOR PAUL ISKE,
MAASTRICHT UNIVERSITY

BRILLIANT FAILURES: FOSTERING CREATIVITY AND PUSHING BOUNDARIES

We met with Professor Paul Iske who will be giving the opening keynote at TNC24. Professor at the School of Business and Economics at Maastricht University, Paul works on service and social innovation and his mission is to make organisations smarter and more innovative. He is also a founder of the 'Instituut voor Briljante Mislukkingen' (Institute for Brilliant Failures), where the focus is to create environments in which innovation and agile entrepreneurship can thrive whilst understanding their complex nature. In his thought-provoking keynote, *"Brilliant Failures: Working together, failing together, learning together"* Professor Iske, recognising the inevitability and fundamental role of failure, also highlights the need for Psychological Safety when taking risks, and introduces the concept of Failure Intelligence.

Interview by: Rosanna Norman, GÉANT

PAUL, THANK YOU SO MUCH FOR JOINING US IN RENNES, WE ARE LOOKING FORWARD TO YOUR OPENING KEYNOTE. WHAT ARE "BRILLIANT FAILURES" AND WHY ARE THEY PARTICULARLY IMPORTANT IN R&D?

First of all, it is a great pleasure for me to join TNC24 and to share my passion about accepting and learning from Brilliant Failures! And yes, Brilliant Failures are fundamentally different from 'regular' failures or mistakes. Everyone makes mistakes, at least, I do. But in R&D, a failure can happen without any mistake being made. Einstein already said it: "If we knew what we are doing, we wouldn't call it research". So, R&D is a

risky business, and we should anticipate that things might not give the results we are looking for and thus, failure is an option. A Brilliant Failure is characterised by a high score of the Brilliancy factor, that can be calculated via the VIRAL-formula: $B = V \times I \times R \times A \times L$, where the V stands for Vision (is there potential value), I for Inspiration, R for Risk management (don't take too much risk, but also don't take too little risk, since that leads to missed opportunities), A for Approach (work together, prepare, make use of existing knowledge), and L for Learning (are there lessons learned? Are they shared and used?). If the score on all five factors is high, then we are dealing with a Brilliant Failure and that is really a step forward, not a step backward!

WHAT DOES IT TAKE TO PREPARE INDIVIDUALS AND TEAMS FOR FAILURE AND BUILD ON THE PSYCHOLOGICAL SAFETY NEEDED TO ACCEPT FAILURE? COULD YOU HIGHLIGHT SOME COMMON MISCONCEPTIONS ABOUT FAILURE, AND HOW THEY CAN BE ADDRESSED?

Failure happens anywhere in life, no matter what the intentions are: in business, sports, love, arts, science… So, it is important to accept this as a given and find the best way to deal with this fact. It is certainly not the smartest tactic to ignore, condemn, hide or ridicule failure, because it will make people cautious before starting potentially important things, simply because they might fail. Furthermore, it will discourage people to share their experiences and because of that, knowledge gets lost. Therefore, it should be equally normal to talk about Brilliant Failures as it is for successes. In both cases we are dealing with good people, working hard to achieve something meaningful, resulting in new insights. Especially, the Brilliant Failures should be recognised as progress and not as a waste of money, time, energy or whatsoever. It is a misconception that failure can be avoided, especially in complex dynamic environments, which often is the case when we deal with R&D.

HOW CAN ORGANISATIONS LEARN FROM FAILURE AND DEVELOP FAILURE INTELLIGENCE?

It is often said that one can learn from failure, and that is so true. But what is the best way to do this? When I thought about this, I was inspired by some things I learned about the concepts of intelligence and learning. In fact, the basis of intelligence is pattern recognition. Think about computer-based intelligence, including AI. Here, patterns in large amounts of data, like numbers, figures, videos, etc. are recognised, leading to a piece of advice, a decision, a conclusion and/or action. The term *recognise* highlights that these patterns were previously cognised, or learned, including the corresponding conclusion, advice, etc. This brought me to the idea to look for patterns in failing and eventually, I found sixteen of them. When you familiarise yourself with these patterns, you will be able to recognise them in your context. This might be before you start something, during or afterwards. At the Institute of

Brilliant Failures, we use these patterns in analysing projects and use them to systematically report on the learnings. So, we apply a technique of semi-structured narratives, highlighting the intentions of a project, the approach, the outcome and the learnings. By doing so, Failure Intelligence is growing, because it becomes increasingly easy to identify the relevant failure patterns including the best way to deal with them.

YOU SAY THAT THE ROAD TO FAILURE CAN BECOME THE ROAD TO SUCCESS. HOW CAN ORGANISATIONS CREATE A CULTURE THAT EMBRACES AND LEARNS FROM FAILURE RATHER THAN FEARING IT?

I have never seen a major development happening by following a straight line from A to B. I have been Head of Innovation of a major bank in the Netherlands, and I have never seen a business plan becoming the reality. Life is always full of surprises. The value of failure depends on how we deal with them. Being afraid and trying to ignore them doesn't bring us any value at all. This means that organisations should consciously prepare for, accept and learn from failure. This starts at the top of the organisations which should consistently promote and reward responsible risk taking and sharing all experiences: successes and failures alike. There are many small steps an organisation can consider to improve the climate for 'trial and error', but it all starts with the shared vision that R&D without failure is an illusion and that people who try, deserve appreciation, irrespective of whether they are successful or not.

COULD YOU SHARE SOME EXAMPLES OF BRILLIANT FAILURES THAT HAVE HAD SIGNIFICANT POSITIVE IMPACTS ON INNOVATION OR PROGRESS?

Thomas Edison said it very clearly: "I didn't fail 100 times, I developed a light bulb in 100 steps." And this is what we see everywhere. It is also reflected in approaches like agile working or scrum, where the decision about the next step depends on the outcome of the previous one. Serendipity also plays an important role in R&D. Think about discoveries like Viagra (originally intended as a drug for Heart Failure, Angina Pectoris), Post-it (based on a failed glue) and many others. But in

general, learnings from the past fuel future success. Like Isaac Newton said: "If I have seen further [than others], it is by standing on the shoulders of giants." And these giants are both people who succeeded as well as those who failed. One also sees successes in business based on previous failures, when looking at companies who are successful after the first market entrant failed as they (the second ones) benefit from the first one's learnings. Facebook was not the first social media platform, but learned from its predecessors. European research shows that 'Entrepreneurial Restarters' on average add more economic value than a first-time starter, because they can apply the lessons learned from their first attempt. I strongly believe in the power of the 'Second Chance'!

AND FINALLY, DO YOU APPLY YOUR BRILLIANT FAILURES PHILOSOPHY TO YOUR OWN CAREER AND PERSONAL LIFE? HOW?

Of course, I had my own failures, some brilliant, others less brilliant. I invented a precursor of the current LinkedIn in 1997, while working for Shell. I developed a system, MASTER (Mapping System for Technical Expertise and Research), which was

so promising that I left Shell and tried to take it to the market. But other companies didn't yet see the added value. In other words: I was too early and too early is also not in time. Important lesson learned! Also, in my job at ABN AMRO, I had to accept failed projects and learned how important it is to support and recognise the people involved. The projects might have failed, but that doesn't mean that they failed. And this is becoming increasingly my view on life in general, including my own activities. If something fails, it might be something I don't like, but if it is a Brilliant Failure, I don't criticise myself, which makes it much easier to deal with. If I lose a tennis match, which happens on a very regular basis, I apply the VIRAL-formula and have to come to the conclusion that the only reason I failed, is lack of talent…

Would you like to discover how Professor Iske and his team at the Institute of Brilliant Failures embrace failure as an important learning moment, prepare to be open to the unknown and learn from the unexpected? Visit the Institute of Brilliant Failures' website to find out more: **briljantemislukkingen.nl**

CONNECT INTERVIEW:
DR NATALIYA KOSMYNA,
MASSACHUSETTS INSTITUTE OF TECHNOLOGY
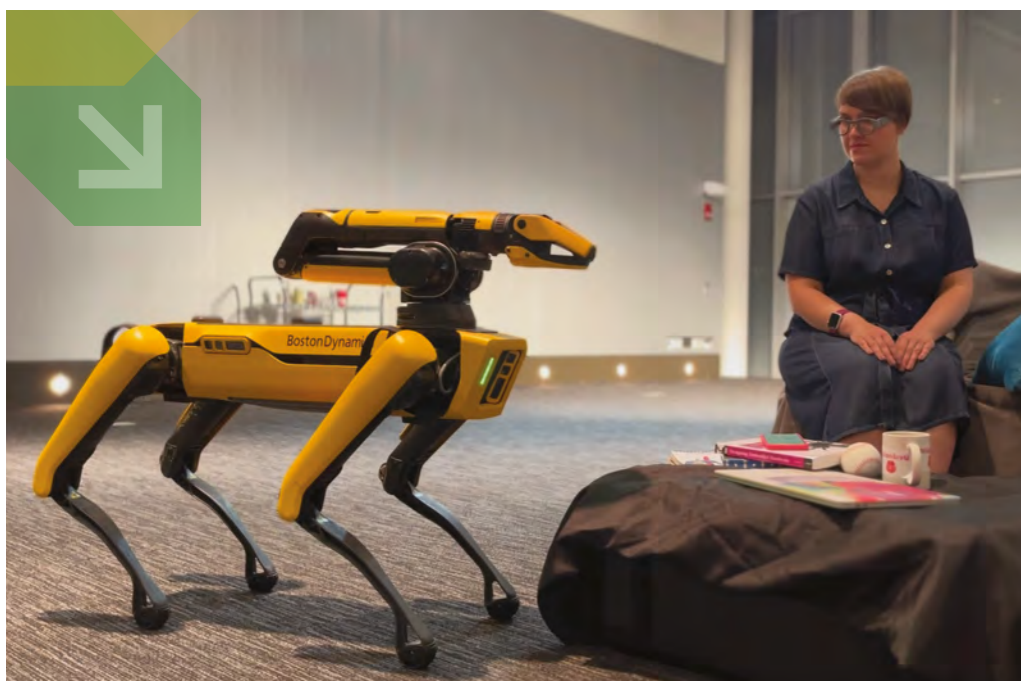
THE POWER OF THE HUMAN BRAIN

Dr Nataliya Kosmyna from Massachusetts Institute of Technology (MIT) closes the TNC24 plenary programme with her keynote *"STEMAI: The Future of Computing"*. Passionate about an idea of creating a partnership between Artificial Intelligence (AI) and human intelligence, for the past 14 years she has been working on designing solutions to control drones, robots and home appliances using brain activity only. Nataliya has already won multiple awards for her work and was also named as one of the 10 Top French Talent 2017 from MIT Innovators Under 35.

Interview by: Rosanna Norman, GÉANT

NATALIYA, THANK YOU FOR CLOSING TNC24 WITH YOUR KEYNOTE, WE ARE SO EXCITED TO WELCOME YOU IN RENNES. WHAT INSPIRED YOUR INTEREST IN BRAIN-COMPUTER INTERFACES (BCI) AND LED YOU TO PURSUE RESEARCH IN THIS FIELD?

My interest in brain-computer interfaces (BCIs) actually began when I was quite young. As a child, I watched the movie "Johnny Mnemonic," where Keanu Reeves plays a courier with a data storage device implanted in his head that allows him to carry large amounts of information that is too sensitive to upload into cyberspace. The idea of merging the human brain with technology started to fascinate me then. "The Matrix" is another movie that really made an impact on me, I think I must have watched it over 17 times! The ability to upload and download data from the brain inspired my studies.

I have always been exposed to brain knowledge as my mother is a neurologist, so I think that this might have further fuelled my curiosity of our incredible vital organ. However, I was not interested in taking the traditional medical route, so I studied Computer Science and interned in BCI research. Eventually, I pursued my Ph.D. in BCI at Université Grenoble-Alpes in France. My research projects often draw inspiration from science fiction, which has played a significant role in shaping my work. For instance, the project for the 'thinking hat' is reminiscent of the magical sorting hat from Harry Potter. This hat incorporates brain sensing technology to enhance a child's mindset. By translating brain science into fictional form factors, we think outside the box and explore innovative solutions. In summary, my journey has been driven by a desire to solve real-world problems using BCIs, rather than creating technology for its own sake.

YOUR WORK SOUNDS BOTH VISIONARY AND PRACTICAL. CAN YOU EXPLAIN WHAT "NEUROADAPTIVE TECHNOLOGY" ENTAILS, AND HOW IT DIFFERS FROM TRADITIONAL BCI APPROACHES? COULD YOU ALSO SHARE ANY RECENT BREAKTHROUGHS OR RESEARCH FINDINGS THAT HAVE EXCITED YOU?

Neuroadaptive technology refers to systems that actively adapt to an individual's brain and behaviour. Unlike traditional BCIs, which often follow predefined commands, neuroadaptive systems dynamically respond to the user's needs. Let me illustrate this with some examples.

Closed-Loop Systems - Imagine driving while feeling tired, a neuroadaptive system would detect your fatigue through brain signals and respond accordingly. It might send alerts, play sounds, or even stimulate you to wake up. If necessary, it could take control of the car and guide it safely to the side of the road. This closed-loop approach ensures real-time adjustments based on your brain's state.

Brain Switch for Paralysed Patients - We also work with fully paralysed patients. Using an app-based system, they can send basic mental commands, which are then transformed into simple actions. For instance, a patient could mentally instruct a robotic arm to pick up an object. This brain switch technology empowers individuals who cannot use traditional interfaces due to physical limitations.

Apple Vision Pro – This project involves an augmented reality headset called Apple Vision Pro. It receives brain signals via a headband and augments the user's reality based on their cognitive state. Imagine receiving context-aware information or assistance seamlessly as you go about your day.

These neuroadaptive technologies hold immense promise for enhancing human performance, attention, and focus. They bridge the gap between our brains and the digital world, opening up exciting possibilities.

WHAT ETHICAL CONSIDERATIONS DO YOU BELIEVE ARE MOST IMPORTANT TO ADDRESS IN THE DEVELOPMENT AND IMPLEMENTATION OF BCI AND NEUROADAPTIVE TECHNOLOGY?

There is obviously a dark side to the use of any technology, BCI is particularly critical: it's about the brain, the final frontier. Relevant legislation is crucial and must be put in place before the 'genie gets out of the bottle'.

Let me expand further on this. Such cutting-edge technology offers immense potential, but it also comes with risks, so here are some critical considerations.

Privacy and Consent - BCIs directly interface with our brains, raising privacy concerns. How do we ensure that users have control over their neural data? Informed consent becomes paramount.

Safety and Responsibility - BCIs must be safe and reliable, developers need to be accountable for unintended consequences. Responsible innovation is essential.

Equity and Accessibility - Ensuring equitable access to BCIs regardless of socioeconomic status or geographical location is vital.

Stigma and Perception - Addressing stigma associated with BCIs—whether as assistive devices or enhancements—is essential for societal acceptance.

Legislation and Regulation - This fast-developing field needs a solid governance framework, imagine that if combined with artificial intelligence, it could enable developers to abuse cognitive biases and trigger reactions and emotions without consent. I am a member of the UNESCO Committee on Ethics of Neurotechnology which looks at the development of sound and ethical regulation in the field of neurotechnology at the international level. I agree with Gabriela Ramos, Assistant Director-General for Social and Human Sciences of UNESCO who says: "This is not a technological debate, but a societal one that needs to be tackled now!"

IN YOUR MID-30S, YOU HAVE ALREADY GAINED INTERNATIONAL RECOGNITION FOR YOUR MULTI-AWARD-WINNING WORK. COULD YOU SHARE WITH OUR READERS WHAT'S 'AROUND THE CORNER' FOR NATALIYA KOSMYNA?

I believe that the impact of my work extends beyond accolades. It's about the people and the community we serve. Whether addressing medical challenges, assisting non-verbal individuals, or supporting astronauts, my work remains human-centric. I work with the brain, the brain is not in a vacuum, it's the human being. Certainly, my ambition—to enable brain upload and download—is visionary, unlocking the brain's power is essential for AI. As my research strives to make this a reality, humanity remains at the heart of our mission. It takes a village—a dedicated team—to turn dreams into transformative solutions.

DID YOU KNOW?

The power of 24 supercomputers in the world cannot reproduce ten minutes of complex brain activity of a mouse. How's that for complexity?

FIND OUT MORE

Dr Kosmyna's work pushes boundaries, her projects demonstrate the practical applications of neuroadaptive technology and its potential impact on various aspects of our lives. To learn more about her groundbreaking work at MIT, where she continues to innovate and explore novel hardware solutions for different applications, visit:

media.mit.edu/projects/avp-eeg/overview

media.mit.edu/projects/thinking-cap/overview

media.mit.edu/projects/ddog/overview

MEET YOUR 2024
GÉANT COMMUNITY AWARD WINNER

We are pleased to announce Marina Adomeit is this year's GÉANT Community Award winner! Marina was nominated for her leadership of Trust and Identity work in successive GÉANT Projects and extensive AAI support for international user communities including EuroHPC.

Words: Grace Cooper, GÉANT

ABOUT MARINA

Marina is the Trust and Identity Project Manager at SUNET, with a focus on international projects and T&I services. She has been working since 2006 in the NREN community, with experience participating in GÉANT projects in tasks related to AAI where she currently leads the Trust and Identity Work Package in GN5-1. Marina has been working within international projects such as Seamless Access Consortium, Puhuri AAI infrastructure for access to EuroHPC LUMI supercomputer, and others.

"Enthusiasm, growth, challenge, fun, and friendship are what comes to mind when I think about working in the GÉANT community. It is an absolute honour to be part of this forward-looking family that aspires towards a bright and modern future for global Research and Education. I am beyond thankful for the mentorship, comradeship, and trust I received from my peers, and this award recognises that these are at the root of our community! The future of digital identity is happening now! It is exciting and full of amazing opportunities that we can shape and realise together to empower the new generations in academia."

Marina Adomeit

Maria Häll, CEO of SUNET, commented:

"SUNET is proud to count Marina as one of our own. Her leadership in AAI and her many invaluable contributions to digital identity over the last decade is a testament to the power of the GÉANT community and to Marina's capabilities as a community leader. We are convinced that we have only seen the beginning of a long journey together with our friend and colleague Marina Adomeit."

THE VIETSCH FOUNDATION AWARDS THE 2024 MEDAL OF HONOUR TO CHRISTIAN GRIMM

On Thursday 13 June the TNC24 stage in Rennes will host the ceremony for the 2024 Medal of Honour by the Vietsch Foundation. Valentino Cavalli, the Chairman of the Board of the Foundation's Trustees, will present the prestigious award to Christian Grimm, CEO of DFN, the German NREN.

Words: Rosanna Norman, GÉANT

"This year we received a large number of very valuable nominations, and we had a tough time in making our choice. We selected Christian Grimm because of the undisputed impact of his achievements in research and education networking at the European as well as international and global levels", Valentino commented.

"The Vietsch Foundation recognised the exceptional value of Christian's role in the restructuring of research and education networking in Europe and the merger of TERENA and DANTE with the establishment of the GÉANT Association. The merger is a great success, as is reflected in the successful GÉANT projects as well as in further collaboration with the EU and between NRENs. Christian Grimm was formerly chair of the GÉANT

Association and he helped to shape the organisation with commitment, dedication and empathy. His five years at the head of the GÉANT Board have laid the foundations for this success and the ever-growing trust between the NRENs. The whole R&E community will benefit from this for a very long time to come."

In accepting the award Christian Grimm said: "Since I started at DFN I have been able to experience the great passion and spirit of collaboration in the European NREN community. The fact that I had the privilege to contribute to GÉANT's success story in its founding years still fills me with great joy today. I am very proud to accept this medal of honour, not only for myself, but for the whole Board of Directors. I also see it as recognition

of what executives and staff of the GÉANT office achieved during the foundation period."

ABOUT CHRISTIAN GRIMM

Christian Grimm is Chief Executive Officer of the German National Research and Education Network (Verein zur Förderung eines Deutschen Forschungsnetzes e. V. – DFN-Verein). Christian joined DFN in 2009 and was appointed to his current position in 2011.

Picture
Christian Grimm, DFN. Credits to Christoph Schieder

In 2013 Christian was elected to the Board of Directors of DANTE Ltd. in Cambridge, UK. From this position he helped drive the merger of DANTE with the TERENA Association in Amsterdam, NL. This process led to the formation of the GÉANT Association in 2014. Christian was elected to its founding Board of Directors and served as Chairman of the Board from 2015 to 2020.

Christian is active in various boards and committees both in German academia and in research and education networking organisations worldwide.

Prior to DFN, Christian was Head of Research and Development and member of the directorate at the Regional Computing Centre for Lower Saxony (RRZN), one of the largest Tier 2 HPC centres in Germany at that time. In parallel, he was appointed Assistant Professor for computer networks at the Gottfried Wilhelm Leibniz Universität in Hannover. He holds a Diploma in Electrical Engineering and a Doctoral Degree in Information Technology.

vietsch foundation

ABOUT THE VIETSCH FOUNDATION

The mission of the Vietsch Foundation is to promote research and development of advanced internet technology for scientific research and higher education. The Vietsch Foundation fulfils its goals in two ways: First, it contributes funding to specific research and development projects that demonstrate potential value to progress European and global research and education networking. And second, each year it awards a medal of honour to people who have contributed to the development of services or technologies of lasting value that are used by the networking community and its users in research, development and education. The Foundation was created through the last will and testament of Willem Karel Vietsch (1952–2014), a Dutch expert, a leader of the international internet community, and also the Secretary-General of TERENA, a former association of European national research and education networks. For details visit: **vietsch-foundation.org**

FTP24: THE NEW WAVE OF TALENT BRINGING INNOVATION TO THE R&E COMMUNITY

The GÉANT Future Talent Programme (FTP) returns to nurture students and young professionals to grow and develop their skills through a unique opportunity provided by the GÉANT Learning and Development Team (GLAD). 17 talented individuals took part in the FTP this year, with sponsorship from 10 different NRENs. The programme provides one to one training and coaching from Michael Koenka of Koenka and Partners to support the participants to deliver impactful presentations.

Words: Grace Cooper, GÉANT

"We have been extremely impressed by the dedication and enthusiasm displayed by FTP24 participants, especially in developing their Lightning Talk concepts. Thanks to their hard work, the quality of submissions was incredibly high, and a record number of FTP participants have been selected to present their ideas at TNC24. The FTP has once again discovered exceptional new talent in our community and given them a chance to showcase their innovative ideas."

Lisa Melrose, Learning Co-ordinator, GÉANT

LIGHTNING TALKS, FIRST ROUND
Wednesday 12 June, 16:00 – 17:30
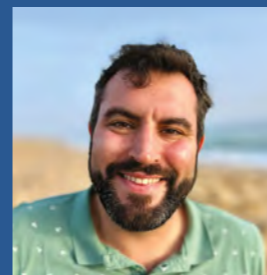
Ricardo J. M Veiga (16:05)

Sponsoring NREN: FCT | FCCN, Portugal

LIGHTNING TALK: STREAMLINING THE UNKNOWN: A DANCE OF CLOUD AND EDGE IN MARINE MONITORING

Billy Holbrook (16:25)

Supporting NREN: GÉANT

LIGHTNING TALK: THE CRYPTOGRAPHIC KEYS TO A SAFER INTERNET: THE RPKI REVOLUTION

Eliza Gyulgyulyan (16:30)

Supporting NREN: ASNET-AM

LIGHTNING TALK: QUALITY ALERT SYSTEM IN DATA LAKES

Antoni Klorek (16:50)

Supporting NREN: PSNC

LIGHTNING TALK: SIMPLIFYING FORMAL DOCUMENTS WITH "SIMPLE WRITING" – THE AI-BASED APPLICATION
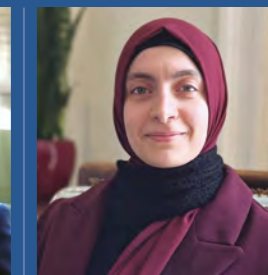
Sawsan El Zahr (17:15)

Sponsoring NREN: Jisc

LIGHTNING TALK: TOWARDS CARBON-AWARE NETWORKS

LIGHTNING TALKS, SECOND ROUND
Thursday 13 June, 11:00 – 12:30

Ismael Castell-Uroz (11:05)

Supporting NREN: RedIRIS

LIGHTNING TALK: EPRIVO.EU
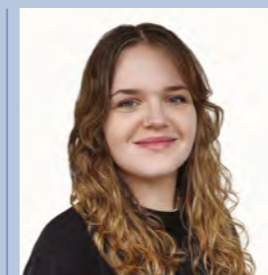
Zoë Fischer (11:45)

Supporting NREN: GÉANT

LIGHTNING TALK: FROM CLIMATE CONFUSION TO CYBER CLARITY: USING EVIDENCE-BASED MESSAGE FRAMING
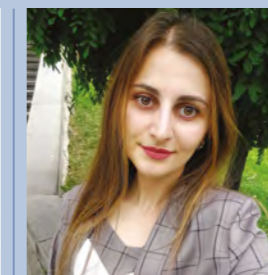
Arusyak Manasyan (12:05)

Supporting NREN: ASNET-AM

LIGHTNING TALK: NETWORK PERFORMANCE OMPTIMIZATION AND EQUIPMENT INTEGRATION ADVISORY SERVICE

Lorena Gomes Gaviria (12:10)

Supporting NREN: CSC/FUNET

LIGHTNING TALK: UNIVERSITY 4.0: EXPLORING THE TRANSFORMATIVE POTENTIAL OF 5G ON THE UNIVERSITY CAMPUS

ALL THE PARTICIPANTS OF FTP24

Bram Boeckx
Belnet

Denim Latic
Restena Foundation

Enrico Miotto
GARR
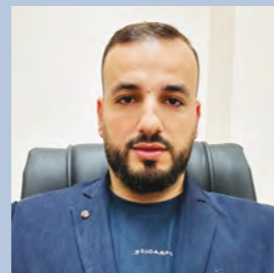
Erison Ballasheni
RASH
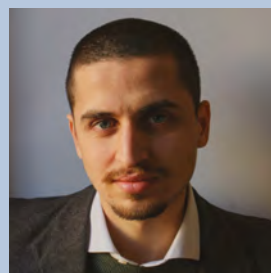
Giulio Domina
GARR
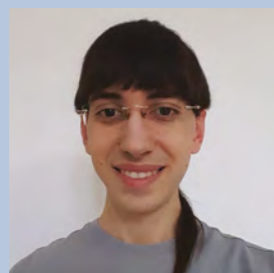
Luca Bassi
GARR

Mike Vandersanden
Belnet
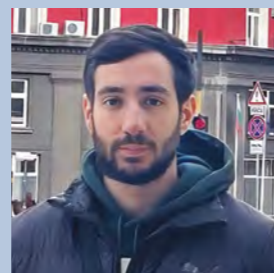
Robert Gadukyan
ASNET-AM

WHERE ARE THE FTP23 PARTICIPANTS NOW?

In 2023, the FTP was a huge success, with 16 talented individuals participating. I spoke to some of the participants to learn about their journey since the programme.

"I finished my Master's degree in Electrical and Computer Engineering at the Faculty of Engineering of the University of Porto with the presentation of my Master's thesis 'The Value of Renewable Energy Communities for the Energy Transition'. Following this, I started working at Chatron, a company that manufactures and sells Solar Light Tubes for solar lighting. I am part of the company's sales department, interacting with international distributors and new clients, but also maintaining a creative spirit, collaborating with the innovation and product development team."

João Brandão

"I am currently concluding my second year of a PhD programme focused on sustainable systems. I am a Women in STEM (WISH) Hume Fellow Scholarship recipient and in addition to my academic pursuits, I am actively involved in several representative roles. I serve as an Education in Ireland Student Ambassador meaning I'm responsible for promoting Irish higher education internationally. I am also the Chair of the Women in Engineering (WIE IEEE) Maynooth Student Branch, as well as the Co-lea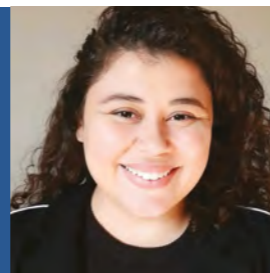d of the WIE IEEE projects working group for the UK and Ireland section, both of which underscore my commitment to advancing the presence of women in engineering and technology fields."

Thalita Nazaré

"I am a Cyber Security Engineer at NTT DATA Italia, specialising in the Banking and Automotive sectors. My expertise lies in cryptography, specifically in the application of Attribute-Based Encryption (ABE) which was a theme I also presented at FTP23. I recently presented a cutting-edge ABE project at a prominent conference in San Francisco, California. My work continues to focus on developing and enhancing innovative security solutions using advanced cryptographic techniques to safeguard sensitive information in these critical industries. Additionally, I have a strong passion for international and research environments. I relish building relationships with peers in these circles and staying abreast of the latest innovations. I am committed to presenting projects in significant contexts, continuously learning, and sharing knowledge."

Martina Palmucci

"I was a Master's student of Microelectronics at the Brno University of Technology in the Czech Republic and affiliated for a second year as a firmware developer for FPGAs in the Liberouter research group at the Czech NREN CESNET. A wonderful offer came from my boss at CESNET which involved a traineeship within the ERASMUS+ programme at the Heidelberg University, Germany. I accepted the offer and, after a one-year practice of FPGA development at the Institute of Technical informatics (ZITI), I continued the Technical Informatics Master's study programme there. I am currently in my second semester of this programme and also continue my affiliation at CESNET as well as at ZITI. In my work, I still focus on high-throughput data transfers inside a computer/server, mainly between an FPGA accelerator card and the host operating system."

Vladislav Válek
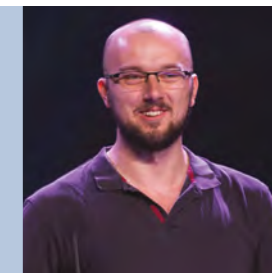
HOW WOULD YOU DESCRIBE YOUR FTP EXPERIENCE?

"Michael was very helpful with building my presentation and made me feel much more comfortable presenting it. Tirana was a great week and the beautiful dinner in the mountains are memories which I will never forget."

João

"The online group sessions were a highlight for me throughout the training. Michael's mentoring was really special."

Martina

"It was great to receive a second opinion from someone who doesn't know my field. Michael explained during my review of my project and abstract that I need to reshape how I write things for people who aren't necessarily in my field and provide some background information to provide a greater insight."

Thalita

"The mentoring with Michael was a truly unique experience. It was great meeting the CEO of GÉANT, Erik Huizer, in Tirana at TNC23. I was apprehensive that during the conference I was going to feel slightly stressed, but the street party at the beginning soon made me realise I had no need to worry!"

Vladislav

WHAT ADVICE WOULD YOU GIVE FOR FUTURE FTP PARTICIPANTS?

"Just go for it! You have nothing to lose! If you are selected to talk at TNC, you will have the chance to experience an unforgettable week. From taking part in the FTP, you will benefit immensely from the training sessions with Michael. He creates a stress-free environment to learn and apply this newfound knowledge in your academic and professional career."

João

"Enjoy every moment and experience. Take the advice that is offered and don't feel worried about what may happen as it is a great learning environment, and you can really enjoy the good vibes from it!"

Martina

"Whatever you may learn during your time in the FTP, take it away with you! I apply the outcomes from this process on a regular basis, such as during research groups, teaching a class, or presenting a topic."

Thalita

"Make it simple. My title and abstract were initially too complex, and after some minor changes I found it much easier to be specific even when discussing a complicated topic. Don't get lost in too many details!"

Vladislav
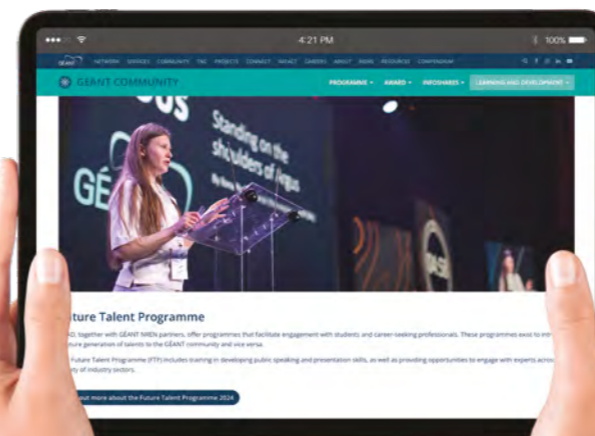
More information about FTP24 and the participants can be found on our community website: **community.geant.org/learning/future-talent-programme**

...g Open-source Tools

EMERGING NREN PROGRAMME AN INCREDIBLE JOURNEY

CONNECT met with Katarina Simonovic from the Serbian Academic Network (AMRES) who, under the auspices of the GÉANT Emerging NREN Programme (ENP), presented the Lightning Talk at TNC23 (Tirana, 5-9 June 2023): 'Log Management and Visualisation of AMRES statistics using Open-source Tools'. Katarina has been working at AMRES for over three years and, as a user service engineer, she is actively involved in the development and deployment of a variety of services. We talked about her involvement in the ENP, her participation at TNC23 and the African experience that followed.

Words: Rosanna Norman, GÉANT

KATARINA, HOW DID IT ALL START?

One day last year, my CEO surprised me by inviting me to participate in the ENP and attend the TNC23 conference. I was obviously thrilled to be nominated as the AMRES candidate. The ENP programme seemed like a fantastic opportunity to meet new people, expand my knowledge, represent my NREN and my country.

HOW DID YOUR PRESENTATION FIT INTO THIS EXPERIENCE?

Well, at the time, I was working with colleagues on a new log management and visualisation tool for AMRES logs. We decided to submit a TNC23 Lightning Talk proposal on our project. Honestly, I didn't expect it to be selected, given the tough competition and the brilliant minds in the community, but my talk was accepted and suddenly I found myself preparing

to present on a big stage in front of a large audience. The excitement turned into pressure, but that pressure really motivated me.

TELL US ABOUT YOUR INVOLVEMENT IN THE ENP PROGRAMME

It was a remarkable journey! I met colleagues from Albania, Bosnia and Herzegovina, Ethiopia, Jordan, Malawi, Palestine, Peru, Sri Lanka and Tunisia. We discussed traditions, food, cultural differences and future plans. GÉANT representatives delivered insightful presentations on community projects, networks and services. We also shared knowledge about tools, software and service deployments. Everyone was kind and friendly. These interactions motivated me to support my Serbian community even more. I reflected on how my involvement could help to improve our services and enable our NREN to make the community stronger and more resilient.

AND WHAT ABOUT YOUR LIGHTNING TALK?

Initially, I felt nervous about presenting in such a large auditorium, especially since I'd never done it before. But once I stepped on the stage, the nerves vanished. The audience was hidden by the reflectors, which helped. Overall, it was an unforgettable experience. In addition, my colleagues' positive feedback meant a lot to me. I believe that it was a proud moment for all of us at AMRES: implementing our idea and our project was incredibly rewarding.

MOVING ON TO YOUR ROLE IN THE EDUGAIN TRAINING TEAM, CAN YOU SHARE YOUR EXPERIENCE DELIVERING TRAINING IN ADDIS ABABA, ETHIOPIA?

The opportunity to deliver training in Africa was both exciting and nerve-wracking. Addis Ababa, the capital city of Ethiopia, welcomed us warmly. I soon recognised a familiar face among the training participants: Lensa Abera, my colleague from the ENP programme. It was fantastic to see her again. Lensa, who works for the Ethiopian academic network, looked after us so well, we couldn't have hoped for a better host. One night, Lensa's colleagues took us to a traditional Ethiopian restaurant. It was unlike anything I had ever experienced. The food was amazing, people danced and laughter filled the air. The atmosphere was delightful, and it left a lasting impression on me.

HOW DID THE TRAINING SESSION GO?

The training was fantastic! The attendees were highly motivated and engaged. They asked us detailed technical questions, making it a very interactive experience. Each night, as I laid down to sleep, I felt fulfilled, but also exhausted. The impact of the training lingered even after we returned home. Three months later, some of the attendees are in the final stages of establishing federations in their countries. Knowing that I played a part in their journey fills me with so much pride.

REFLECTING ON THE PAST YEAR, WHAT STANDS OUT TO YOU?

So much happened since I joined the ENP programme. My first TNC conference, the Lightning Talk and the friendships I've formed — all of these experiences hold immense value for me. Additionally, my transition from being an eduGAIN trainee to being able to contribute to AMRES becoming a full member of eduGAIN has been also so fulfilling. Looking ahead, I'm eager to continue to support research and education networking in my community.

Since the start of our chat Katarina's positivity and enthusiasm about her work and the NREN environment were very clear: "I am so grateful to be part of the GÉANT community: it's truly unique and offers a different perspective". Thank you, Katarina for sharing your remarkable journey with us. Your dedication and passion are truly inspiring This community is very lucky to have you!

ABOUT ENP

The ENP, funded by the GÉANT Project, has been delivered alongside TNC since 2018. The programme aims to integrate representatives from emerging NRENs from around the globe into the TNC community and to create further synergies and connections at different organisational levels between European and international NRENs.

For further information about the ENP, contact Leïla Dekkar, International Relations Project Manager at GÉANT

X-it: GÉANT is no longer active on X (FKA Twitter)

As per 2 May 2024, GÉANT ceased activities on the main GÉANT profiles on the X social media platform (Formerly Known As Twitter).

This decision followed thorough considerations and discussions within the GÉANT organisation, consultations with the community and particularly with Marcomms teams across NRENs, as well as almost two years of surveying and analysing the social media landscape and our place in it.

Words: Leonardo Marino, GÉANT

X doesn't mark the spot

Our decision to X-it was not made lightly. Since the rise of social media, Twitter stood out as the preferred platform of the R&E community and as a fitting solution for GÉANT – one mixing insightful content with lighter tones and personal elements, representing the official voice of organisations, policy makers and influential figures, often sparking meaningful discussions among news, chatter, memes and the usual funny videos of cats and dogs.

However, not much of this is left now. In the past two years, we have seen Twitter go through radical transformations, changed ownership, morphing into X and into a completely different platform which increasingly amplifies hate speech, fake news, scams, extreme views, and illegal content. Verification badges that were once a symbol of trust have lost all meaning, essential features were dropped or limited to paying users, and costs seem to have been cut at the expense of security, privacy, and content moderation. We have closely observed these developments with growing concern and concluded that the X platform is now irreparably misaligned with our values.

The X-it of the R&E community

We are of course not the only organisation in our community to have noticed this drift. In a parallel analysis, the Dutch NREN SURF came to similar conclusions and also announced their X-it on 2 May 2024. You can find their official announcement here: **https://www.surf.nl/en/news/surf-stops-using-x-twitter**

Among European NRENs, the Norwegian Sikt had also announced their X-it in November 2023, the Luxembourgish Restena pointed their followers towards other social media platforms, while other NRENs have consistently decreased or ceased their activities on X. Many more are the research infrastructures, e-infrastructures, universities, and libraries that recently announced their X-its, such as the German National Research Data Infrastructure (NFDI), the University of Innsbruck, the Université libre de Bruxelles, Rennes 2 University, the Helmholtz Open Science Office, to name a few. Researchers largely reduced their use of X/Twitter as well, as reported in a survey published by Nature on 16 August 2023, leaving the communities once known as "Science Twitter" and "Academic Twitter" scattered across different social media platforms. Observed from the perspective of GÉANT profiles, this ongoing exodus of users and of community members and organisations has also been evident and showing signs of acceleration, as is a consistent decrease of engagement with GÉANT content. With both our community and potential audience mostly out of X already, there is now little value left in using the platform for GÉANT's activities altogether.

Our X-it strategy

Our X-it took effect on the main GÉANT profiles as GEANTnews and TNC_GEANT, while for X profiles related to our projects, we continue discussions with partners in order to take joint decisions on the way forward.

To prevent theft and misuse of our X handles and identities, we will not shut down GÉANT profiles but simply cease all activities, with the exception of occasional posts driving followers towards our social media accounts on other platforms, also aimed at keeping our accounts active and avoiding their removal.

GÉANT will of course keep being active on other social media channels, in particular LinkedIn (currently our primary social media channel), and Mastodon (the rising decentralised social media part of the Fediverse, where GÉANT is active together with SURF, DFN, NORDUnet, RENATER, SUNET, Restena).

Please follow us here, if you aren't already doing so!

- in **GEANTnetworks**
- m **mstdn.social/@geant**
- f **GEANTcommunity**
- ▶ **GEANTtv**

The Future of Learning – tailored to you

What do you think of when you hear the word "learning"? Perhaps you think of a training course, with an expert sharing their thoughts, or an online instructor-led course. These approaches can be valuable, but increasingly, learning is moving away from the classroom towards on-demand learning where each person can create their own tailored learning path Learning happens naturally all the time. From a chance conversation with a colleague to a quick internet search, opportunities to build knowledge and skills have never been closer.

Words: Sarah Hughes and Dom Mayerl, GÉANT

In GÉANT Learning and Development (GLAD) we are thinking about how to integrate learning into the flow of work. In addition to our range of "formal" training programmes which you can find in our new Course Catalogue, we are investing time in creating self-paced learning courses on eAcademy. We also provide licences to O'Reilly Media technical training, and publish recordings of past training sessions on GEANT.Tv. All this means that you can go straight to the information you need as soon as you realise you need it, without waiting for a formal training session to be created.

Tailored learning doesn't stop there. GLAD recently launched the GÉANT Mentoring Programme.

Recognising the need for a more balanced workforce, under the GÉANT Gender Equality Plan, GLAD committed to deliver a formal mentoring programme for the GÉANT community and beyond. Using the TOGETHER platform, we will provide training for mentors, establish effective mentor and mentee pairings and gather comprehensive feedback.

Learning is an important incentive to attract and retain talented employees. At TNC23, participants from NRENS in Europe, Africa and North America joined a growing community of people-focused individuals to share ideas about how to attract and motivate talented people. In a competitive recruitment environment, we heard several NRENs explain that they seek to recruit new graduates and "grow their own talent" rather than recruiting externally. Of course there are challenges and opportunities to this route, and its success requires employees to spend time sharing knowledge.

Join GLAD at TNC24 to talk about the potential for tailored learning in your organisation.

For more information about GLAD's activities, visit **community.geant.org/ learning**

Picture
Above:
Sarah Hughes, Head of Learning and Development, GÉANT

Beyond bricks and mortar: the campus in 2040

Technological progress is rapidly affecting education. Virtual classrooms are becoming more familiar every day and it won't be long before generative AI plays as big a role in our lives as the smartphone. This raises the question: if physical and digital worlds are increasingly merging, what will the campus look like in 2040?

Words: Evelyne Hermans, SURF

To answer this question, SURF launched the Future Campus 2040 project in 2023. The project marks one of SURF's first major endeavors to not only spotlight the campus within its agenda, but also to broadly engage institutions in this dialogue.

During the project, SURF conducted a thorough analysis of technological and educational trends, as well as anticipated developments in the areas of sustainability, nature and well-being. This led to a final report with four scenarios that provide insights into possible developments of the campus in 2040. It can be used by institutions and organisations to better prepare for the future.

The scenarios at a glance

The growth scenario

In this scenario, the campus in 2040 is a hub of economic and technological progress, blending physical and digital learning through smart technologies. While fostering innovation, it faces challenges in student privacy and adapting to rapid changes. It is the most logical scenario we can easily envision.

The discipline scenario

By 2040, the campus is a hub with green spaces and energy-efficient buildings, emphasising regulations, public values, and sustainability. Sustainability and inclusiveness are no longer choices, but obligations. Government leads educational initiatives, while lecturers, supported by tech, form the core of the learning process. This strikes a new balance between human values and technological progress.

The transformation scenario

The 2040 campus has transformed into a flexible, personalised ecosystem. The interdisciplinary hub offers students dynamic learning journeys, aided by AI-coached lecturers, with a focus on innovation, creativity, and sustainability. Students follow tailored learning programs in an authentic context, in which the analogue and digital are seamlessly integrated.

The collapse scenario

In 2040, the campus represents technology dominance and decline. The physical campus is in disrepair due to a lack of resources and decision making. The virtual learning environment has been taken over by tech giants and shows an isolating landscape in which personal connection and autonomy have made way for profit and control. In this scenario, the balance between human values and tech progress has been erased.

Shape your own future

Nobody knows what the future is going to look like, but together we can try to shape the most desirable future ourselves, and at the same time arm ourselves against undesirable situations. In order to achieve this, we have to make strategic choices in the here and now that anticipate all possible scenarios. Whether you are having new buildings constructed or adopting new online learning environments, you have to be aware that the future is already happening and factor this into your decisions now.

How? Reach out to other institutions who are struggling with the same questions. Contact the people of SURF's Future Campus 2040 project or download toolkit at **futurecampus.nl/toolkit**. Together we can devise strategic initiatives to ensure we can all face the future with confidence.

Picture
Future Campus made by Barend Last with Midjourney

SURF

HEAnet completes connection, **1,000 Primary schools across Ireland** with enterprise-level broadband connectivity.

HEAnet

Ireland's National Education & Research Network
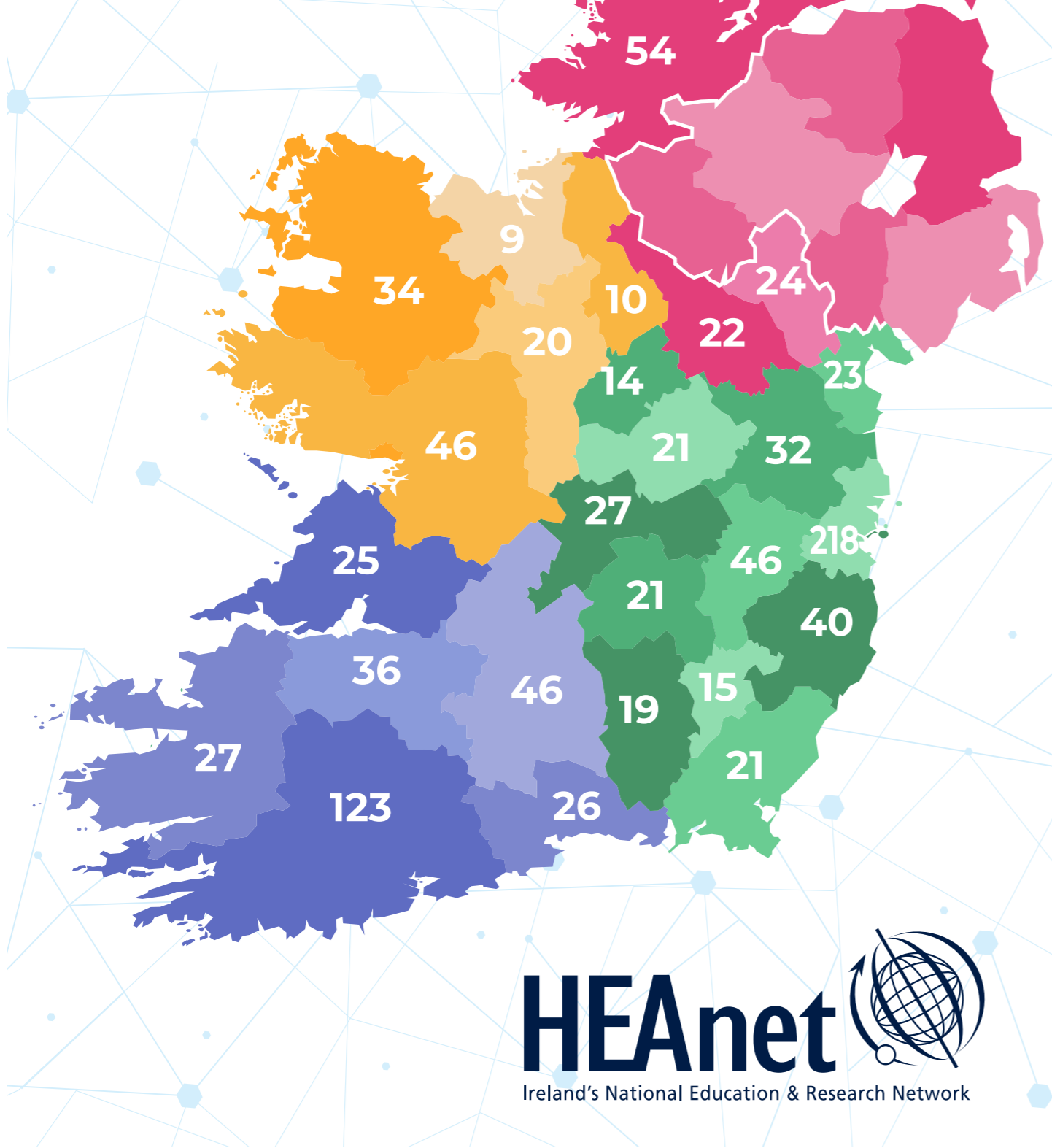
HEAnet completes 1,000 Primary Schools across Ireland with enterprise-level broadband connectivity

HEAnet is pleased to announce that it has completed the connection of high-speed internet access to over 1,000 primary schools across Ireland.

Words: Sharon Moylan, HEAnet

Picture
Minister for Education, Norma Foley, TD and HEAnet Schools Network Director, Dónal Ó Cearbhaill

The HEAnet Schools Network plays a crucial role as the primary conduit linking both primary and post-primary schools throughout the country to the Internet. Established as part of the Irish Government's Broadband for Schools Programme, the Schools Network leverages HEAnet's extensive network infrastructure to provide reliable high-speed internet connectivity to Primary and Post-Primary schools nationwide.

With funding from the EU National Recovery and Resilience Plan, (NRRP), the Department of Education implemented a project to support students facing educational disadvantages due to limited digital access. The delivery of connectivity to even the most remote primary schools to a minimum of 100 Mbps has benefitted 1,000 schools.

Aligning with the Department's 'Digital Strategy for Schools to 2027', the high-speed connectivity in schools across the country aims to support the Department's Objective Pillar 1: 'Supporting the embedding of digital technologies in teaching, learning and assessment'.

The significance of reliable high-speed internet access in today's educational sector cannot be overstated. With the broadband connections now in place, this enhanced, enterprise-level connectivity will continue to support the Department's Digital Strategy, Pillar 2: 'Digital Technology Infrastructure'. This initiative aims to enhance access to a diverse array of in-class activities, ranging from digital learning platforms to video calls and remote learning, while also encompassing administrative and technical support services.

Dónal Ó Cearbhaill, Schools Network Director at HEAnet said, "HEAnet are delighted to have completed this significant milestone by delivering enterprise-level connectivity to 1,000 primary schools. With the aid of NRRP funding, we are able to bridge the digital divide, ensuring that all Irish schools are able to enjoy the same minimum level of Internet access regardless of their geographic location or the level of broadband access previously available to them. By connecting these schools to the HEAnet network - with secure filtering for student safety - we are now providing reliable, enterprise-level connectivity that will continue to enable schools to realise their digital ambition. We have already seen the positive impact of this high-speed technology in post-primary schools since 2015 and are delighted to now be able to support the primary schools in the same way."

All post-primary schools have a minimum connectivity level ranging from 200 Mbps to 1 Gbps, whereas primary schools are now connected at a minimum of 100 Mbps thanks to this project.

HEAnet work closely with the Schools Broadband Service Desk, managed for the Department of Education by Oide Technology in Education, to provide support for all aspects of the Schools Broadband Programme as part of the 'Digital Strategy for Schools to 2027'.

In conclusion, HEAnet will continue to support the digital infrastructure and resources to ensure that all schools in Ireland have access to high-quality internet connectivity. This will help bridge the digital divide and empower students from diverse backgrounds to thrive in the ever-increasing digital world.

The National Recovery and Resilience Plan (NRRP) has been developed by the Government so that Ireland can access funding under the EU's Recovery and Resilience Facility. Ireland is expected to receive €988 million in grants under the Facility. The Recovery and Resilience Facility is the largest component of NextGenerationEU, the European Union's response to the global pandemic. The aim is to help repair the immediate economic and social damage brought about by the pandemic and to prepare for a post-Covid Europe that is greener, more digital, more resilient and fit to face the future.

"Jumping forward": how NRENs can promote innovation

Words: Stela Tsirakis Toti, RNP

The high jump is one of the most traditional Olympic sports. Since Ancient Greece, athletes jumped forward until 1968 when, at the Olympic Games in Mexico City, the north American Dick Fosbury innovated the sport by jumping backwards, a technique now known as the "Fosbury Jump". The athlete revolutionised the sport by copying the jump of his niece, who did gymnastics at the time.

Just as the athlete provoked his colleagues with this jump, RNP is playing a role in Brazil provoking the market with innovative business models. The first example is the Connected North Program, where the NREN launched sub-river cables through the Amazon rivers, and structured a neutral operator for its sustainability, sharing the infrastructure with internet service providers (ISP) and mobile companies, and ensuring its operation and maintenance.

"The more relevant innovation is the neutral operator model proposed by RNP. Although it is challenging to lay cables in the beds of the huge Amazon rivers, it is even more difficult to do so without a monopoly. And we achieved that. With the pilot project we could enable many operators to participate in this connectivity", says Eduardo Grizendi, Engineering and Operations Director at RNP.

"We are going to replicate this model in the other seven infovias, which will connect, when all finished, a total of 58 cities with 12,000 km of sub-river optical cables, benefiting up to 10 million people. In addition to high-speed internet access and service to local educational and research institutions, the project is expected to boost the region's economic development and strengthen policies for public education, health, security, defense and the judiciary", adds Grizendi.

The second business model innovation is Internet Brasil. It delivers, free of charge, eSIM Cards, that is, mobile broadband chips, to thousands of students in conditions of poverty or extreme poverty.

"We called the eSIM Cards as 'neutral chips', because they are not linked to a single operator. Therefore, with the possibility of remotely changing the personal mobile service operator, depending on the student's usage experience. Attendance of up to 700,000 students began with a proof of concept (PoC) for 10,000 students, whose eSIM Cards with 20 GB of monthly data have already been delivered to them. The functionality of remote change of personal mobile service operator without the need to change the chip operator worked as expected, enabling the start of the process of scaling up the distribution of the chips. On the other hand, the project is enabling the understanding of this market by working with mobile virtual network operators (MVNOs) and companies that provide eSIM Cards and remote device provisioning", celebrates Antônio Carlos Nunes, Services and Solutions Director at RNP.

"These experiences show that academic networks can act as vectors of digital transformation for education and research institutions, as well as important influencers in public policies, proposing new business models for the market. Additionally, NRENs can impact digital inclusion processes even more proposing significant connectivity", concludes Nunes.

Pictures
Credits to RNP collection and Alexandre Rezende

RNP

It's a Quantum Affair

Danish Government launches ambitious Quantum Strategy and DeiC plays leading role in realising world class Quantum Infrastructure for Danish Research and Innovation.

Words: Marie Charllotte Søbye, DeiC

Collaboration is the heart of the matter

Martin Bech and Henrik Navntoft Sønderskov are spearheading the DeiC quantum initiatives in close collaboration with the Danish Universities. "We are actually moving forward with very concrete initiatives which will help Danish research and innovation gain advantage and bring revolutionary solutions to life", says Henrik Navntoft Sønderskov, Head of Quantum at DeiC.

Denmark has a longstanding and strong tradition when it comes to Quantum Physics. 100 years ago, Danish Physicist Niels Bohr laid the foundations for an international hotspot for quantum mechanics when he founded the Niels Bohr Institute for Theoretical Physics in Copenhagen. "Carrying forward this tradition and helping quantum infrastructure come to life is of course very exciting for us in DeiC", Henrik continues.

So far, DeiCs quantum infrastructure initiatives unfold within the following areas:

Quantum Communications

DeiC Forskningsnettet participates in the European EuroQCI project supporting secure data communications based on quantum technology. The objective is to create a coherent quantum infrastructure across Europe using both fibre cables and satellites. DeiC is establishing and operating the necessary fibre stretches, and the complete European infrastructure is expected to be ready in 2024. "In particular, we hope to investigate to what extent quantum signals can coexist with other signals in a fibre. If successful, it could potentially reduce the cost of deploying quantum-encrypted networks significantly", says Martin Bech, Head of DeiC Forskningsnettet.

Quantum Competences

A task force is responsible for building national quantum competences in close connection with quantum competence activities within the EU. The initiative aims to disseminate skills and information on increased risks of quantum technology among researchers and businesses. It will target a broad audience and ensure a better understanding of the possibilities and relevance of quantum infrastructure for society.

Picture
Martin Bech, Head of DeiC Forskningsnettet (left) and Henrik Navntoft Sønderskov, Head of Quantum, DeiC (right). Photo credits to Claus Boesen

Quantum Excellence Centre

Another task force is engaged in the development and dissemination of quantum computer applications bringing to life a new generation of software and algorithms which can be used across different types of quantum computer technologies. Already, the DeiC National Quantum Algorithm Academy Fellowship Programme has launched its first project grants for Postdocs and PhDs on Quantum Algorithms and Quantum Software.

Quantum Computer Access

A third task force works to establish access to as many quantum computers and various test and technology platforms as possible. As part of this endeavour DeiC participates in the LUMI-Q consortium under EuroHPC.

Quantum technology is leaning into many new areas of our society, somewhat shrouded in mystery. Therefore, in DeiC we will work hard to collaborate with all relevant partners to bring forward concrete initiatives that enable competitive quantum infrastructure for both industry, businesses, research, and innovation.

Learn more about Danish NREN DeiC and DeiCs quantum initiatives at **deic.dk/en/quantum-infrastructure**

DeiC
DANISH eINFRASTRUCTURE CONSORTIUM

Establishing Jisc's International Priorities and Principles

Jisc's four international strategic priorities, aligned with its mission and values, have been distilled into a pragmatic set of principles. These guidelines direct colleagues in how to engage with global partners on projects, enhance collaboration, and realise the breadth of their international work. This unified framework ensures that everyone at Jisc has a consistent, shared approach, whether they're working on development projects, providing conflict zone support, or handling international collaborations..

Words: David Patterson, Jisc

A key principle is understanding member and customer needs. By leveraging data insights from international engagements, Jisc can provide a more refined and beneficial experience for members and customers alike. Using our CRM system helps establish a baseline for international work and offers critical insights into global activity. This data-driven approach allows Jisc to better cater to the unique requirements of its diverse user base – and making sure that international projects align with their evolving needs.

Jisc has also built a reputation for resilient and high-capacity infrastructure through its strong and trusted relationships with NRENs and global partners. By encouraging transparent collaboration within worldwide research and education networks, Jisc maintains that the UK has the technology and support necessary to be a global leader in education and research. This collaborative culture makes certain that the UK remains well-positioned to meet the evolving demands of the international education landscape.

Global collaboration drives research, innovation, and economic growth. The economic, cultural, social, and civic contributions of international students make the UK a competitive knowledge economy and enhance the country's global influence. Jisc plays a pivotal role in empowering members, stakeholders, and funders to achieve their global ambitions and support the UK's international competitiveness. However, working globally is not without risks. Geopolitical tensions, climate change, cybersecurity issues, and supply chain disruptions pose significant challenges. By being proactive in understanding these challenges, Jisc can mitigate risks and protect itself and its members, funders, and customers. A well-informed risk management strategy enables Jisc to maintain its high standard of international operations.

To put these principles into action, Jisc has established three internal groups. The International Network offers a forum for all staff to discuss the challenges of global collaboration, share updates on international projects, and increase awareness of the policy landscape affecting research and education. Then there is the Strategic International Risk Group, a team of senior colleagues, collaborates to identify, assess, and contextualise international risks, shaping Jisc's response to safeguard its operations. Lastly, the GÉANT Leadership Group, composed of those directly involved in the GÉANT project, coordinates efforts to maximise the value of NREN collaboration.

These initiatives reflect Jisc's dedication to a proactive, strategic approach to international engagement. They ensure that the organisation is well-prepared to support the global ambitions of its members and customers.

Picture
David Patterson, Head of International, Jisc

For more information on Jisc's international strategy, contact David Patterson, Head of International at Jisc.

GARR acquires cutting–edge submarine technology to connect Sardinia

Completed the first step towards the full integration of the research network on the island with the ultra-fast connectivity infrastructure of Italy's academic network

The Italian research and education network is expanding its new optical infrastructure, GARR-T, thanks to the recent acquisition of optical spectrum in a submarine cable to Sardinia. This expansion is funded by the EU Recovery Fund project TeRABIT, which aims to develop an advanced computing and network infrastructure for Italy's scientific community. The connection utilises industry-leading optical networking technology from Infinera, operating across the Sparkle BlueMed submarine cable system's 1.8THz spectrum.

Words: Elis Bertazzon, GARR

Thanks to the current acquisition and use of state-of-the-art technologies, GARR will be able to exploit the optical spectrum of the BlueMed submarine cable system. This means that within the fibre there will be multiple lanes, managed by GARR, exclusively dedicated to research data traffic. This innovation represents the first step towards implementing a dual super-fast fibre optic connection in the island of Sardinia.

The deployment of the Infinera technology solution (Infinera ICE6 800G GX), coupled with the Sparkle submarine cable system, strengthens GARR's high-performance optical backbone, thus enabling students, professors, and researchers to collaborate at the highest level and facilitate collaboration between research institutions and universities at the national and international level. Also, once in production, the expansion to Sardinia will provide additional access for centres involved in the National Center for Research in High-Performance Computing, Big Data, and Quantum Computing (ICSC).

A connectivity infrastructure for Sardinia and Europe

The new Sardinia connectivity will be operational by 2025 and will offer not only rapid data transmission but also redundancy and reliability, thus benefiting the entire scientific community of the island. Moreover, this new network connection will support the candidature of the Sardinian Sos Enattos area to host the Einstein Telescope project, the European third-generation gravitational-wave detector, which will be 10 times more sensitive than those currently existing.

A virtual fibre bridge

"Thanks to the open cable technology, which gives operators the possibility to freely manage a range of spectrum rather than single signals, this new virtual fibre bridge will create a seamless integration between GARR-T optical infrastructure in the Italian mainland and the one in the Sardinia island. This acquisition is the first step of GARR-T expansion, which will be completed by 2025 and will provide up-to-400-Gbps connectivity all over the Italian territory", says GARR CTO Massimo Carboni.

Mauro Campanella, the scientific coordinator of the TeRABIT project, commented: "We are building a comprehensive infrastructure, perfectly harmonised with other ongoing interventions funded by the EU Recovery Fund. When operational, the new connection will bring Sardinia's infrastructures and researchers closer to TeRABIT's HPC computing systems and ICSC resources installed nationwide."

Once the expansion is complete, the GARR-T network will span 25,000 kilometres, cover 35 ROADM with 38 amplifier sites, and reach a total capacity of about 40 Tbps throughout Italy.

Further information on the TeRABIT project: **terabit-project.it/en**
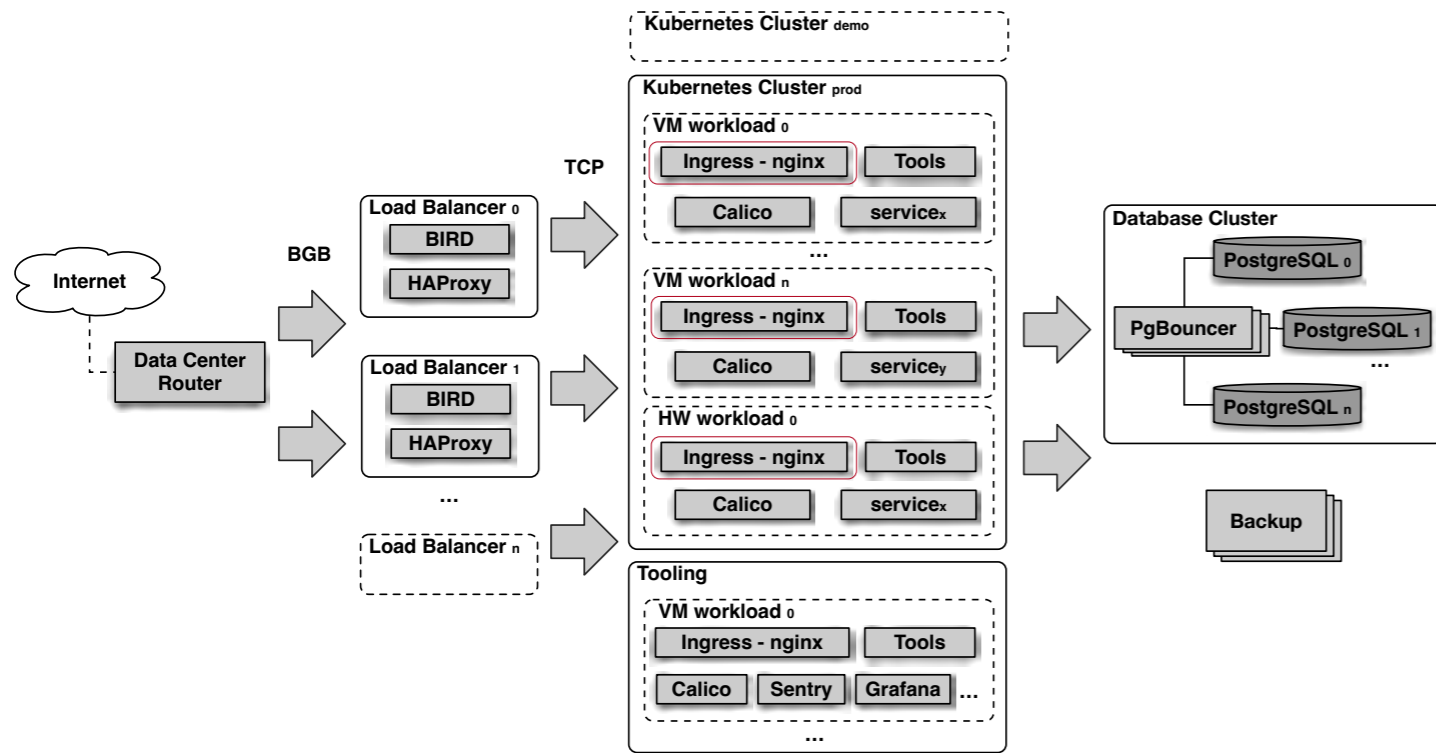
GRNET's Platform for Running Digital Public Services

In 2019, GRNET (National Infrastructures for Research and Technology), under the auspices of the Ministry of Digital Governance, became involved with the digital transformation of the Greek public sector while maintaining its traditional role, i.e. being the Greek NREN. Specifically, it became responsible for the development and maintenance of the gov. gr portal and several governmental services including the electronic issuance of documents signed by the Greek state.

Words: Dimitris Mitropoulos, Head of the Reliability Engineering Directorate and Assistant Professor at the University of Athens

Offering services for the general public of a country introduces a set of challenges that differ from those associated with services targeted at the academic and research communities. Some key issues involve faster development and deployment cycles, scalability and resiliency, security, and public perception. To cope with such challenges, GRNET teams, including primarily the SRE (Site Reliability Engineering) team, developed AppStack, a cloud-native platform with an enabling environment for integrating open-source software (OSS) components. Currently, AppStack hosts more than 200 user flows for governmental services.

Through AppStack, technical teams work together based on a common pipeline with different capabilities. The pipeline starts with the developers working on software artifacts and applying Continuous Integration (CI) practices using GitLab CI.[1] Once they have finished an application version, they generate a corresponding container. All container images are then placed in Harbor,[2] a container registry that offers a way to process and distribute such images. To deploy and operate corresponding containers, we utilise Kubernetes (K8s),[3] a well-established container-orchestration system. K8s comes with several key properties including resource isolation and effective workload distribution. We simplify the process of managing applications on Kubernetes by using Helm.[4] Helm provides a means to package applications into reusable packages called charts. AppStack incorporates a monitoring stack which includes Sentry,[5] an error tracking framework, the Prometheus[6] alerting toolkit, and the EFK (Elasticsearch,[7] Fluentd,[8] and Kibana)[9] suite that offers log management capabilities.

As internet traffic reaches GRNET's data center (see accompanying picture), our routers forward the traffic to the Load Balancers (LBs) that stand in front of the Kubernetes clusters. The communication between the router and the LBs is done by using the Border Gateway Protocol (BGP). Notably, BGP supports features such as policy-based routing and traffic engineering. Our LBs employ (1) BIRD[10] to establish BGP connections with the router, and (2) HAProxy[11] to distribute the network traffic across the clusters. In this manner, SREs are able to control the rate of requests and change load balancing methods on the fly.

On the clusters' side, the Ingress-NGINX controllers[12] receive and manage traffic. To secure our services from attacks, we have also integrated the ModSecurity[13] Web Application Firewall (WAF) as an additional layer of Ingress-NGINX. To handle traffic inside clusters we use Calico,[14] a networking solution for containerised workloads that uses BGP to handle large numbers of routes. All data is stored in a separate database cluster. As a backend database we use PostgreSQL,[15] a relational database management system that employs concurrency control mechanisms and indexing capabilities to optimise query performance. To improve the performance of our databases we utilise a connection pooler named PgBouncer.[16]

The scalable architecture of AppStack allows for multiple deployments per day even with thousands of users connected. In this manner, we are able to respond to changing conditions and feedback quickly and release new features and updates. Our experience from running AppStack indicates that it has great potential, and our plan is to expand it as more services are scheduled.
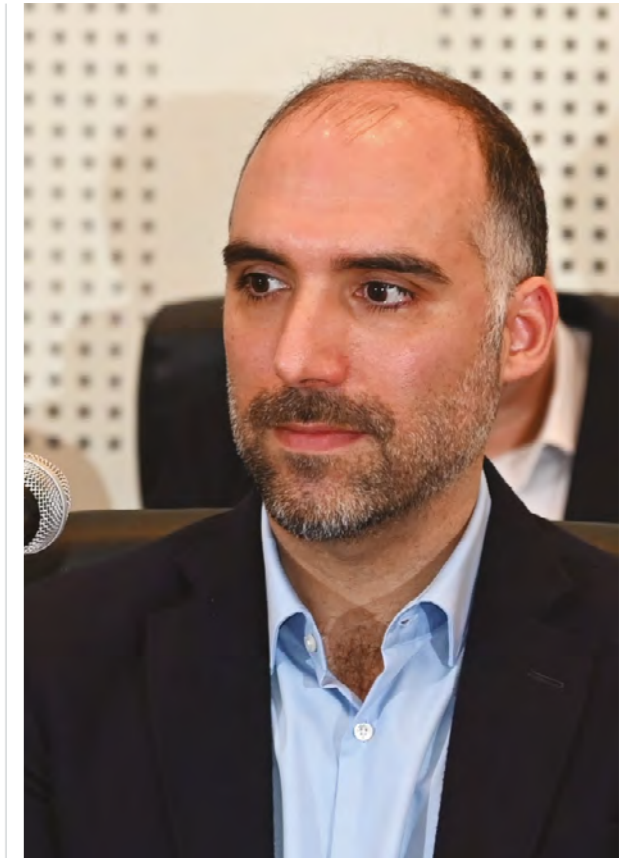
More about GRNET:
grnet.gr/en/company

[1] docs.gitlab.com/ee/ci/
[2] goharbor.io/
[3] kubernetes.io/
[4] helm.sh/
[5] sentry.io/
[6] prometheus.io/
[7] www.elastic.co/
[8] www.fluentd.org/
[9] www.elastic.co/kibana
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[11] www.haproxy.org/
[12] github.com/kubernetes/ingress-nginx
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[14] docs.tigera.io/calico/
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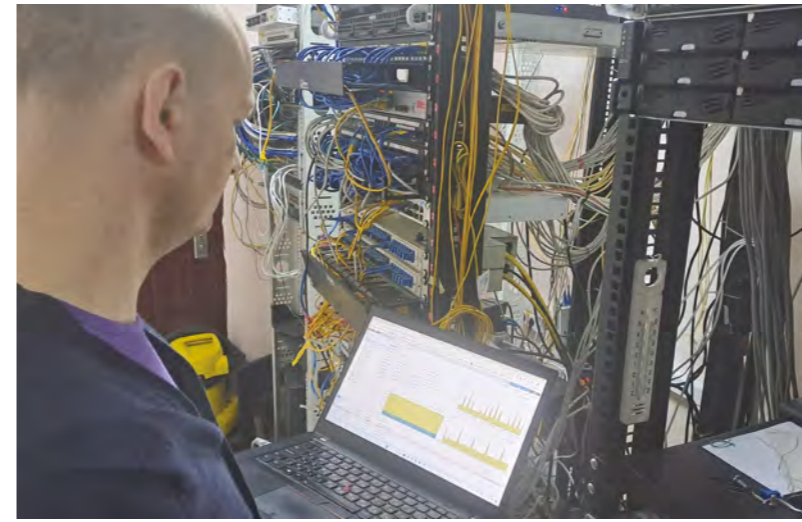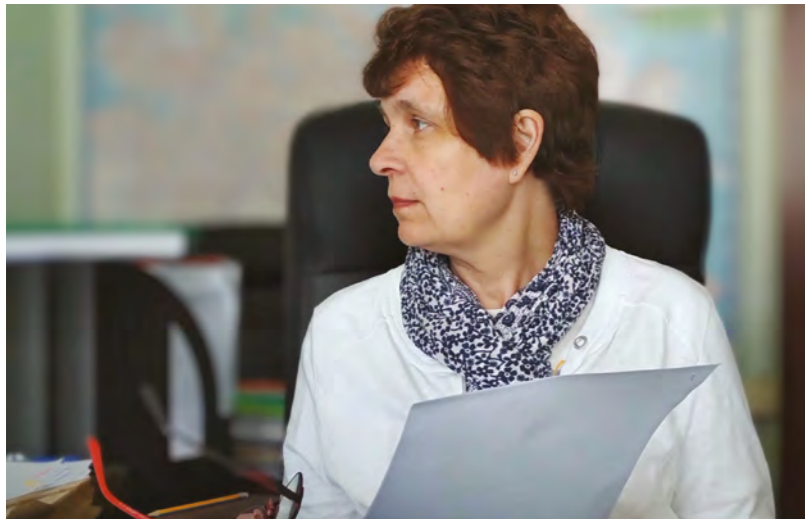
Picture
Above: Dimitris Mitropoulos, Head of the Reliability Engineering Directorate and Assistant Professor at the University of Athens

Impact of Computer Aid's humanitarian equipment on Ukrainian researchers and educators

In December 2023, the URAN Foundation (a charitable organisation of the URAN Association, the Ukrainian NREN) received 65 laptops from the UK for distribution to Ukrainian R&E institutions. This humanitarian aid was organised by the GÉANT community through the Computer Aid charity: Computer Aid prepared and delivered the laptops, GÉANT paid for them with funds donated to the Vietsch Foundation by European NRENs, and URAN took care of their distribution.

Words: Tetiana Preobrazhenska, URAN

Preparation and delivery

"First thing, the URAN Association's technical specialists checked each laptop and replaced all the power cords and UK plugs." Larysa Shevchenko, director of the URAN Foundation, says.

In order to enable the activation of the pre-installed Windows licence on all laptops, the URAN specialists prepared and posted relevant instructions on the NREN's website. The next step was the distribution of the equipment.

"We based our distribution on a survey shared with users in the Summer of 2023 about their IT equipment requirements" Larysa Shevchenko

explains. "First of all we looked at institutions in cities that had been intensely shelled. This was the main criterion. We also gave priority to universities evacuated from the occupied territories. In total, we selected 16 institutions."

The entire URAN team was involved in the equipment preparation:

- the finance team advised the beneficiary institutions on the correct document preparation for humanitarian aid;
- the technical specialists checked the laptops and equipped them with new power cords;

- the rest of the team added the necessary supporting documents to the kits and packed them.

"Each team member, whenever available, arranged the shipments in between shelling or air raids. In February 2024 we shipped the last batch of laptops; the whole process from start to finish took almost two months. Due to our lack of experience with charity donations, we initially struggled to choose the correct documentation and didn't identify an effective way to distribute responsibilities within the team straight away. Now we know how to organise the process effectively, and hopefully future batches will reach our users more rapidly" Larysa Shevchenko adds.

How scientists are using the humanitarian IT equipment

One of the first institutions to receive the laptops was the O. Ya. Usikov Institute for Radio Physics and Electronics of the National Academy of Sciences of Ukraine. This scientific centre conducts radio physical research on solids and biological objects, studies radio wave propagation, and is engaged in remote sensing of the Earth's environment from aerospace carriers.

The Institute is located in Kharkiv, which suffers from daily shelling and power cuts. "To organise work in such conditions, reliable IT equipment is vital," says Nadiia Savenko, deputy head of the telecommunications and grid technologies department. "People have to work remotely, and the equipment must be able to withstand power surges and hold battery power for a long time. The five laptops we received from the URAN Foundation are so valuable to us, they even have a Windows licence.

The equipment allocation was based on the institution's immediate needs. Our laptop is used to display information on a large screen in the institute's conference hall, which is used for internal scientific seminars (the institute teaches postgraduate and doctoral students), Academic Council's meetings, and by staff members (who are also researchers) to defend their dissertations. The second laptop was assigned to the finance department, where a computer had broken down due to a power outage.

Two more laptops were provided to employees for remote teaching: for decades, the institute has been cooperating with Kharkiv universities,

and its employees have been giving lectures and seminars to students.

"I use the fifth laptop to work remotely," Nadiia Savenko explains. "I provide the uninterrupted operation of the institute's local network, without which it is impossible to carry out any scientific work; I also perform other official tasks. Thanks to its reliable and powerful power supply unit, the laptop allows me to work even during many hours of power outage."

How educators are using the laptops

Zaporizhzhia State Medical and Pharmaceutical University (ZSMFU) is also one of the recipients of some humanitarian laptops. ZSMFU trains future doctors and pharmacists. The university counts more than 9,000 students, over 2,500 from abroad, from 42 countries. The institution has its own clinic and medical college.

The city of Zaporizhzhia, like Kharkiv, is shelled daily from the ground and air, so the university needs IT equipment to support distance learning.

"The humanitarian laptops' technical features are superior to those of our previous laptops" says Viktor Prytula, head of the university's computer technology centre. "Exactly what we needed to ensure a more reliable performance of our IT infrastructure."

The new, more powerful laptops were assigned to technical specialists, as the work of the distance learning platform depends on them. Viktor and his team gave the older computers to teachers who would use them for the less power-consuming distance learning activity.

"Our technical specialists are the main beneficiaries of the laptops we received from URAN" Viktor Prytula explains. "The laptops provide online learning in classrooms and shelters, they maintain and test the university's network equipment: such vital task for any institution in the frontline zone. The university's educational process is carried out remotely and depends entirely on the correct operation of the IT equipment."

Further information

In April 2024, the URAN Foundation received a second batch of 105 laptops from Computer Aid; the URAN team has already completed their delivery to scientists and educators in the cities more directly affected by the ongoing Russian invasion.

Read the GÉANT CONNECT #45 magazine **interview with Ludovic Gautier** to find out how Computer Aid organised the first delivery of laptops to Ukraine.

Pictures
Top left:
Larysa Shevchenko, Director, URAN Foundation

Second and third from left: The ZSMFU network administrator in the server room configures the university's equipment using a humanitarian laptop

Fourth from left: Nadiia Savenko from O. Ya. Usikov Institute homeworking using a humanitarian laptop

uran
Ukrainian Research and Academic Network

15 years of FileSender

In April 2024 FileSender celebrated its 15th anniversary. It originated from TERENA's TF-Storage where discussions showed a clear need for a service to transfer large files and started in 2009 as a joint project of the NRENs from Norway, Australia and Ireland. FileSender is today deployed as a national R&E service in more than 45 countries and has been selected for the file transfer functionality of the EOSC EU Node.

We looked back on previous years and summarised the key steps of the development, challenges faced, and achievements the FileSender community is proud of.

Words: Olga Popcova, RENAM and the FileSender Board

Key steps

One of the key steps was choosing a web-only delivery model early on. At the time this was a quite novel approach, as back then research software was typically required to be installed on the user's desktop. FileSender has been browser-native from the start: no client install is needed.

Having a reliable lead developer and maintainer, contributing structurally to FileSender, is crucial to ensure steady development and integration of community contributions over time. Currently we engage with the FileSender 3rd lead developer, Ben Martin (after Chris Richter and Étienne Méléard), and the project is still going strong.

It was very important to include encrypted transfers. Initially, it was a 'forked version', with a proof-of-concept version created in 2012 at SURF, the Dutch NREN, as a response to the corresponding demand from the Amsterdam University Medical Center.

After many years of availability as a beta-release, field testing and security audits of the encryption module, the functionality officially became available to a wide audience when it was included in the FileSender 2.0 release of June 2018.

Translation management (with the support of the POEditor translation management platform) makes it possible to render the FileSender user interface in many languages. This provides an opportunity for the community to contribute more easily and collaborate, enabling crowdsourcing of translations without requiring significant management overhead.

Over the last 15 years many NRENs and individual people contributed funds and time in large and small amounts to FileSender development demonstrating the value of producing software together: a better result for a lower cost per contributing organisation and a rewarding environment for people to work in.

Challenges

With FileSender's increasing popularity, aligning opinions on the direction of FileSender takes more time and patience. It also means the quality of the software becomes more and more important, a challenge emphasised by the increased focus on security, usability and ease of provisioning of services. This has an impact on the budget which needs to steadily increase as well.

The need for a smooth flow of financial contributions ended up spawning the Commons Conservancy foundation, where other GÉANT open-source projects also have found a home. Through it we have the capability to receive funds from many contributors with low effort from our side. The Commons Conservancy also ensures longevity of governance and a smooth-running collaboration 'substrate'. We are in a good place regarding our financial-administrative organisation, but it took years to bring all of this together in a 'happy flow'.

One of the major difficulties in the long term is supporting the popular browsers and making sure appropriate testing of the FileSender software is in place. Browser technology, its standards and deployment are unpredictable. We've seen Internet Explorer come and disappear; we've seen Web 3.0 appear. Under these conditions, it's inevitable to manage long protracted painful rewrites, UX changes and code refactoring – and survive it!

Achievements

Our steady pace of development and adoption has led FileSender to become the de-facto standard for web-based large file transfer in R&E. Appearing as a requirement in the EOSC EU Node specifications, then bidding and winning the bid as a Managed Large File Transfer service for end-users, the FileSender service becomes a key component of the emerging EOSC Federation.

While there are various online service offerings in the file-sharing market, FileSender is one of very few long-term, stable open-source packages that allows you to provide your own large file transfer service. It remains popular due to its embrace of the open-source paradigm in spirit and code, privacy by design, end-to-end encryption support and above all native browser support for sending very large files.

We thank GÉANT and the NRENs, which contributed significantly over time: AARNet, ACOnet, Belnet, CESNET, CSC, DeiC, GARR, HEAnet, RENATER, RNP, Sikt, SURF and Switch. We have come quite far with this collective effort during these 15 years, but if we are to continue this – we'll have to scale up the effort (and hence the budget) to support increased quality and security requirements. We call upon all NRENs to join the R&E FileSender community and infrastructure and start running a FileSender also in your country!

"While it started with the basic value proposition of easy transfer of large files, e.g. not having to send USB sticks, hard drives, etc., over time we've seen a shift towards the notion of 'secure transfer' becoming more important, which we facilitate through both 'the NREN as a trusted intermediary' and through the browser-native end-to-end encryption of transfers."

Jan Meijer, Chair of the FileSender Board, Senior Advisor for International Strategy, Sikt, Norway

"Aves IT performs a variety of services, one of which is application management for FileSender installations, for NRENs and other business customers. We offer solutions for running FileSender in your own datacentre/cloud or in our datacentre. Aves IT contributes in-kind and donates time to help FileSender grow and mature."

Nils Vogels, FileSender in-kind contributor, owner of Aves IT, the Netherlands
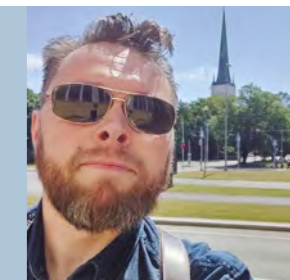
"I am proud of the FileSender community, which acts with respect to each other, but at the same time is not afraid to challenge each other. People work together internationally, across time zones to try to make FileSender a better product. In the portfolio of SURF, this is one of the products that users rate highly and one of the key services our institutions rely on."

William van Santen, Product Manager Cloud Services, SURF, the Netherlands

Visit the FileSender official website **filesender.org**

WiFiMon: Spreading Across the Globe

If you want to turn your **Wi-Fi drama into Wi-Fi nirvana**, WiFiMon is the right tool to help network administrators pinpoint issues quickly and take proactive measures to address them, ultimately improving the user experience

Words: Elisantila Gaci (RASH), Robert Tadevosyan, (ASNET-AM) and William Kibirango (RENU)

Picture
Members of the WiFiMon team

WiFiMon has recently attracted significant interest from multiple organisations spread across the world. New WiFiMon users originate from National Research and Education Networks (NRENs) as well as research institutions. These organisations are: (i) RENU, the NREN of Uganda, Africa, (ii) ASNET-AM, the Armenian NREN, Asia, (iii) CERN, the European Organisation for Nuclear Research in Europe and (iv) RNP, the Brazilian NREN, South America.

These users have been closely collaborating with the WiFiMon team during the previous two years by employing WiFiMon to efficiently monitor their Wi-Fi networks as well as proposing new features based on their experience and network monitoring needs. Indicatively, discussions with CERN and ASNET-AM resulted in the development of a novel feature, which helps WiFiMon administrators detect points of significant interest within the performance measurements.

ASNET-AM and WiFiMon

ASNET-AM started using the WiFiMon service two and a half years ago. During this period, multiple WiFiMon versions have been installed and the corresponding monitoring features have been extensively tested. Currently, ASNET-AM utilises WiFiMon to monitor Wi-Fi performance in production networks based on a single-node WiFiMon installation (version 2.2.0). The current WiFiMon installation relies on both WSPs and WHPs, monitoring the performance of approximately 200 Wi-Fi users, including researchers, professors, engineers, and university students. Regarding WHP measurements, two Raspberry Pi devices are used, which are installed in two major Points of Presence (PoPs) across ASNET-AM: (i) Presidium of NAS RA and (ii) IIAP NAS RA.

RENU and WiFiMon

At RENU, requirements for Wi-Fi performance monitoring have been closely related to the deployment of Metro eduroam (i.e. eduroam away from campus). Metro eduroam has transformed the way Ugandans carry out research and education in the country, enabling remote work during the COVID-19 pandemic. More than 200 institution sites have been included into the service, whereas Metro eduroam supports that interconnection of over 51,000 end-users off-campus. WiFiMon has been selected as a viable choice for monitoring NREN Wi-Fi performance across the Metro eduroam deployment. The main reason behind WiFiMon selection was its capabilities to capture end-user experience on the eduroam SSID, broadcasted on access points deployed on multiple sites across the country. In RENU, we are currently testing WiFiMon in conjunction with our solar-powered router deployments to expand Metro eduroam to even more remote areas in Uganda with intermittent electricity, let alone connectivity. At this stage, the need to monitor eduroam service performance has never been bigger.

EUROPE
ASIA
AFRICA
SOUTH AMERICA

Five Hundred and Fifty Cables Under The Seas

The sight of a communication line unspooling from the stern of a large ship, drifting down to settle on a dark seabed that we know little about, surrounded by oceanic expanse, has the potential to conjure up excitement and wonder in most of us. It's easy to find oneself caught adrift in the romantic worlds of exploration and scientific advancement, as if imagining yourself aboard Verne's Nautilus or Cousteau's Calypso. Yet upon closer inspection, the stark reality of submarine cable communications is not one harmonious tide of collaboration between world regions or pondering inventors. It is a surge of competition, transaction, expansionism and fierce industrialisation – spanning as far back as the 1850s. And it's time for that undercurrent to change.

Words: Hendrik Ike, GÉANT

Since the first (but short-lived) transatlantic telegraph cable was laid in 1858 between Newfoundland and Ireland, a boom of cable infrastructures followed suit. Messages between world regions and continents that had previously taken weeks or months to deliver, now only took seconds. It's practically impossible to describe how this truly advanced the development of modern society. In many ways, it is still too early to tell. Yet there is one impact that is immediately observable, in an indirect fashion.

Money doesn't always talk

Whilst traditional telecommunication methods via such cables have facilitated the efficiency of global trade since its inception, the invention of

Picture
Laying cable for hydracoustic station HA01 in Cape Leeuwin, Australia, 2009

modern internet communication has cemented the backbone of economic globalisation. Around 97 percent of international data traffic is carried through submarine cables. Without such an infrastructure, global trade would grind to a halt. Yet to attain the economic value of the submarine cables themselves is a tricky business. This draws comparisons to our own community – where we understand that it is close to impossible to estimate the monetary value of scientific research and education, whilst all the time knowing that it is through such work that most of human progression lies. Due to this paradox, it is through other lenses that submarine cables are often described or portrayed – be that either by policy makers or the private sector.

Diving deep into data diplomacy

The global scramble for the seabed has truly commenced. Either funded by government programmes or private consortiums, member states and/or transnational corporations are teaming up to lay (and more importantly, own) more submarine cable systems. A variety of actors have different interests in doing this. Take major global powers and how they handle their internet governance, for example. The United States will always prioritise an internet that is commercially friendly. China emphasises an internet which safeguards state sovereignty above all else. And Europe? As the European Commission (EC) wishes to remain consistent throughout its collegial

processes, then a human-centered internet, where citizen online rights are protected, will likely be the key driver.

But for whichever perspective you analyse here, it's important to note that they all require one essential element of effective governance – control. And how that control works at a submarine level can lead to disagreement and confusion. Forget political agreements or memorandums of understanding. If Acceptable Use Policies, Peering Policies, or simply the laws that companies or states act within contradict each other, then national security concerns swiftly arise. And don't even mention the complexities of collecting and spending the funding correctly.

This is why the EC's what-used-to-be-termed 'European Sovereignty'

has now transformed into the more blissfully vague 'Strategic Autonomy' policy angle. Europe's digital aims are now not so much as to work with diversified foreign partners, but more the need to act alone or at least primus inter pares for the sake of our own digital single market. And for that to become a reality, it is working heavily on implementing via the Global Gateway strategy several submarine cable landing points in Europe, along with several pieces of consumer protection legislation, such as the Digital Services Act or NIS2 Directive. In a world that is becoming increasingly unstable and volatile in different areas (this does not require spelling out), the EC seems to follow a safeguarding approach when looking beyond its borders.

Coming up for air

The sole aim of diplomacy should be to ensure the continued constructive relations between states or regions. Science diplomacy, as a tool, is becoming an increasingly important asset of the practice. Submarine cables are critical to supporting multilateralism by showcasing how global communication is essential for international cooperation. They underpin the operations of not just industry, and we must state here too, R&E entities, but also global organisations such as the United Nations and the World Health Organization, which relied on these networks during the COVID-19 pandemic for coordinating a global response. To be even more matter of
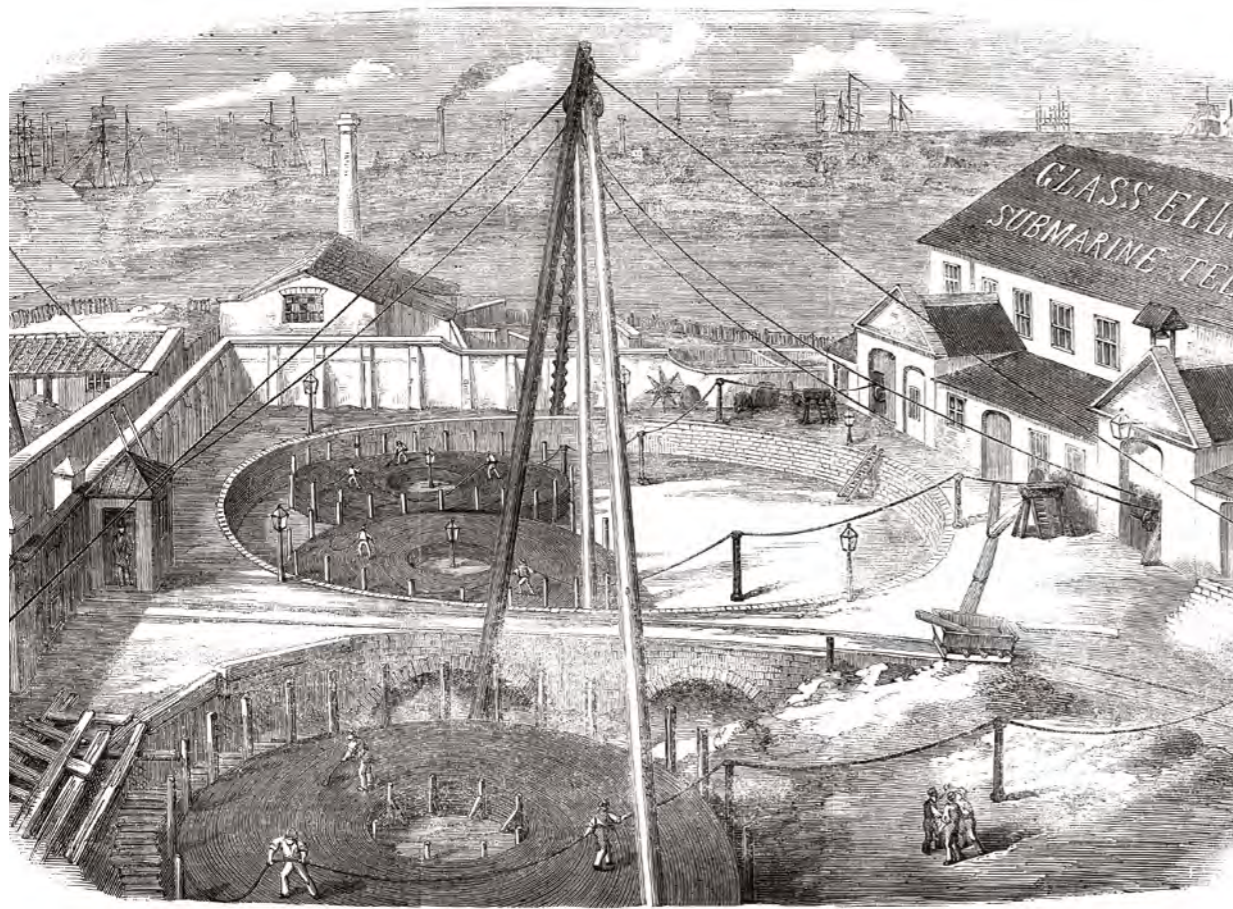
fact, such cables facilitate real-time negotiations and maintain diplomatic ties at times of extreme hardship during multilateral summits between world leaders.

Economically, submarine cables are vital for managing international trade agreements and transactions to enhance economic interdependence. They also support military alliances like NATO by enabling synchronised defense strategies and operations across countries. Additionally, in times of crises such as natural disasters, these cables are crucial for rapid information transmission, aiding effective international response and aid delivery.

It is indisputable therefore that submarine cables foster an interconnected world where cooperative solutions and collective action are enhanced through robust global communication networks, thus laying the technological groundwork for effective multilateralism. It is important to remember this when arguing the values of such infrastructures from an NREN/REN perspective. As a community, such infrastructures are essential to us, but other actors, including industrial ones, need and rely upon such cables too, in order to bring about economic growth, environmental protection, civilian prosperity, security and diplomatic solutions. As such, any large consortia advocating for submarine cable advancement should be able to speak with a single yet diverse and rich voice. And this is just as well if one looks at future predictions for the sector.

It's that bandwidth boom – again...

Problems or no problems – one constant remains in this increasingly interconnected world. The demand for more capacity and bandwidth. The global submarine cable systems market is poised for significant expansion, registering a compound annual growth rate of approximately 12.5% over the next few years, and is fueled by an insatiable global demand for connectivity, advancements in telecommunications infrastructure, and burgeoning requirements in energy transmission and data center expansions, including research infrastructures and large scientific facilities. This unbridled data market expansion is also a victim of emerging technological trends, such as the integration of renewable energy sources, the widespread deployment and integration of 5G (soon to be 6G) networks, and the acceleration of digitalisation in telemedicine – look at the Common European Data Space for health, to name but one example of a thematic data area.

By 2030, global internet data traffic is expected to more than triple compared to early 2020 levels, influenced by an increase to over 4.8 billion internet users and nearly 30 billion connected devices. This is a huge number.

This predicted surge underscores the need for a robust and scalable internet infrastructure planned ahead of time, and so it goes without saying that the significant expansion and upgrades of submarine cable systems are pivotal to ensure that we continue the boom and avoid a painful bottleneck – going bust will not even be an option.

Please hold, another caller is on the line

Thus far, the trends described have accounted for regular optical internet data transfer. But other alternative communication methods and innovations can potentially be used on the same submarine cable infrastructure and are knocking on the door. This will only add further to the importance of sustained investment. Take Time & Frequency communications, Quantum Key Distribution (QKD), or even cable sensing technologies.

Cable sensing technologies, such as those used in the SUBMERSE project, capitalise on existing submarine cables to monitor various Earth and oceanic systems, providing real-time data for scientific research and practical applications. These technologies enable the detection and analysis of seismic activities by measuring natural and artificial seismic waves, aiding in the rapid assessment of earthquake impacts and enhancing tsunami early warning systems. They also track continental plate movements, offering insights into tectonic shifts and potential earthquake triggers. In oceanographic contexts, cable sensing facilitates the observation of seabed interactions, benthic flows, and the effects of human activities on marine environments. This broad range of applications not only helps in understanding geological and oceanographic processes but also supports the study of marine mammal behaviors and interactions, providing valuable data for conservation and research efforts in marine biology. It is with pride then that we as the GÉANT Community can now affirm that we facilitate the use of our current submarine infrastructure to perform cutting edge scientific research. This is beneficial to our members, end-users, research infrastructures, and the EC.

Another form of alternative communications is Time and Frequency (T&F) Networking. This involves distributing accurate time and frequency references across various systems and networks. The technology is essential for applications and services where precise synchronisation must be exact, so for example in telecommunications, finance, broadcasting, and scientific research. It underpins the reliability and efficiency of modern digital networks and systems, providing the synchronisation backbone necessary for many of today's technologies. Our T&F investment is by no surprise also set to increase in the future, combined with our collaboration with respective National Meteorological Institutes.

Finally, QKD is a cutting-edge method for secure communication that utilises principles of quantum mechanics to generate and share a cryptographic key between two parties. It allows for the secure distribution of cryptographic keys with the assurance that any suspicious eavesdropping attempt will be detected. While QKD does not encrypt or send the actual messages, it provides the secure key needed for encryption in a separate classical channel, ensuring confidential communication. This technology is seen as potentially revolutionising secure communication in the face of growing computational power and the future threat of quantum computing to conventional encryption methods.

So why are submarine cables more important than ever?

Global cooperation in the field of submarine cables is an essential element of both internet governance and diplomacy. Research & Educational activity is fueling demands to support investments in submarine systems – in remote areas as well along more traditional routes. The changing profile of the ownership/ utilisation of the internet is noted and the public interest role of R&E can be seen to be significant enough to act as a conduit to ensure a retention of an open, resilient and distributed internet structure. Submarine cable agreements between National and Regional Research Education Networks (NRENs/RENs), based on the common values of trust and reciprocity, allow public entities to not just share and disseminate public research and educational data, but innovate solutions and services to bolster scientific advancement – that the world sorely needs.

Submarine cables are foundational to the fabric of global communication and economic interdependence, serving as the backbone of the world's data traffic. This extensive network is crucial for scientific, educational, economic, and diplomatic purposes. They are needed to foster geopolitical stability by enhancing the interconnectivity between nations and economies, making conflicts less desirable due to the intertwined economic consequences that would follow. To learn more about this subject, please feel free to attend the session '**United or divided: How will our community be working together by 2040?' on Thursday afternoon at TNC24**, where we hope to cover this subject in more detail.

Submarine cables extend beyond mere data transmission; they are pivotal in promoting transparency and the free flow of information. This openness is crucial for building trust and understanding between nations, reducing the likelihood of conflicts arising from misunderstandings or misinformation. Additionally, the resilience provided by submarine cables during crises ensures that communications can continue even when other infrastructures fail, supporting effective crisis management and rapid response efforts.

As the digital transformation accelerates, the proactive measures of NRENs and RENs in owning or leasing submarine cables are essential for sustaining global research and educational collaborations in an increasingly connected world.

Dedicated, centralised funding to improve these networks to be allocated, be that by the EC, United Nations, or World Bank, would aid global stability and quicken our ability to conduct the research we so urgently need in order protect our planet and peoples. With such a premise, and subsequent opportunity, it is an urgency impossible to ignore.

Security Days 2024:
collaboration will secure tomorrow's knowledge

Taylor Swift Can Save Us

'Only Taylor Swift can save us now' is the powerful quote that best summarises the GÉANT Security Days' closing keynote "Lies are (not!) everywhere" by the Czech TV journalist Daniel Stach, host of the popular prime time science programme Hyde Park Civilisation. Daniel delved into the impact of AI on our ability to recognise false information. His talk highlighted the recent events that prompted the introduction of a US bill addressing nonconsensual, sexual deepfakes — following the proliferation of AI-generated pornographic images featuring singer Taylor Swift on social media. He emphasised individual responsibility in navigating this complex landscape, recognising that the ultimate solution lies not solely in technology, but also in our discerning ability and rational skills.

Words: Rosanna Norman, GÉANT

Picture
Czech TV journalist, Daniel Stach at the GÉANT Security Days 2024

A 'fil rouge'

Collaboration, sharing experiences, best practices and knowledge are the common threads arising from the majority of talks and discussions at Security Days since the very start, but let's delve into the conference programme to find out more. Day one comprised two parallel tracks with side meetings and workshops that stimulated engagement and debates among the 150 cybersecurity experts from across the international research and education community. One of the two tracks, entirely dedicated to the Special Interest Group-Information Security Management (SIG-ISM) meeting, was structured around the four core areas of cybersecurity: legislation, implementation, monitoring and training and awareness.

Ana Alves, CISO for GÉANT and her meeting co-chair, Rolf Sture Normann from Sikt, kicked off the meeting: "Our aim is to identify with all of you the essentials to build up, strengthen our network and become more resilient against the ever growing and evolving cyber threats."

The other track comprised a Cyber Threat Intelligence (CTI) workshop where NREN participants from the Netherlands, Cyprus, Ireland, Sweden and Poland presented use cases for threat intelligence and their individual journeys and experiences. The workshop was followed by an interactive and dynamic session on products and services giving insights into which kinds of security products and services NREN create, develop and deploy for their members.

Cybercrime knows no borders

On day two, the conference's opening plenary started with a welcome address from Klaas Wierenga, GÉANT CITO. Underlining the growing importance of security for Research & Education (R&E) globally, Klaas looked at international developments and also highlighted some of the most significant changes on the horizon that will affect NRENs such as the European NIS2 legislation, EuroHPC and EOSC.

Klaas closed: "Cybercrime does not stop at borders: cybercriminals, targets and technical infrastructure span multiple jurisdictions, bringing many challenges. We need to collaborate closely in the months to come, collaboration and global information sharing can make a real difference in our fight against cybercrime."

What is your mission?

Andrea Kropacova from CESNET, the National Research and Education Network of the Czech Republic took the stage to add her warm welcome to Prague highlighting CESNET's history, their top priorities, security being one of them, and outlined the NREN's security portfolio of services, stressing the importance of the role that her small, but efficient security team plays for R&E in Czechia.

Andrea concluded: "What is your mission? Mine is to maintain quality of the security services provided by the Czech NREN, to support IT personnel from connected institutions and to educate a new generation of experts."

Getting ready for the post-quantum age

The long-awaited opening keynote 'Moving the goal to post-quantum', starting from the premise that public key cryptography is the security foundation that trust and confidentiality online are built on, warned that it is under threat from being broken by powerful quantum computers. Fortunately, the academic research community has been working hard on quantum-safe cryptographic algorithms that remain secure even if practical quantum computers become a reality. Transitioning the whole internet to these new cryptographic algorithms, however, is a major undertaking that comes with many challenges. Roland explained the basic need for post-quantum cryptography and highlighted, using examples from R&E networking, what challenges we are likely to face in the coming years. "We have time but have to start preparing". (You can read our interview with Prof. van Rijswijk on CONNECT #45 online.)

Humans and cybersecurity

The Human Factor session on day two reminded us that managing human risk has become more critical in today's interconnected world and highlighted that a human-centric approach, where employees are at the heart of an organisation's security strategy, is a key success factor to empower the community in the face of evolving cyber challenges. The session also took a deep dive into common pitfalls brought by a user-blaming and punitive cybersecurity culture, but also presented concrete examples on how NRENs can be at the forefront of cultivating a positive and open cybersecurity culture.

Have you got five minutes?

The Lightning Talks plenary session closed Security Days day two with 13 lively, informative and animated five minute presentations which offered great content, perspectives, insights and ideas on various aspects of cybersecurity. From external communication during a cyber crisis, on how to deal with a ransomware attack, from novel security awareness approaches to innovative tools and a vision of the Security Operations Centre (SOC) of the future. The room was buzzing, what a great way to close the day!

Security: we cannot do this on our own

Day three opened with a session on operational security: with the growing number of threats, the developments in technology and the fast rise of AI, cooperation in operational security has become crucial. Notwithstanding the high levels of confidentiality of some individual incidents, NRENs also need to learn from their peers in the community to be able to efficiently and effectively protect assets and users. In a very honest and humorous talk, presenters from SURF demonstrated that although management and technical staff may not seem to speak the same language at times, only via regular and open communication are they able to address otherwise unsurmountable and complex issues. The session also highlighted, in a passionate talk by Brian Nisbet from HEAnet, that a SOC cannot be built without intense interaction with other NRENs and users, because only interactions make miracles happen. But speaking of miracles, could the ultimate one be a large virtual pan-European collaboration: the R&E security intelligence hub?

Look for the write up by Nicole Harris about the social engineering exercise organised at Security Days on CONNECT online: **Let me hack you: a different kind of social engineering**

CISOs, wizards and professors

The closing plenary had plenty of food for thought in store for us all. What does it take to be a CISO? Simple, be a multitasking master, bring everybody onboard, communicate and share, monitor legislations and compliance and ultimately make the organisation secure with a solid and pragmatic approach to cybersecurity; according to Ana Alves. The session continued with a talk by Jan Kolouch from CESNET, which by identifying Prague as the real Ankh-Morpork, the imaginary city-state of many Discworld novels by Terry Pratchett, recognised librarians, wizards and professors in the world of NRENs and their constituencies. Jan captured and engaged the audience with national case studies and closed with the recommendation not to succumb to the illusion of technology when looking for solutions, to choose diversification and look for a balance between the fulfilment of formal requirements and the reality of what can be achieved.

Alf Moens, Security Lead from GÉANT closed the conference: "Collaboration at all levels and across national borders, the need to share experience and expertise, and the importance of the human factor in such a technical environment are the most discussed and key takeaways of Security Days 2024. I am impressed with the active participation and great engagement of all delegates and hope that Security Days will help to make the community better prepared and more resilient against cyber risks."

To find out more about the GÉANT Security Days 2024 programme and download the presentations, visit: **security. geant.org/geant-security-days-2024**

Will there be a Security Days in 2025? Stay tuned and watch all the GÉANT communications channels for updates.

GÉANT Security Bootcamps:
Strengthening Cybersecurity for R&E

In the summer of 2023, the GÉANT's Partner Relations and Security teams organised a series of meetings with Chief Information Security Officers (CISOs) and management representatives from European National Research and Education Networks (NRENs). The primary goal was to gain insights into the NRENs' security status, challenges and needs. These discussions aimed to provide relevant support and introduce to the community GÉANT's newly appointed CISO, Ana Alves.

Words: Rosanna Norman, GÉANT

Identifying Security Gaps

The CISO workshops revealed that not all NRENs were meeting the basic security requirements, they also showed that some organisations were not even utilising the GÉANT Security Baseline, a framework developed by and for NRENs to meet their needs and requirements. Recognising this critical gap and the lack of resources that some NRENs face, GÉANT sought a solution to address these vulnerabilities.

The Security Bootcamp

The solution came in the shape of the Security Bootcamp initiative. This innovative programme aims to provide hands-on experience and training sessions to NRENs. Its primary objective is to support the implementation of the GÉANT Security Baseline, as well as to demonstrate its benefits and ease of use. Specifically, the bootcamps target NRENs that face resource constraints (both human and time), however the programme can also support NRENs that would like to use it as a knowledge chain and redeploy it for their connected members (e.g. universities, research institutions). During these interactive workshops, participants gain hands-on experience with the security baseline, moving beyond theoretical learning to practical application. It's a tailor-made programme which delivers benefits deriving from the shared experience with peers from NRENs with a similar security maturity level.

Picture
Participants of the first GÉANT Security Bootcamp

Tailored Programmes

Each bootcamp programme is based on pre-defined objectives agreed with each NREN and on the results of the security baseline assessment, and covers the following essential areas:

- Structure: understanding the organisational security setup, roles and responsibilities within NRENs.
- Strategy: developing effective security strategies aligned with NREN goals.
- Objectives: defining clear security objectives to guide implementation.
- KPIs (Key Performance Indicators): measuring progress and success.
- Planning: creating actionable plans to enhance security posture.
- Policy: establishing and provide robust security policies and guidelines.

Senior Management Involvement

Crucially, senior management participation is vital. Their engagement ensures alignment between security initiatives, top management strategy and overall organisational goals. By actively participating, senior leaders contribute to an open culture of security awareness and commitment.

Peer Learning and Collaboration

The bootcamps set-up favours a micro-network environment of up to four NRENs with similar maturity levels, where participants engage in open and trusting discussions, sharing knowledge, experiences, and best practices. This collaborative approach aims to allow NRENs to learn from their peers, improving their cybersecurity status.

"Key to a successful bootcamp is openness and communication with peers. In this environment participants can openly speak about the gaps in their security management and learn from each other. It is all about learning from and contributing to the NREN community." says Michel Gerdes, Senior Consultant and DPO, DFN-CERT. Michael has been involved in the bootcamp concept's preparation and delivery from the start working closely with Ana Alves.

Successful Launch: Eastern Partnership NRENs

The inaugural GÉANT Security Bootcamp took place in March 2024 and involved the Eastern Partnership NRENs: GRENA (Georgia), ASNET-AM (Armenia), AzScienceNet (Azerbaijan), RENAM (Moldova).

"The Security Bootcamp event was very important for GRENA as we are in the process of developing a Data Protection Policy and an Information Security Policy for our organisation. The experience shared by GÉANT in this field was valuable, interesting and useful."

Ramaz Kvatadze CEO, GRENA, Georgia

"The GÉANT Security Bootcamp gave us an understanding of how to stand on the front lines of information security to ensure a safer tomorrow for all."

Babak Nabiyev, Head of AzScienceNet NOC, Azerbaijan

Expanding Horizons

Ana Alves, GÉANT CISO closes:

"The security bootcamps give us the opportunity to share our expertise and offer our support to the R&E community. Our aim for our members is to reach a robust security maturity level and achieve a more proactive security posture. I firmly believe that by investing in awareness and prevention we can improve our security landscape. We are also working on a pilot to extend the initiative beyond Europe with the hope to strengthen cybersecurity practices across continents."

GN5-IC1 project sets the compass to chart GÉANT's Intercontinental Connectivity

The global connectivity landscape is undergoing significant transformations and becoming increasingly intricate [see article at pages 52-55]. We spoke with GN5-IC1 coordinator Veronika Di Luna (GÉANT) to find out how the project is navigating this complex scenario and how it is helping GÉANT to define its intercontinental connectivity investments.

Interview by: Leonardo Marino, GÉANT

Veronika, why is GÉANT re-defining its intercontinental connectivity approach?

Currently, 25% of the traffic across the GÉANT Network backbone either originates from or is destined for locations outside of Europe, supporting global data-intensive research activities. Moreover, we forecast 30-35% growth year on year on GÉANT intercontinental traffic, due to big scientific projects such as the LHC and ITER significantly increasing data production, or as the SKA Observatory and the High-Luminosity LHC becoming operational. Interest in intercontinental investment is also shifting, due to a variety of factors: key submarine cables reaching their end of life, changes in the market, a stronger appetite for long-term stability, geopolitical tensions in crucial transit locations, a need for improved capacity and resilience beyond our European network.

From a policy standpoint, the European Commission revised its stance on the topic through the launch of the Global Gateway strategy [see again the article at pages 52-55]. In this context and considering the sheer volume of intercontinental investment, it has become necessary for GÉANT to transition towards a more strategic and systematic approach.

How does this fit into past and ongoing GÉANT efforts?

GÉANT has already been moving for some time from a model based on short-term contracts towards mid- to long-term investments: in Europe through the GN4-3N project, and globally through projects like AfricaConnect, EaPConnect and – most prominently – the BELLA initiative. As a further step in this direction and building on these successful experiences, GÉANT is now participating in the MEDUSA Submarine Cable Project, the EC's first digital Global Gateway aiming to connect North Africa and Europe.

Additionally, we are increasing our efforts to support the resilience and security of global submarine cable systems, and recently joined the International Cable Protection Committee (ICPC) as the first member organisation from the R&E networking community. GÉANT also continues to work to strengthen the global fabric of R&E networking, through intercontinental collaborations such as the Advanced North Atlantic (ANA) Consortium, the Asia-Pacific-Europe Ring (AER), the "Bridging Europe, Africa and the Americas" (BEAA) Collaboration, and participation in GNA-G, the Global Network Advancement Group.

What steps did GN5-IC1 take towards a new approach?

Our focus in the past year was on the definition of a series of pillars and guidelines, that would help us to identify the main reasons and areas for investments and support our intercontinental connectivity strategy. The project was well positioned to lay the groundwork for this activity, as the team combines the knowledge of the international landscape and of the user needs, strategic planning and network architecture expertise, as well as the market intelligence and procurement knowledge. Following the initial draft, we expanded the consultation to our community, to ensure the alignment of GÉANT's investments with the GÉANT Association Strategy, with other ongoing activities, and with the needs and interests of both GÉANT and of its members, who are ultimately the ones benefitting from the investments and bearing their recurring costs. The process took about eight months and involved consultations with the NIAC (Network Infrastructure Advisory Committee), with the broader community and with the GÉANT Board.

Can you tell us more about the pillars and guidelines you identified? What's their aim and what are the main differences between them?

Pillars and guidelines are not prescriptive. Both are primarily meant to be used as reference points, and as guidance to evaluate investments and present cases to the governance for approval. In particular, pillars are meant to outline the general direction and the reasons for our investments. Our approach is based on three pillars:

1. **Serving the needs of the European R&E Community**. This ensures that our investments meet the global data communication needs of GÉANT Member RENs and their connected European big science infrastructure and collaborations.
2. **Global Collaboration**. This pillar covers collaboration with other regions and focuses on the development of R&E Networking globally.
3. **European Autonomy.** This is in many ways similar to the first pillar, however, we decided to keep it as a standalone item, as it goes beyond simple traffic forecasts and R&E requirements and focuses more on the strategic investments and European digital autonomy on the key routes.

Guidelines on the other hand define how particular decisions within a pillar are taken and how GÉANT's intercontinental connectivity investments can reinforce one or more of the pillars. For instance, some of the guidelines informing Pillar 1 state that priority should be given to connectivity solutions that add to diversity and use technologies enabling simple and affordable future capacity growth, and to nodes that are existing Hubs and Open Exchanges, in politically stable locations and providing appropriate resilience and capacity. Guidelines in support of the third pillar of European Autonomy also state that investments should be made toward locations/nodes with an appropriate level of openness and connectivity towards other locations.
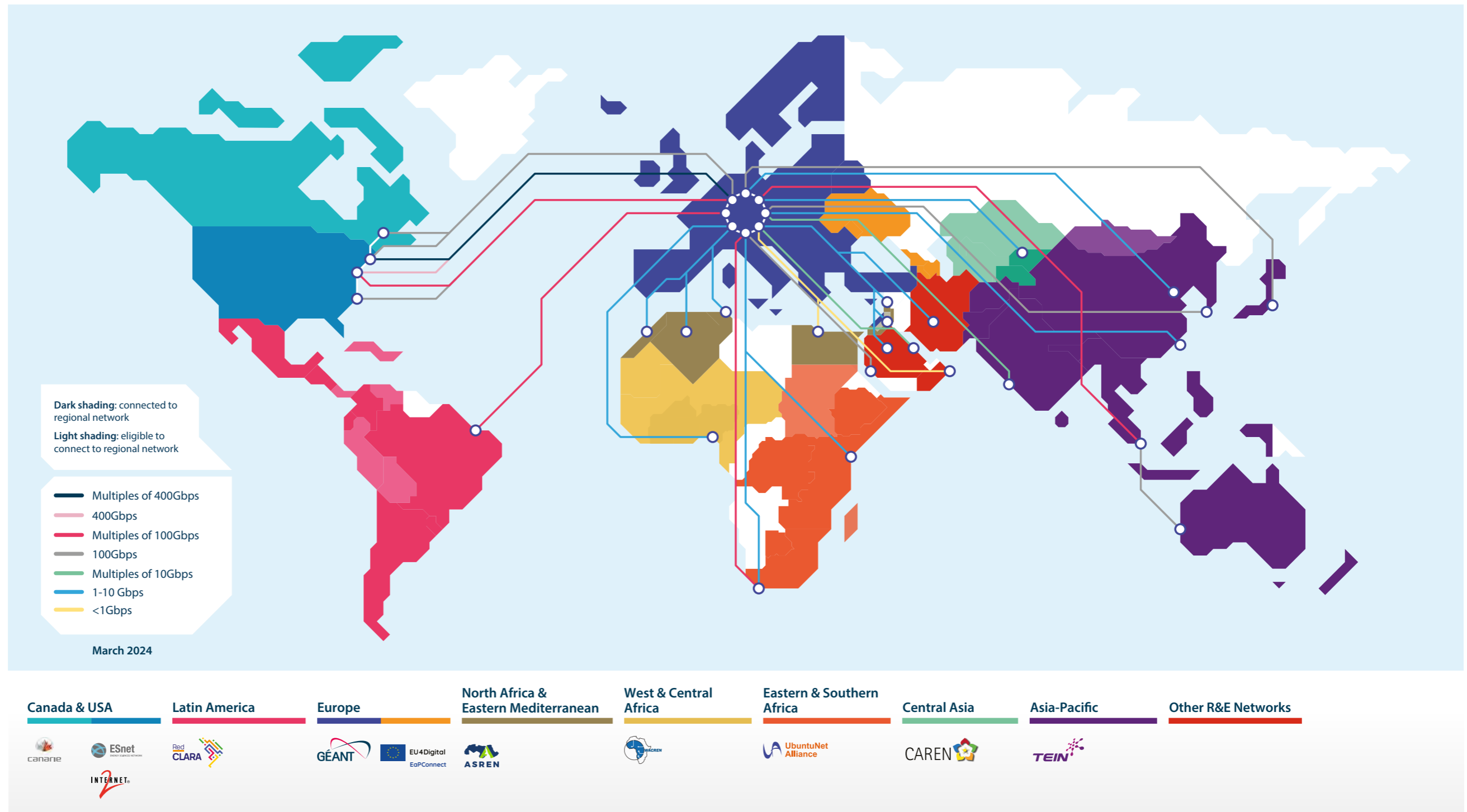
How is this approach guiding GÉANT's intercontinental connectivity and investments?

One of the main aims of this work was to set a check-in point to review and validate the work done until now in GN5-IC1 against the approach we defined. At the time of writing, only a small portion of the GN5-IC1 budget has been spent, primarily to establish a new 100G link to Singapore, which then allowed us to renew collaboration with our Chinese partner CSTNET.

Having recognised this initial phase of investments as fitting with our approach, we are now actively set to ensure that the remaining majority of the GN5-IC1 budget is spent in line with it. In doing that, we will also be mindful that further investments will be partly covered via the upcoming GN5-2 project, or via other funding sources, as in the already mentioned case of MEDUSA.

At present, the GN5-IC1 project is focused on delivering a major expansion of transatlantic connectivity between Europe and North America, the world region with which GÉANT exchanges the most international R&E traffic. We are planning a game changing long-term investment towards Terabit capacity in coordination with our partner ESnet and with the ANA Collaboration, in line with Pillar 1 and in response to the growing traffic forecasts for the connectivity between European and North American users.

In regard to future planning, a particular area of interest will be the Asia-Pacific region, which is registering increasing traffic growth. It is clear to us that our initial investment in connectivity to Singapore is just a first step in support of that region. We are at the same time being mindful of the increased collaboration between Europe and India, exploring the use of the BELLA connectivity for multiple purposes and to serve as a backup solution for other world regions, considering the requirements of large scientific projects like the SKA Observatory (SKAO) being built in Australia and South Africa. Consistently with Pillar 3, we will also

Dark shading: connected to regional network

Light shading: eligible to connect to regional network

— Multiples of 400Gbps
— 400Gbps
— Multiples of 100Gbps
— 100Gbps
— Multiples of 10Gbps
— 1-10 Gbps
— <1Gbps

March 2024

Canada & USA | **Latin America** | **Europe** | **North Africa & Eastern Mediterranean** | **West & Central Africa** | **Eastern & Southern Africa** | **Central Asia** | **Asia-Pacific** | **Other R&E Networks**

harmonise our investments with the EC's Global Gateway programme and with the EU's strategic partnerships as the ones with India and Japan. Geopolitical considerations also come into play, as in the case of sanctions against Russia affecting connectivity between Europe and Japan, to which our colleagues at NORDUnet and at Nordic NRENs are already responding with their vision and plans for Arctic connectivity.

How far into the future will this approach guide GÉANT?

With the planned transatlantic investment, we will exhaust GN5-IC1 investment budget, however we are already looking at the investment needs and opportunities beyond the project lifetime while always keeping in mind the pillars and guidelines.

The strategic work we did in GN5-IC1 should be able to guide our approach to intercontinental connectivity investments for the mid- to long-term. Regardless, we believe that the pillars and guidelines we defined will be a good basis for future iterations. We certainly want them to be current, so possibly after 4-5 years we will need to revise them to see if they are still standing and reflecting the reality we operate in.

About the GN5-IC1 project

Launched in December 2022 and with a duration of 36-months, GN5-IC1 is a GÉANT-led project, funded as part of the GN5 Framework Partnership Agreement in Horizon Europe, and sister project to the GÉANT GN5-1 project. Its ambition is to plan and implement the first phase of a new intercontinental connectivity investment programme for the GÉANT European Research and Education community, as well as to put in place a mid- to long-term investment plan for GÉANT.

For further information about GN5-IC1, visit the official webpage of the project: **network.geant.org/gn5-ic1/** and read our previous interview with the project's team on **CONNECT42.**

GÉANT

THE GÉANT PROJECT (GN5-1 AND GN4-3N)

HIGHLIGHTS

The GN5-1 and GN4-3N European Commission project reviews were successfully completed towards the end of March, held virtually over the course of three days with reviewers joining from parts of Africa, Europe, and the United States.

Although the GN5-1 review was only for the first 12 months, the depth and breadth of the work already covered was truly impressive.

The GN4-3N review was the final review that closed off a hugely successful exercise in renewing and expanding the network infrastructure, making great strides in bridging the digital divide and achieving a significantly greater outcome than the original project scope anticipated.

On behalf of GÉANT's Project Management Office, we'd like to thank everyone involved in the preparation and delivery of the reviews, as well as the hundreds of contributors from across the consortium that continue to make the GÉANT projects so essential to European research and education.

We've collated here the highlights of these two projects, and remind you that project achievements covering the past 15 years can be found online at **resources.geant.org** under Project Output.

The following highlights are from the EC-funded GN5-1 and GN4-3N projects from 1 January to 31 December 2023 (GN5-1 Period 1, GN4-3N Period 4). GN5-1 is the first phase implementing the actions defined in the 72-month GN5 Framework Partnership Agreement

(GN5-FPA) established between the GÉANT Consortium and the European Commission in 2021. GN4-3N concludes the last of three phases implementing the actions defined in the 68-month GN4 FPA between the GÉANT Consortium and the EC that started with GN4-1 in May 2015.

160+ FTEs
600+ contributors
39 partners
43 countries

GN5-1
9 Work Packages
42 Tasks
36 Deliverables
45 Milestones

TNC23
715 event attendees
362 online participants
19 commercial partners

GÉANT provides Europe's research and education (R&E) community with the connectivity and collaboration services needed to support evidence-based decision making and effective knowledge exchange with their peers around the world.

The GÉANT projects are a fundamental element of the European Research Area. Through its integrated catalogue of connectivity, collaboration and identity services, GÉANT, together with its National Research and Education Network (NREN) partners, provides users with reliable, secure, unconstrained access to communication, computing, analysis, storage, applications and other resources, whenever and wherever needed.

GN4-3N has delivered the most significant restructuring of the GÉANT backbone network in a decade, designed to support the needs of Europe's R&E community for the next 15+ years. In parallel, GN5-1 delivers excellence in networking and related services, extending its reach to strategically important and emerging areas such as high-performance computing, quantum key distribution (QKD) and time and frequency (T&F), evolving the Communication Commons towards data-driven research and education, supporting open science and strengthening Europe as a global research hub. The demands of the R&E community are evolving faster than ever in terms of quantity and types of data and diversity of disciplines, and GÉANT's flexible, agile and long-term approach remains vital to ensuring they are met.

Delivering tomorrow's network today

The GÉANT network continues to deliver world-leading connectivity services and extremely high performance for all users, while the largest infrastructure refresh in a generation has future-proofed European and international high-speed networking beyond the next decade, empowering research and education without constraints or boundaries.

Community-centric strategic planning: network evolution studies and workshops, the CTO workshop, and Network Infrastructure Advisory Committee (NIAC) meetings ensured community engagement and strategic alignment in defining the roadmap that sets out how the GÉANT infrastructure will evolve.

Next-generation network: 69 routes added to production service; 405 new Infinera nodes deployed; 50 legacy links decommissioned; 34 countries connected; total of 26,047 km of dark fibre or spectrum now lit. IP backbone links upgraded, reconfigured and added to support traffic growth.

Strong OLS foundation: rollout of Infinera FlexILS completed. The new Open Line System (OLS) provides a robust, flexible, state-of-the-art, long-term infrastructure that reduces dependency on the market, increases capabilities to introduce emerging technologies and services (e.g. the new GÉANT Spectrum Service, QKD and T&F distribution), is well placed to support big science users and HPC requirements, and that bridges the digital divide by extending the network to the edges of Europe.

Packet layer: procurement stage for the renewal of the packet layer concluded, with the contract awarded to Nomios/Nokia. The design for Phase 2 provider router functionality was completed and a migration strategy developed.

Effective network management: focused on management tools to support automation and multi-vendor environment. New GÉANT automation platform introduced and GÉANT Orchestration and Automation Team (GOAT) established. Improved reporting for capacity and performance monitoring implemented.
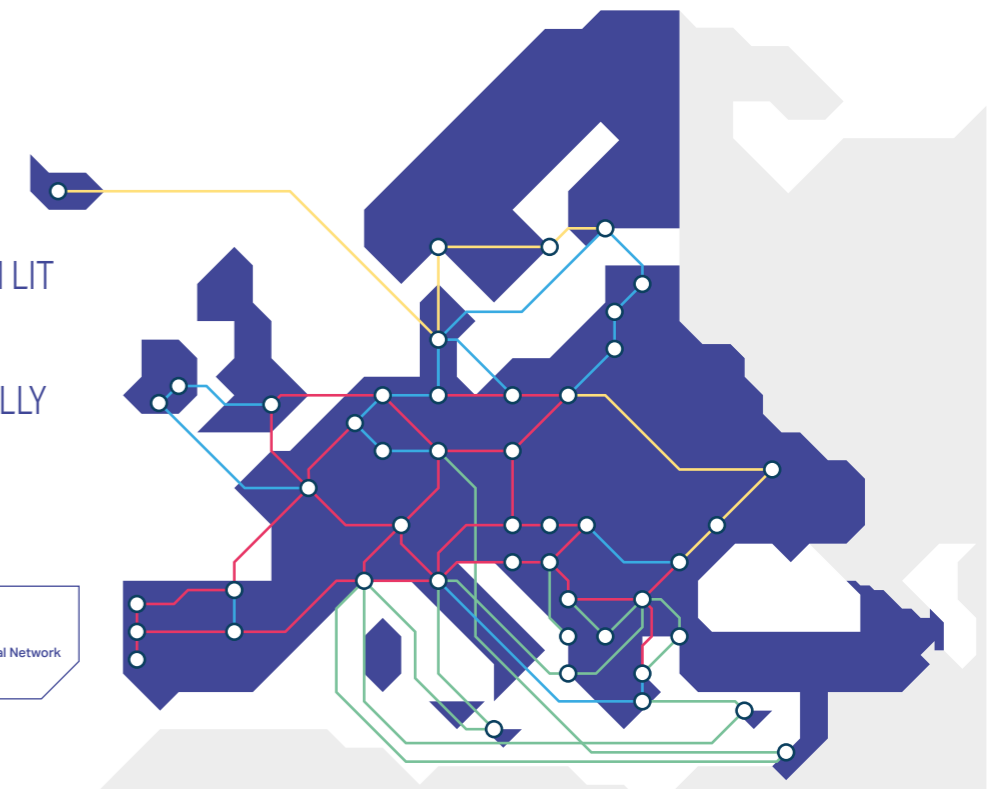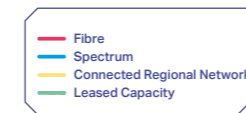
GN4-3N
26,047 km
OF DARK FIBRE AND SPECTRUM LIT

261
PHYSICAL SPANS

69
ROUTES FULLY DEPLOYED

€50.5M
TOTAL BUDGET

Fibre
Spectrum
Connected Regional Network
Leased Capacity

Service innovation: 3 services successfully passed the Product Lifecycle Management (PLM) Production Gate: GÉANT Managed Wavelength, GÉANT DTN Testing Facility and GÉANT Spectrum Service, enabled by the network refresh.

Enhanced security: significant progress in each of the key areas of people, process, tools and infrastructure to protect the network and users in a rapidly evolving threat landscape. Including establishment of a new Security Operations Centre, implementation of NeMo-based DDoS detection and mitigation solution, and integration of university research teams.

Meeting changing needs with service excellence

GÉANT's range of user-focused connectivity, collaboration, trust and identity, above-the-net and security services remains vitally important to research, education, and an evolving European e-infrastructure. An agile development approach ensures services continue to meet user needs in a rapidly changing environment, while the PLM framework ensures their quality and relevance.

Expanding above-the-net services: OCRE 2024 Framework procurement activities started; draft strategy for above-the-net services delivered; NREN cloud engagement database created; attendance at Cloud Forums increased; collaboration with global partners including I2, EUNIS and NII/SINET continued.

eduroam: record-breaking 7.5 billion national and international authentications in 2023 (20%+ growth); 5,100+ IdPs using CAT (8% growth); new geteduroam clients.

eduGAIN: 1 new federation joined, making a total of 79; 5,500+ IdPs participating (5%+ growth); operations team expanded; new governance model created; new operational architecture and automated deployment strategy underway; reporting tool enhanced; OpenID Federation proof of concept started.

Core AAI Platform: transformation from IAM solution to comprehensive platform solution completed; 21 deployments in total, including HPC community, EOSC and student mobility; exploratory work on advanced services underway.

InAcademia: 1 new identity federation became operational, bringing total to 10; 12 countries; 1,026 IdPs; 2.9M validations; rebranding completed; work towards innovative plugin for SME e-commerce platform underway.

eduMEET: spin-out to independent, community-financed open-source project underway; increasing NREN interest; used to connect and stream data from Yellowstone National Park's volcanic activity and transform it into a live musical performance, as featured on IMPACT website.

Network eAcademy: 8 new learning units published (5 OAV, 3 Quantum); 26 learning units in total; 2,700+ views from 484+ organisations in 66+ countries; new architecture and maturity model analyses completed.

Innovation: Above-the-Net, T&I and NetDev incubators continued to deliver innovative projects, with a total of 6 completed in P1 and 7 new projects identified.

Security services outreach: 2 crisis management workshops held; work to establish R&E Cyber Threat Intelligence Hub and security mentorship programme underway; Security Baseline Compatibility Matrix and Awareness Status Report published; awareness raised through successful Cyber Security Month campaign and 4 NIS2 infoshares.

Assuring quality and relevance: 3 services successfully passed the PLM Production Gate and 1 service passed the End of Life Gate. The PLM process underwent further evolution, ensuring that it continues to provide effective support to GÉANT products and services throughout their lifecycle.

eduGAIN
79 members
5,500+ institutions

IaaS+ Frameworks
469 contracts
950 institutions
28 countries

InAcademia
2.9M validations

eduMEET
Spin-out to independent community-financed project in progress

Core AAI Platform
Supporting European Research Infrastructures, HPC and Student Mobility

#love2eduroam
#love2eduroam
#love2eduroam

See highlights from past GÉANT projects →
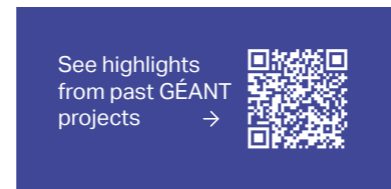
Strengthening the R&E community

By interconnecting Europe's NRENs and facilitating high-speed links with other regions across the globe, GÉANT connects schools, universities, and the world's largest research projects, enabling scientific discoveries, supporting remote learning, and upskilling communities.

Reaching end users: persona-targeted marketing for value-added end-user services developed, to improve effectiveness of marcomms activities.

Aligning with societal goals: the new Policy Engagement Task baselined the NRENs' awareness of and contribution to Sustainable Development Goals (SDGs) and digital rights and principles in preparation for defining best practices and recommendations.

Highlighting GÉANT's hidden presence: a new IMPACT section, "By Nature Invisible", created, featuring typical user personas and scenarios that show how the services provided by GÉANT and the NRENs work in the background to support scientists, researchers and students in Europe.

Strengthening relationships: 3 major face-to-face events held: the Project Management Convention, attended by 75 Work Package Leaders, Task Leaders, Coordinators and the Project Management Office; TNC23, with 715 attendees from 59 nations, 107 speakers, 362 unique online participants and 19 exhibiting commercial partners; and the Symposium, which attracted 260 project participants.

Nurturing growth: the Emerging NREN Programme drew 13 participants from Albania, Bosnia and Herzegovina, Ethiopia, Jordan, Malawi, Palestine, Peru, Serbia, Sri Lanka and Tunisia; the Future Talent Programme recruited and trained 17 students from 8 NRENs; and the T&I Mentoring Programme recruited 3 students from 2 NRENs. NREN Twinning Programme launched, pairing RENU (Uganda) with Sikt (Norway) and MAREN (Malawi) with ASNET-AM (Armenia).

Increasing visibility: the CONNECT website achieved its best results to date, its 124,200 visitors representing a 54% increase. In light of the changing social media landscape, GÉANT is shifting its focus towards rising platforms such as LinkedIn and Mastodon.

Promoting gender equality: GÉANT's Women in STEM campaign, run in parallel with Women's History Month, showcased the diversity, depth and breadth of female representation in the GÉANT community, encouraging girls and women who want to work in STEM subjects to pursue their goals.

Driving innovation: 10 GÉANT Innovation Programme projects completed, exploring innovative ideas in the areas of e-Health, Trust and Identity, Networking, and Security, with the overall aim of strengthening innovation in the community.

Sharing knowledge: 30 meetings took place within the GÉANT Community Programme, totalling 1,935 registered participants: 22 Task Force and Special Interest Group meetings, 3 "one-off" workshops and 5 collaborative project meetings.

Developing skills: 15 live training events were run for 216 attendees from 34 NRENs, and 18 new training modules were added to the eAcademy. Onboarding materials were fully refreshed at the start of GN5-1 to get new project contributors up to speed.

Shaping policy: the 2nd iteration of the CEO Track took place at TNC23 with 58 NREN and RREN directors, enabling focused discussions on topics of strategic importance at a global level. Regular coordination meetings held, on key areas including EOSC and EuroHPC.

eduroam
7.5 BILLION NATIONAL AND INTERNATIONAL AUTHENTICATIONS

104 TERRITORIES
10,000+ INSTITUTIONS
38,400+ LOCATIONS

Innovation Programme
YOUR_IDEA_HERE
10 projects completed

FUTURE TALENT PROGRAMME
17 students from 8 NRENs

COMMUNITY PROGRAMME
30 meetings
1,935 participants

EuroHPC Joint Undertaking
Connectivity to all EuroHPC sites

eosc

CONNECT
54% increase in visitors
400+ posts

Sikt

Introducing CNaaS to the Research and Education Communities of Uganda: A Tale of Global Collaboration in Networking Innovation by RENU and Sikt

In a world increasingly interconnected through digital means, the importance of robust and reliable networks cannot be overstated. Across continents, organisations dedicated to advancing education and research are constantly seeking innovative solutions to meet the evolving needs of their communities. In November 2023, the Research and Education Network for Uganda (RENU) entered a twinning partnership with the Norwegian Agency for Shared Services in Education and Research (Sikt) to roll out Campus Network as a Service (CNaaS) in Uganda. In the spirit of collaboration and mutual growth, the partnership between RENU and Sikt stands as a shining example of international cooperation yielding tangible results.

Words: Caroline Tuhwezeine and Patience Nagaba, RENU, and Vidar Faltinsen, Sikt

Picture
CNaaS team from Sikt visiting RENU in Kampala

The story begins with a bold vision: to bridge the geographical and technological gaps between Norway and Uganda, leveraging each other's strengths to pioneer a transformative networking initiative. What ensued was a 6-month pilot project, conducted under the auspices of GÉANT's NREN Twinning Program for GN5-1.

At the heart of this initiative lay the ambitious goal of establishing the new service, CNaaS, tailored to Uganda's unique context while drawing upon the rich expertise and experience of Sikt in Norway. This service is envisaged to transform many institutional Local Area Networks by leveraging the expertise of the NREN technical staff, where an institution would outsource RENU to manage the set-up, monitoring, and management of the institution's campus network.

Despite the geographical distance separating the two countries, the teams from Sikt and RENU quickly forged a collaborative bond, united by a shared commitment to innovation and excellence.

The journey was not without challenges. Budget constraints and equipment limitations threatened to derail progress, while concerns about job security loomed large for IT staff at partner institutions. Yet, it was precisely in the face of these challenges that the true spirit of collaboration shone brightest.

Through regular touch-base meetings and face-to-face interactions, the teams navigated these obstacles with resilience and determination. Knowledge transfer workshops became a platform for sharing insights and best practices, fostering an environment of mutual learning and growth.

One of the project's crowning achievements was the successful onboarding of Heritage International School as RENU's inaugural CNaaS client. Despite initial apprehensions, Heritage's enthusiastic embrace of the service underscored the school's potential to address longstanding network issues.

"When RENU came on board with CNaas, the first thing they addressed was the network security. They found out that there was unaccounted-for bandwidth that was going out, which was solved in an instant. The CNaaS team also found out that most of our equipment was outdated, and not doing what it was supposed to do, which the team helped us resolve as well. I have since got great reviews from our end-users since we took on CNaaS!" Said Keneth Baguma, ICT Director, Heritage International School.

As the project draws to a close, reflections from both Sikt and RENU offer valuable insights into the transformative power of collaboration. Sikt acknowledges RENU's creative approach to problem-solving, while RENU expresses gratitude for Sikt's generosity in sharing expertise and resources.

Looking ahead, the partnership is poised for even greater heights. With plans to expand CNaaS offerings through enhanced promotional activities, the teams remain steadfast in their commitment to advancing educational and research opportunities in Uganda and beyond.

Through initiatives like the Sikt-RENU partnership, we not only bridge geographical divides but also harness the collective power of global innovation to drive positive change.

Together, we can build a more connected, and inclusive world!

Modern Ethernet Networks for the AI Era

The AI era promises to innovate research and information sharing. The computational demands of AI applications are significant and push the limits of our digital infrastructure. To optimise AI workloads and reduce Job-Completion Time (JCT), we not only need more powerful CPUs, GPUs and TPUs but also smarter, faster networks.

Words: Christophe Compain, Arista Networks

To find out how Arista supports Higher Education and Research facilities visit **solutions.arista. com/arista-for-higher-education-and-research**

Visit Arista Networks on booth no. 7 at TNC24

As a steering member of the Ultra Ethernet Consortium (UEC), Arista is proud to be at the forefront of building the best networking infrastructure for resilient AI clusters, leveraging its industry-leading, standards-based Extensible Operating System (EOS®) software stack and Arista Etherlink™ platforms to facilitate the next technological evolution.

Application Requirements

In training large AI models, parameters are distributed across thousands of GPUs, with each GPU communicating the results of its calculations to its neighbours via a dedicated network.

A typical AI training workload involves potentially billions of parameters, large sparse matrices, derivatives and scalar computations distributed across hundreds or thousands of specialised processors or 'peers'. Data from these peers undergoes reduction or merging with local data, initiating another cycle of processing.

In this compute-exchange-reduce cycle, between 20% and 50% of the job time is spent communicating across the network.

A high-specification, robust network infrastructure is essential to ensure efficient data transfer during the exchange-reduce cycle of AI applications by minimising network congestion. Additionally, quality networks facilitate seamless data import during the initiation of new AI sessions, streamlining operations and enhancing overall performance.

The Scalability Challenge for AI Networking

As the distributed computing environment expands and the number of possible connections between nodes increases exponentially, efficient resource utilisation across a network needs meticulous optimization and carefully considered network architecture choices.

Efficiently distributing this computation is essential for delivering results within acceptable processing times. However, the distributed nature of AI application logic has three significant implications for the network.

Firstly, the primary goal is to synchronise all GPUs to process simultaneously and produce results collaboratively, necessitating the use of RDMA (Remote Direct Memory Access) transport to minimise latency and facilitate collaborative communication patterns.

Secondly, the nature of AI training involves moving large amounts of data with a small number of flows, requiring a network with substantial bandwidth and mechanisms to efficiently manage it.

Thirdly, it follows that in order to support RDMA, the network must have specific characteristics including:

- tight synchronisation to coordinate bursty traffic flows efficiently
- specialised handling including back-pressure mechanisms to prevent congestion in "many-to-one" flows or incast scenarios
- mechanisms for efficiently managing a diverse set of substantial data transfers including a small number of large-size flows

Arista Ethernet-based AI Networking

Similar to high performance computing (HPC) and supercomputing deployments, building connectivity for AI clusters involves both front-end and back-end networks, each with specific requirements.

The front-end network facilitates general purpose connectivity externally, handling general-purpose tasks such as user access, control and administration, and connectivity to high-performance shared storage for staging parameters and cluster outputs.

The back-end network is an island that provides a high-capacity messaging bus for the cluster. Design goals for this network deviate from those of a typical data centre and are central to AI networking.

The main components of high-speed back-end AI networks are:

- **Performance**: With 400GbE and 800GbE network switches, Ethernet can provide low latency and scalability for AI workloads

- **Lossless behaviour**: Crucial for efficient data transport, ROCEv2 (RDMA Over Converged Ethernet version 2) addresses low latency and lossless requirements
- **Flow-distribution**: IP/Ethernet delivers load balancing and no collisions for low-entry AI flows across various architectural scales
- **Back-pressure**: PFC/ECN protocols efficiently handle large bandwidths and mitigate congestion impact due to 'incast' flow patterns
- **Telemetry**: Real-time traffic counting at microsecond intervals and monitoring interface congestion/queueing latency provide in-depth visibility of AI workloads
- **Security and Management**: Virtual LANs, access control lists, multi-tenancy with VxLAN and encryption maintain data centre security and compliance

Embraced by major AI users, open, standards-based IP/Ethernet infrastructure like Arista's is favoured for both front-end and back-end networks and, unlike proprietary networking technologies, can be readily redeployed into other parts of the enterprise if needed.

Arista's programmable and highly modular EOS software stack is unmatched in the industry, empowering customers to construct resilient AI clusters. With support for hitless upgrades, it ensures uninterrupted operation, avoiding downtime and thus maximising AI cluster utilisation.

Arista Etherlink™ supports dynamic load balancing, congestion control, and reliable packet delivery to all NICs supporting RoCE across a broad range of 800G systems and line cards based on Arista EOS.

As the UEC finalises its extensions to optimise Ethernet for AI workloads, Arista is poised to deliver UEC-compatible products. These offerings will be easily upgradable to the standards the UEC sets in 2025.

ARISTA

"Five Ones" Smart Education Solution for a Digital Education Community

Reading guide: By adoption of ICTs, Huawei provides leading smart education solutions featuring One Screen, One Network, One Cloud, One Platform, and One Portal for education customers to drive digital transformation and the high-quality development of education.

Words: Huang Yu, Education Solution Expert of Huawei Enterprise Business

Education is becoming increasingly smart. Teaching, scientific research, campus management, and school services are undergoing profound changes.

Teaching and learning activities have shifted from using traditional blackboards to multimedia tools, from learning in a fixed location to now anytime, anywhere, and from one-way lecturing to more student-centric learning.

Scientific research needs to solve complex computing and analytics tasks and relies more on technologies like high-performance computing (HPC), high performance data analytics (HPDA), big data, and artificial intelligence.

Big data is now the basis of refined management and service decision-making. Administrators need to be abreast of key information regarding each service system in real time. In addition, there has been a gradual shift from decentralized to one-stop campus services to improve the experience of faculties and students.

Facing such profound changes in concept and form, the industry is actively exploring the in-depth integration of ICTs and education. Technologies such as knowledge graphs and big data make learning more personalized, while 5G

and cloud enable hybrid learning more accessible. The demands of scientific research on computing power and storage are soaring. These successful practices have stimulated the sector's interest in applying ICTs. However, new problems like scattered construction, repeated construction, data silos, and outdated ICT infrastructure, are also emerging, which severely restrict reform. How to better utilize ICTs to upgrade and innovate education models is an urgent challenge for every stakeholder in the industry.

Picture
Frank Huang, Huawei

Renovating Smart Education with ICTs

As a leading global ICT solutions provider, Huawei believes in people-oriented education. We are committed to integrating ICTs such as cloud computing, big data, and artificial intelligence into the entire education process in order to promote innovation in teaching, scientific research, management, and services. To be specific, Huawei's Smart Education Solution uses advanced ICTs to offer intelligent interactions, connections, platforms, and applications to support customers in their digital transformation.

Change the education concept and follow the national top-level design

During the process of digital transformation, education administrators need to make centralized plans and high-level guidelines, and then implement them step by step. At the national level of China, policies such as the Mid- and Long-Term Development Plan for Education Informatization (2021-2035) and the 14th Five-Year Plan for Education Informatization set differentiated informatization goals for higher, vocational, basic, pre-school, and adult education. These policies coordinate the set-up of the informatization environment, including the network, cloud platform, contents, and informatization standards for education as well as corresponding policies and regulations. Universities and vocational colleges need to invest manpower, funding, and much more to plan informatization roadmaps according to their long-term plans. When it comes to basic education, primary and secondary schools normally are lack strong ICT capabilities. Therefore, education management departments need to take the lead in providing more platform and application support so that schools can focus on common ICT infrastructure construction.

Based on our ICT capabilities and industry understanding, Huawei proposes the concept of "digital education community". We look to utilize this to create all-scenario education resource connection and aggregation as well as all-dimensional openness and collaboration. The concept will help consolidate full-cycle O&M and continuous evolution with advanced cloud, network, edge, and device technologies.

"Five Ones" smart education solution

Huawei has built the "Five Ones" smart education technical architecture: one screen, one network, one cloud, one platform, and one portal.

One screen is the terminal interface for human-machine interaction represented by various display terminals, including PCs, tablets, digital, conference terminals, smart blackboards, and LED large screens. In different scenarios, there are matching intelligent interaction terminals for collecting and displaying information based on the requirements of each education subject. "One screen" is as important to smart education as a key is to a lock; it opens up the whole system to the user.

One network supported by new technologies and applications is needed to better drive the transformation of teaching, school management, and services. Nowadays networks are not only connected to mobile phones and computers, but also to IoT terminals and smart devices. Based on technologies such as 5G, optical network, and Wi-Fi 7, Huawei integrates wired, wireless, office, and IoT networks to connect campus networks, education MANs, education and research networks, and the Internet. This builds one secure, stable, and intelligent network, improving the bearing capability of the service system as well as user experience.

Huawei builds one smart education cloud with centralized standards and services to integrate smart learning, teaching, scientific research, evaluation, management, and campus for an intelligent education environment where everyone can learn anytime and anywhere. In this way, the quality of teaching and learning can be greatly improved, and we can provide everyone with equal access to quality educational resources.

One platform is a public education digital platform that supports smart applications for teaching, scientific research, management, and services. It shares data across clouds, networks, devices, and systems, breaking data silos. This platform enables the agile innovation of education services and optimizes cloud-pipe-device synergy to connect physical and digital spaces for more intelligent educational data services and governance.

The campus intelligent operation center (IOC) and super app are built at one portal for centralized operation and management. It doubles as a one-stop display for teaching, scientific research, management, and services. Through IOC, school leaders can keep abreast of the status of the campus and carry out refined management, while logistics, security, information and other departments can enjoy more centralized, automated, and intelligent operation. The super app builds a unified smart education portal to connect people, events, and things so that users can access various cloud applications conveniently through only one app. Universities can build a mobile campus portal based on the super app to provide mobile terminal services that can cover work, learning, and life, fulfilling the goal that anyone can learn anytime, anywhere.

Working with the Industry and Moving Forward with Smart Education

To date, Huawei has served more than 2800 education ministries, universities, and research institutes in over 120 countries and regions. Over 30 of the QS World University Rankings' top 100 universities have chosen Huawei as their partner for digital transformation.

Looking ahead, Huawei will continue to deeply engage with the education industry and flexibly integrate big data, artificial intelligence, and cloud with education scenarios to develop scenario-based solutions with partners and drive high-quality education development through digital transformation.

> "As a leading global ICT solutions provider, Huawei believes in people-oriented education. We are committed to integrating ICTs such as cloud computing, big data, and artificial intelligence into the entire education process in order to promote innovation in teaching, scientific research, management, and services."
>
> Huang Yu, Education Solution Expert of Huawei Enterprise Business

"Huawei Innovative Digital Infrastructure Enables Intelligent Transformation in Education", **https://e.huawei.com/en/industries/education**

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Explore our solutions
in action

Nokia Data Center Fabric: take control, make it simple and manageable.

Alexandre Silvestre
Europe Data Center Fabric Business Development for Enterprise

Research and Education Networks (REN) are not only responsible for handling highly compute-intensive tasks in large data centers, but also for transferring large amounts of data, very often spread over large geographical distances so that researchers, scientists, and academia can collaborate and share research across the world. This imposes several challenges to the operational teams that carry on the efforts for building and maintaining data centers, wide-area networks, and interconnection points.

To minimize such challenges, the IP and data center networks that carries this information must be designed to be both scalable and simple to operate. They must support dynamic increases in connectivity and capacity without compromising the manageability, translated by how easy their operators can work to keep it up and running with minimum downtime.

To achieve simplicity and manageability, REN operators must have full control and observability of their networks. This means that the network must be open and programmable, supporting widely adopted community tools for automation, embracing the concept of Network-as-Code, with full access to all network data through scalable open telemetry stacks. As an example of extensibility and flexibility is the ability to change the native outputs of management interfaces (such as CLI commands and YANG models) as well as to allow the easy development of customized applications,

like running Python or binary code within the network nodes. That could include the addition of plugins that integrate with GenAI or LLM models to automate network operations. All this extensibility allows the networks to be customized to fit into each organization's operating model, speeding up provisioning, minimizing errors and improving troubleshooting tasks.

The networks also need to be reliable, given the importance of the research works that depend on it. Network reliability must be inherent in the fabric design with an architecture based on well-defined and solid standards and protocols, tested and supported by the majority of the industry ecosystem players. The NOS (Network Operating System) should also run protocol stacks that are both field-tested at scale and with the lowest exposed vulnerabilities.

REN handle massive amount of data that flows inside and between multiple data centers. It's important to have a comprehensive strategy of an end-to-end architecture from DC to WAN, both at the IP and optical layer with cross-domain management to optimize bandwidth, performance, reliability, and security. This architecture must also encompass security aspects, such as the possibility to encrypt the critical research data that leaves each data center or to embed protection mechanisms to avoid DDoS attacks reaching each of the connected data centers.

Visit our webpage for more information:
https://nokia.ly/TNC24

Meeting the growing demand for connectivity

The emergence of AI heralds a new era filled with both exciting opportunities and daunting challenges in the realm of technology. However, the complete extent of AI's impact and influence on networks remains largely uncharted territory. Recognising this trend, many service providers are already prioritising the reinforcement of their networks, particularly in built-up areas where a significant portion of AI-generated data is produced and transmitted.

Words: Thomas Fabre, EXA Infrastructure Senior Director, Network Investments

The advancements in AI present numerous challenges for infrastructure providers responsible for deploying and maintaining the physical backbone of telecommunications networks. But, at the forefront of these challenges - and possibly the most obvious - is the imperative to ensure that networks are ready to handle the augmented data traffic and complexities brought about by AI applications. This includes optimising network architecture, bandwidth allocation, and traffic management to prevent and mitigate congestion and ensure service quality.

Staying ahead of escalating demands

With escalating demands for bandwidth and network resilience under pressure, a few things have become clear: the importance of diversity in strategising new network deployments, and taking advantage of managed optical fibre networks (MOFN) and open Cable Landing Stations (CLSs). Let's have a look at these key areas, starting with the advantages of MOFN:

- **Reliability**. First and foremost, you can consider MOFN as something you can depend on. Service providers actively monitor and maintain the network infrastructure, meaning that any issues that arise can be addressed quickly. This naturally leads to reduced downtime and improved service availability for customers.

- **Performance**. With the ability to optimise network configurations and traffic routing, service providers can ensure superior performance in terms of bandwidth, latency and consistency for data-intensive applications.

- **Scalability**. In the current climate which imposes demand for dramatic growth, scalability to accommodate increasing bandwidth demands is an obvious advantage of MOFN. The ability to add additional fibre strands, implement cutting edge tech equipment and optimize network configurations as needed is key to supporting growing customer requirements.

In response to recent technological challenges, we're also seeing the emergence of open CLSs. What makes a CLS 'open' is the access to multiple service providers, therefore allowing them to serve the needs of numerous subsea fibre pair owners.

The resilience of open CLSs offers a key strength to manage escalating demand. With the ability to connect to multiple submarine cable systems through open CLSs, ISPs can minimise connectivity disruption as and when any cable outages or other disruptions occur. What's more, they also invite the option to choose between a variety of subsea cable systems which all offer different routes and capacities, allowing companies to choose the cable(s) best suited to their changing needs and capacity demands.

All in all, there's no doubt that we'll be seeing the take up of AI services within the telco space, likely in the not-too-distant future. With the recognition of the value of diversifying network deployments and other advantageous technologies, telcos will be able to meet the growing demand for connectivity and reap the benefits.
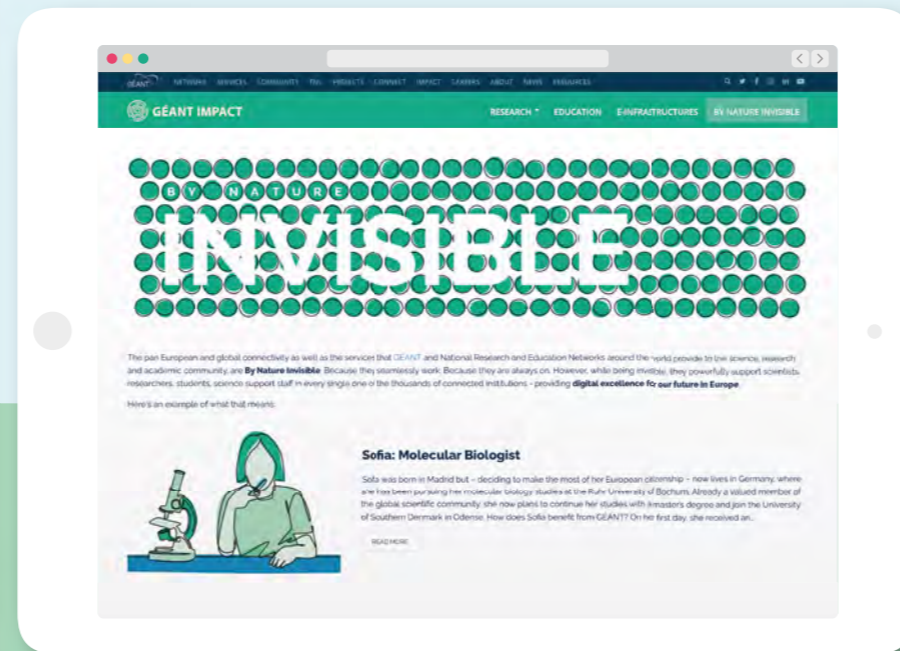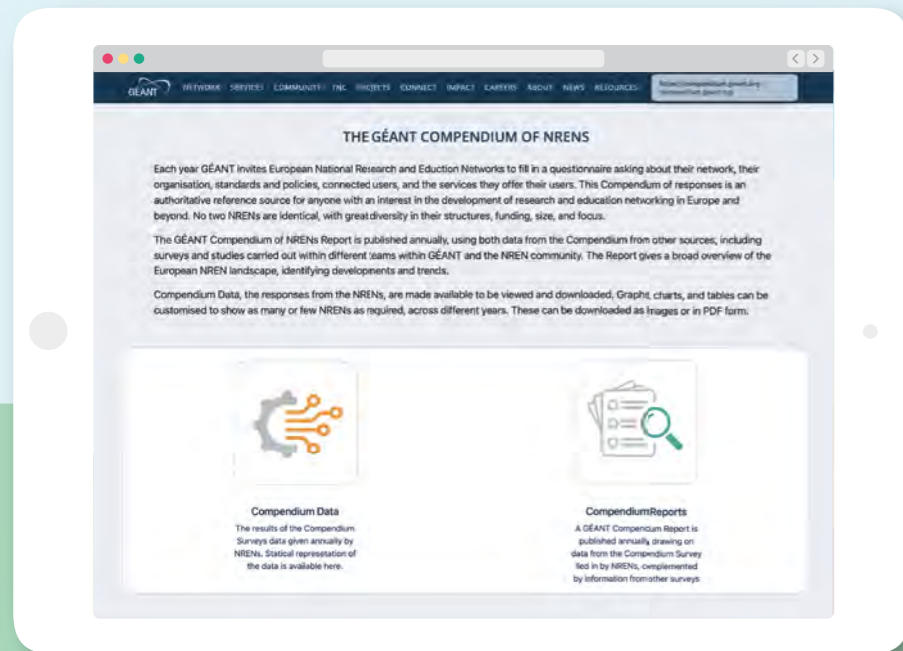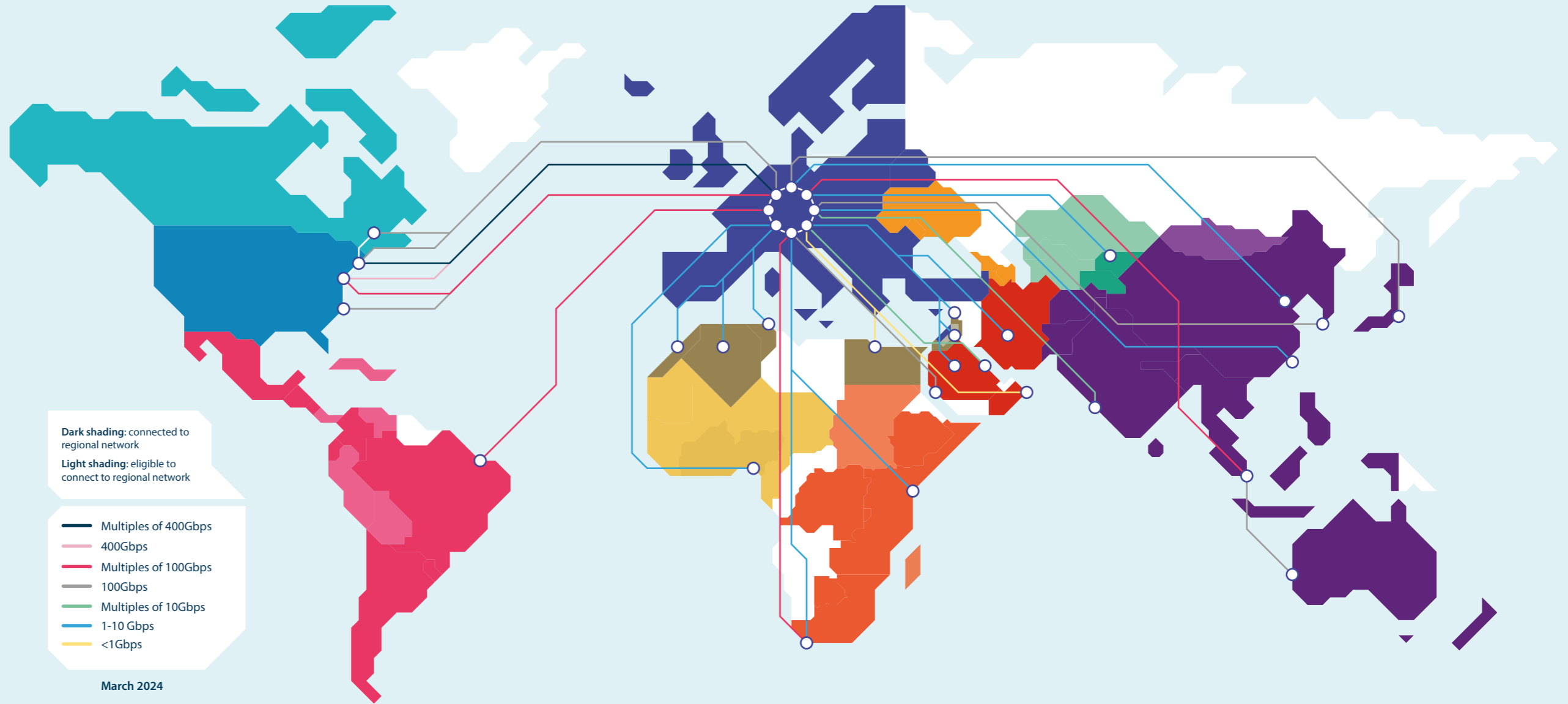
Do you want to find out more about how EXA Infrastructure is addressing these challenges? Please visit us at booth no. 5 or visit **www.exainfra.net**

GÉANT at a Glance

We're bringing you greater content across a wider range of channels: from our Annual Report to showcasing the amazing research projects the GÉANT community supports. And CONNECT is online (connect.geant.org) and you can sign up to our weekly newsletter. You can also get involved on social media – see you online!

GÉANT is Europe's leading collaboration on network and related infrastructure and services for the benefit of research and education, contributing to Europe's economic growth and competitiveness. We develop, deliver and promote advanced network and associated e-infrastructure services, and support innovation and knowledge-sharing amongst our members, partners and the wider research and education networking community. Together with our NREN partners, we interconnect 50 million users at 10,000 research and education institutions; and via extensive global partnerships and GÉANT-managed networking projects, reach over 100 countries worldwide.

Dark shading: connected to regional network

Light shading: eligible to connect to regional network

▬▬	Multiples of 400Gbps
▬▬	400Gbps
▬▬	Multiples of 100Gbps
▬▬	100Gbps
▬▬	Multiples of 10Gbps
▬▬	1-10 Gbps
▬▬	<1Gbps

March 2024

THE GÉANT COMPENDIUM OF NRENS

Each year GÉANT invites European National Research and Education Networks to fill in a questionnaire asking about their network, their organisation, standards and policies, connected users, and the services they offer their users. This Compendium of responses is an authoritative reference source for anyone with an interest in the development of research and education networking in Europe and beyond. No two NRENs are identical, with great diversity in their structures, funding, size, and focus.

The GÉANT Compendium of NRENs Report is published annually, using both data from the Compendium from other sources, including surveys and studies carried out within different teams within GÉANT and the NREN community. The Report gives a broad overview of the European NREN landscape, identifying developments and trends.

Compendium Data, the responses from the NRENs, are made available to be viewed and downloaded. Graphs, charts, and tables can be customised to show as many or few NRENs as required, across different years. These can be downloaded as images or in PDF form.

Compendium Data
The results of the Compendium Surveys data given annually by NRENs. Statical representation of the data is available here.

CompendiumReports
A GÉANT Compendium Report is published annually, drawing on data from the Compendium Survey fed in by NRENs, complemented by information from other surveys.

Sofia: Molecular Biologist

Sofia was born in Madrid but – deciding to make the most of her European citizenship – now lives in Germany, where she has been pursuing her molecular biology studies at the Ruhr University of Bochum. Already a valued member of the global scientific community, she now plans to continue her studies with a master's degree and join the University of Southern Denmark in Odense. How does Sofia benefit from GÉANT? On her first day, she received an...

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