The technology behind the performance

The GÉANT2 network is based upon fibre optic communication lines. Where possible these are fibres leased and operated entirely by GÉANT2. Each such fibre can support around 90 different wavelengths (or subtly different colours of light). Since each of these wavelengths can be used to carry a separate 10Gbps communication channel, there is clearly scope for enormous data capacity.

The GÉANT2 IP network uses these 10Gbps channels to connect routers together, each channel being shared by many users. The router examines each data packet sent and directs it towards its destination. Each packet may pass between several such routers before reaching its destination.

GÉANT2 point-to-point circuits use identical 10Gbps channels to the IP network, but in this case no more than nine users will share each wavelength. If a single user requires 10Gbps capacity between two points in Europe, GÉANT2 can configure a compete wavelength between transponders (the optical components that generate and receive the light). This creates a completely transparent end-to-end connection, meaning that the data flow does not interact with any equipment en route, so there should be no danger of packet loss between the countries involved in the collaboration. Alternatively, the transponders can be connected to switching equipment which allows the wavelength to be subdivided into smaller (but still dedicated) communication channels. Each of these channels can be then switched to direct each sub-wavelength channel to the required destination.

Importantly, both full wavelength and sub-wavelength channels offer guaranteed capacity between the end-points of the circuit and, because the destination points and the network path are pre-determined, offer the greatest possible stability and security for the data flow.

The technologies offered for GÉANT2 P2P services are Gigabit Ethernet (for sub-wavelengths), 10 Gigabit Ethernet or STM-64 (for full wavelengths). In most cases these technologies are transparent to the user and will depend upon the the national infrastructure created by the local NRENs. In the case of a technology mismatch between NRENs, GÉANT2 can create a 'Media-Converted' circuit which uses the backbone switching equipment to make the necessary conversion.

Glossary

- DEISA – 'Distributed European Infrastructure for Supercomputing Applications'
- CERN – CERN is the European Organization for Nuclear Research. The name CERN is derived from the French "Conseil Européen pour la Recherche Nucléaire"
- Gigabit – A gigabit = 10^9 = 1,000,000,000 bits
- Gigabit Ethernet – (GbE or 1 GigE) is a term describing various technologies for transmitting Ethernet frames at a rate of a gigabit per second.
- Teraflop – FLOPS is a computing term "Floating Point Operations Per Second" and is a measure of computing performance. A Teraflop equals 1×10^{12} FLOPS
- NREN – Stands for "National Research and Education Network", and can represent both a physical network and the organisation that runs the infrastructure. GÉANT2's project partners include 30 of Europe's NRENs.

GÉANT2 delivers the next generation research and education network for Europe. With over 30 million research and education users in 34 countries across the continent, GÉANT2 offers unrivalled geographical coverage, high bandwidth, innovative hybrid networking technology and a range of user-focused services. Its network links total more than 50,000 km in length and its extensive geographical reach interconnects with other world regions, enabling global research collaboration. Europe's academics and researchers can now exploit the power of dedicated GÉANT2 "point-to-point" links, creating optical private networks solely for their use, that connect specific research centres.

GÉANT2 is co-funded by the European Commission under the Sixth Research and Development Framework Programme. The project partners are 30 European National Research and Education Networks (NRENs), TERENA and DANTE. It is co-ordinated by DANTE, the research networking organisation that plans, manages and builds research networks all over the world. For more information visit www.geant2.net

Contacts **user-support@geant2.net** **www.geant2.net/users**

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GÉANT2 Optical Private Networks

- Does your research generate huge volumes of data?
- Are you working in an international environment, with collaborators all across Europe, and beyond?

Coping with the research data explosion

The rise of the Internet has enabled scientific and research collaboration on an unprecedented scale. Using networks such as GÉANT2, researchers can share data seamlessly with colleagues across Europe and the wider world, speeding up work in critical areas such as climate change, radio astronomy and particle physics.

However the ease of collaboration and the pace of scientific change has encouraged the development of new projects and applications which generate huge amounts of data. Sharing this information between multiple research locations and over long distances puts a major strain on even the fastest networks. These massive data flows cause network congestion, slowing down performance for all users while still not being able to guarantee quality of service for the most demanding applications.

The solution is to deploy point-to-point connections – dedicated paths created between demanding users that guarantee high speed connectivity through reserved capacity to researchers. Effectively offering the benefits of a dedicated private network without the cost of building and managing one, point-to-point connections solve the congestion issues caused by the research data explosion and guarantee high quality service to benefit all users.

The ability to offer point-to-point connections is a key feature of the GÉANT2 network. The world's first international hybrid network, GÉANT2 is designed to switch both data packets (like the commercial Internet) and whole data streams for point-to-point connectivity. Combining the two switching methods in one network is innovative and opens up new service possibilities in terms of bandwidth, quality and speed.

Is GÉANT2 point-to-point for you?

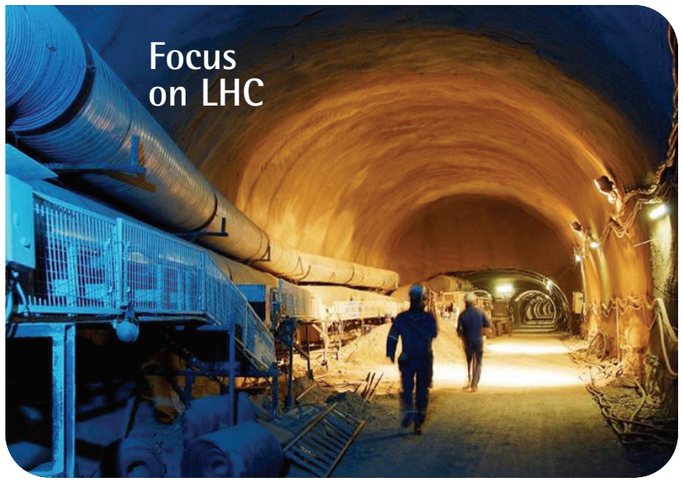
- Are you a "data-heavy user", with data flows in excess of 1Gbps?
- Do you need to collaborate and transmit data across international borders?

If the answer to these is yes, then your research could benefit from GÉANT2's point-to-point connections. The next step is to get in touch with GÉANT2 user support to discuss your requirements further. You can contact the team at user-support@geant2.net, or complete the form at www.geant2.net/users

Who can use point-to-point?

The benefits of point-to-point can be exploited by all kinds of researchers working in diverse scientific areas. The disciplines that can benefit include:

- **Particle Physics** • **Astronomy** • **Supercomputing**
- **Genetic Modelling** • **Weather Forecasting**
- **Climate Change** • **Healthcare**



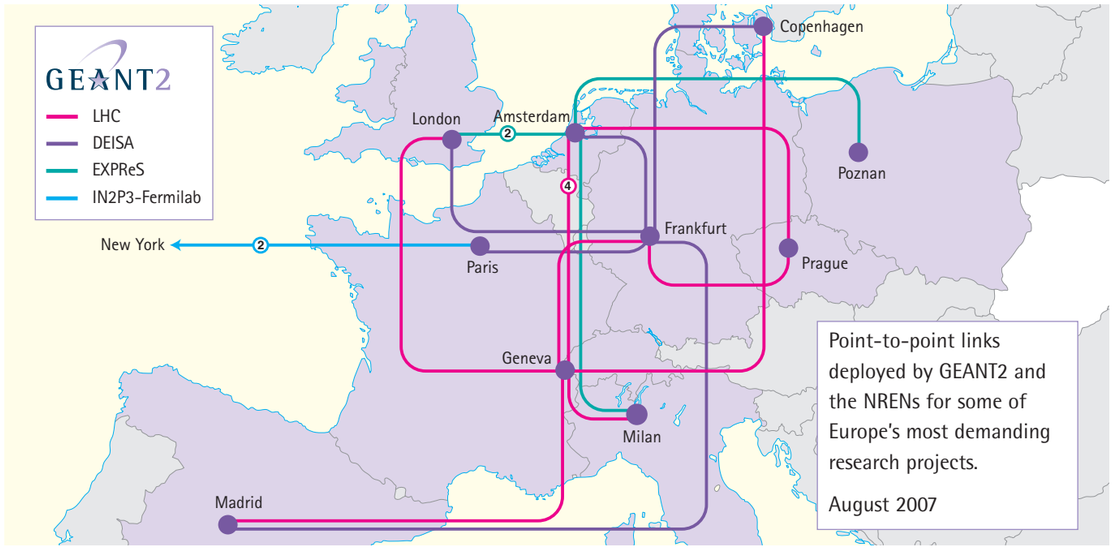
Construction of the LHC at CERN, copyright CERN.

The largest scientific experiment ever undertaken, CERN's Large Hadron Collider (LHC) will create conditions similar to those in the immediate aftermath of the Big Bang, enabling researchers to study the most fundamental properties of particles and consequently develop a greater understanding of the universe we live in. The sheer scale of the endeavour is difficult to comprehend – it will produce 15 million gigabytes – some 3 million DVDs, worth of data every year which will need to be analysed, archived and made available to around 5,000 researchers in some 500 institutes worldwide. To handle this data mountain, the LHC Computing Project has chosen an innovative globally distributed model for the task – a computing grid.

For this grid to work, it relies on guaranteed, high capacity, bandwidth between the 12 LHC primary processing centres around the globe. DANTE is a key player in this worldwide collaboration, and together with global research network partners, is responsible for the operation and implementation of the LHC Optical Private Network (OPN) using GÉANT2 and global point-to-point links.

The size and complexity of the project is mirrored in the close collaboration between the research networking organisations essential to the LHC's success. Therefore to ensure this happens effectively requires the creation of close working relationships between stakeholders at strategic, technical and operational levels. Key GÉANT2 personnel are involved in a number of long term working groups delivering the capability that CERN needs for the networking success of the LHC.

"The Large Hadron Collider is a major step in mankind's voyage of discovery and will help us understand the secrets of the universe itself," commented David Foster, Head of Networking, CERN. "However without the ability to seamlessly deliver this data to collaborating scientists worldwide we will not gain the full benefits of this enormous programme. Working with DANTE, the NRENs and our collaborators worldwide to create the LHC Optical Private Network ensures that thousands of researchers will be able to access and study LHC data whatever their location and represents a huge step forward towards true globalisation of research and innovation"



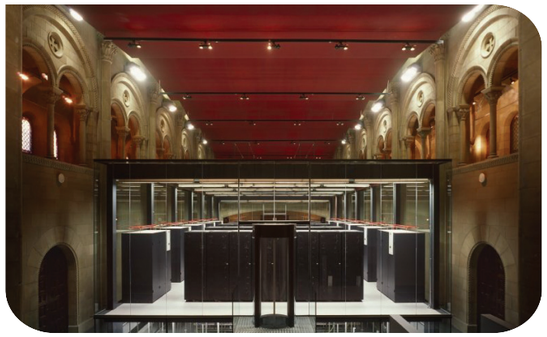
Focus on DEISA

DEISA is an EU funded distributed supercomputing environment consisting of 11 of Europe's biggest supercomputers. It provides leading scientific researchers with access to a European cluster of state-of-the-art High Performance Computing (HPC) resources with a current aggregated computing power of over 200 teraflops.

DEISA has increased connectivity speeds between its supercomputing centres ten-fold to 10 Gbps through dedicated GÉANT2 point-to-point links. This private network is enabling researchers to gain faster and more efficient access to DEISA's shared file system, supporting ground-breaking applications in computational sciences.

Requests for supercomputing resources amongst scientific research domains are on the increase, with 23 separate projects scheduled for operation in 2007. These include research projects such as SEISSOL (research into earthquake simulations), COMSIMM (looking at current and future climate trends), ICAROS (stratospheric ozone research, climate change), gyro3d (plasma instability) and HELIUM (radiation-matter interactions).

Victor Alessandrini, Project Director, DEISA explains the project's use of GÉANT2 thus: "The underlying aim of the DEISA project is to enable scientific discovery across a broad spectrum of science and technology. By exploiting the point-to-point connections that GÉANT2 provides, we're able to create a high speed, integrated European supercomputing environment. This will enable us to share the massive computational resources that are needed for efficiency and performance."



The MareNostrum Supercomputer at Barcelona Supercomputing Centre, copyright BSC.

Services beyond high capacity links

Installing these links is just one part of deploying point-to-point connectivity. Monitoring the performance of these links, and trouble shooting network issues, are important to ensure that GÉANT2 users receive the service they expect. Co-ordinating the monitoring of these dedicated circuits creates new challenges as it spans different National Research and Education Networks (NRENs), each of which operates independently with its own approach to monitoring, troubleshooting and supplier liaison. To ensure continuous high performance a new system has been introduced that monitors traffic status across the multiple domains that connect the centres. With NREN support, DANTE has created the GÉANT2 End-to-End Co-Ordination Unit (E2ECU) that monitors international point-to-point connections. This provides an important operational overview of circuits which cross multiple network domains, and in many cases, multiple time zones. This is particularly relevant for GÉANT2's transatlantic point-to-point links, which have been deployed to link physicists at Fermilab in the US with their colleagues at IN2P3 in France.