CASE STUDY

GÉANT
connect • communicate • collaborate

GÉANT and EXPReS: Revolutionising the world of radio astronomy

The Lovell telescope at Jodrell Bank Observatory

Man has always been fascinated by the stars, making astronomy one of the first sciences to develop. As technology has improved, moving from the naked eye to advanced radio telescopes, so has the ability to see further into the universe. Achieving this level of detail requires unparalleled collaboration between telescopes around the world, often in real-time. With these astronomical observations creating huge amounts of data that needs to be shared quickly, high speed networks are critical to building a more comprehensive and detailed view of our universe.

Extending astronomical reach

One of the most powerful techniques in astronomy is Very Long Baseline Interferometry (VLBI). This technique uses multiple radio telescopes to simultaneously observe the same region of sky. Data from each telescope is then correlated centrally, simulating a single, giant telescope, to provide high resolution images.

One of the leaders in driving forward the successful use of VLBI is the Joint Institute for VLBI in Europe (JIVE). Based in the Netherlands, it co-ordinates major astronomical projects that involve telescopes from around the world.

However when JIVE first began in 1993, there was no way of transmitting this mass of astronomical data electronically, meaning it needed to be physically shipped from across the world. This time-consuming process meant that real-time results were impossible to obtain, a particular problem given the short-lived nature of many astronomical events, such as supernovae and other stellar outbursts.

Real-time data sharing and collaboration

To efficiently and effectively transport the data, astronomers developed electronic VLBI, or e-VLBI, using high-speed, responsive networks to quickly and reliably transfer the huge amounts of data from the telescopes to the central correlator. In 2002, JIVE began using network connections to prove that e-VLBI was possible. The first European e-VLBI observations were conducted in 2004.

The Challenge

To reliably send vast amounts of data from multiple telescopes around the world to a supercomputer in The Netherlands, for processing images of the universe in real-time and quickly distributing them to astronomers.

The Solution

Connect radio telescopes to high-speed networks and send data at rates of up to 1024 Mbps per telescope for real-time processing and instrument monitoring.

Key Benefits

GÉANT and the national research networks have helped EXPReS to revolutionise data sharing in the field of radio astronomy, with super-fast data transfer that enables collaboration amongst researchers and new insights into the universe.

SURFNET

EXPReS

SUPERCOMPUTING POZNAN NETWORKING

In 2006, JIVE led an international consortium to begin EXPReS, a project funded by the European Commission, to improve the capabilities of e-VLBI through support of software, research tools and network connectivity. EXPReS networked additional telescopes and upgraded the JIVE correlator and the national fibre capacity to process 1024 Mbps streams from up to 16 radio telescopes at a time.

Real-time astronomy in action

Since EXPReS began in 2006, there have been over 100 e-VLBI observations conducted by the European VLBI Network, with more being conducted every year, making e-VLBI one of the most network intensive user applications of GÉANT.

One such project was a pan-European observation of supernova SN 2007gr using telescopes in the UK (Jodrell Bank and Darnhall), Italy (Medicina), Poland (Torun), Sweden (Onsala) and the Netherlands (Westerbork).

By linking telescopes across the globe to create an internationally distributed electronic Very Long Baseline Interferometer (e-VLBI) we are able to chart evidence of previously unseen astronomical events. Scalable, high speed networks are central to our mission and working with networks such as GÉANT enables us to push back the frontiers of astronomy.

Dr Huib Jan van Langevelde,
coordinator for the EXPReS project
and director of JIVE.

A supernova forms when the central region of a massive star collapses at the end of its life, while its outer layer is expelled in a gigantic explosion. SN 2007gr was discovered in 2007 using the Katzman Automatic Imaging Telescope in California, USA, and optical observations showed that it was Type Ic, known to result from the most massive stars.

Supernovae are very distant sources, and the radio emissions they produce fade quickly, meaning that the highest resolution imaging techniques such as VLBI are required to receive the extremely faint emissions and reveal the details of the explosion process. The e-VLBI technique gives more flexibility to carry out the observations at any time, and the near-real-time results are very helpful for making decisions about follow-on observations. As SN 2007gr was located in a relatively nearby galaxy, closer than any other Type Ic supernovae detected in the radio spectrum, it offered a unique opportunity to study this phenomenon.

VLBI, particularly with the telescopes involved in EXPReS, gives us superior power and resolution for our observations. e-VLBI, however, also gives us the opportunity to quickly identify and further study supernovae and other transient phenomena that would otherwise be missed.

Dr Zsolt Paragi,
Senior Support Scientist at JIVE

The findings, published in Nature, reported detection for the first time ever of a mildly relativistic outflow in a Type Ic supernova, thus supporting the link with Gamma Ray Bursts, some of the most energetic explosions in the Universe.

The combination of e-VLBI and high speed, high capacity networks such as GÉANT are underpinning real-time astronomical observations that have extended our knowledge of the universe by allowing astronomers to collect evidence of previously unseen astronomical events.

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The world is criss-crossed with high-capacity data networks, connecting and serving research and academic institutions across the globe. Separate from the public Internet for reasons of security and performance, these networks make an enormous practical contribution to research in a wide variety of areas - saving lives, building knowledge, and establishing real-time collaboration between scientists all over the world.

GÉANT is the pan-European data network dedicated to the research and education community, built and operated by DANTE. Together with Europe's national research networks (NRENs), GÉANT connects 40 million users in over 8,000 institutions across 40 countries and supports research types as diverse as medicine, climate change and performing arts.

Revolutionising the world of radio astronomy, GÉANT and its counterparts provide a stable and reliable connection between radio telescopes around the world and the high speed computing power of JIVE. The network traffic accumulates in the Netherlands, where SURFnet provides the backbone to service all the datastreams to the correlator in Dwingeloo. This extensive collaboration is vital in enabling real-time astronomical observations, allowing us to learn more about the universe around us.

For more information:

GÉANT: www.geant.net
EXPReS: www.expres-eu.org/
JIVE: www.jive.nl/
PSNC: www.psnc.pl
SURFnet: www.surfnet.nl
Supernova SN 2007gr observation:
www.geant.net/Media_Centre/News/pages/SupernovaExplosion.aspx

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