Francisco Colomer (for the NEXPReS team)

NEXPReS: evolving the use of e-Infrastructures in the Radio Astronomy Community

May 27, 2011

Springer

Chapter 1
NEXPReS- evolving the use of e-Infrastructures in the Radio Astronomy Community

Abstract NEXPReS is a three-year project aimed at further developing e-VLBI services of the European VLBI Network (EVN), with the goal of incorporating e-VLBI into every astronomical observation conducted by the EVN. The project is developing tools to help take advantage of computational and networked infrastructures to the intensive data analysis demands of radio astronomy. The project is also helping construct tools that will allow users to build dynamic networks and buffer peta-byte scale data sets.

1.1 Radio astronomical observations at the highest spatial resolution – and in real time!

e-VLBI, or real-time, electronic Very Long Baseline Interferometry, uses fibre optic networks to connect radio telescopes to a central data processor, a purpose-built supercomputer which correlates data from the telescopes in real-time. These observations allow to map the structure of cosmic radio sources at the highest spatial resolution ever achieved in Astronomy. Moreover, transferring data electronically and correlating it in real-time eliminates weeks of waiting from the current VLBI method of storing data on disks and shipping them to the correlator for processing. This allows researchers to take advantage of Targets of Opportunity for conducting follow-on observations of transient events such as supernova explosions and gamma-ray bursts. e-VLBI also allows for high precision tracking of space probes.

EXPReS project was an Integrated Infrastructure Initiative (I3), funded under the European Commission's Sixth Framework Programme (FP6) from March 2006 through August 2009. EXPReS's objectives were to connect up to 16 of the world's most sensitive radio telescopes on six continents to the central data processor of the European VLBI Network at the Joint Institute for VLBI in Europe (JIVE). Specific activities involved securing "last-mile connections" to the telescopes, and updating the correlator to process up to 16 data streams at 1Gbps each in real time.

1.2 Further development: project NEXPReS

The very successful outcome of EXPReS brought to further development into the "Novel EXplorations Pushing Robust e-VLBI Services" (NEXPReS) project, comprised of 15 astronomical institutes and National Research and Education Network (NREN) providers. NEXPReS in an e-Infrastructure project funded by the European Union's Seventh Framework Programme under Grant Agreement RI-261525.

The objective of NEXPReS is to offer enhanced scientific performance for all use of the EVN and its partners. The proposed activities are to allow the introduction of an e-VLBI component to every experiment, aiming for enhanced robustness, flexibility and sensitivity, in order to boost the scientific capability of this distributed facility and offer better data quality and deeper images of the radio sky to a larger number of astronomers. By providing transparent buffering mechanisms at telescope and correlator it will be possible to address all the current and future bottlenecks in e-VLBI, overcoming limited connectivity to essential stations or network failures, all but eliminating the need for physical transport of magnetic media. It will require high-speed recording hardware, as well as software systems that hide all complexity. Real-time grid computing and high bandwidth on demand will be addressed as well, to improve both the continuous usage of the network and prepare the EVN for the higher bandwidths which will ensure it will remain the most sensitive VLBI array in the world. The proposed programme strengthens the collaboration between the European radio-astronomical and ICT communities. Finally, this will be essential to maintain Europe's leading role in the global project for an Square Kilometer Array (SKA) telescope.

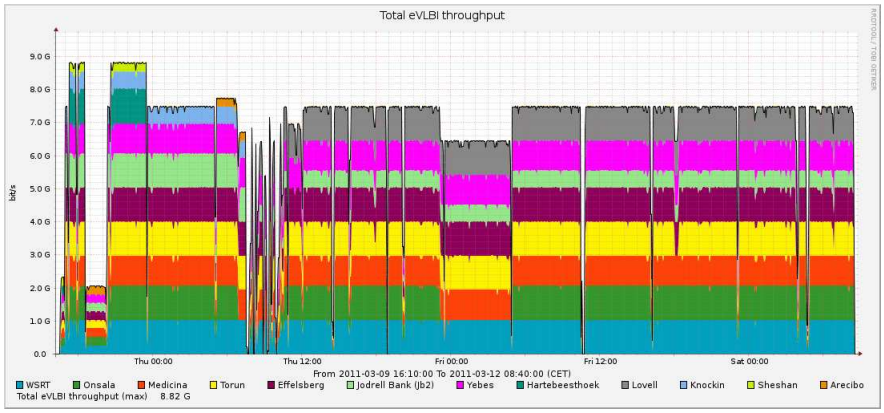

Fig. 1.1 Achievement of an e-EVN milestone: 64.5 hours continuous operation with data streaming from the radio telescopes (Effelsberg, Jodrell Bank, Knockin, Medicina, Onsala, Torun, Yebes and Westerbork, as well as Hartebeesthoek in South Africa, and Shanghai in PR China) to the correlator (at JIVE, NL) at a rate of about 7 Gbits/s (and up to almost 9 Gbits/s).