SKA PROJECT UPDATE - SIGNAL AND DATA TRANSPORT CONSORTIUM DELIVERS A KEY MILESTONE

Signal and Data Transport (SADT) is the backbone of the SKA telescope project ensuring both effective operation of the telescope and transportation of the science data from the receptors to the users and data archives.

The two SKA instances in Australia and South Africa have similar signal and data transport requirements and have generated significant design challenges for the team.

This consortium, led by the University of Manchester in the UK and supported by teams around the world consists of three separate, but equally vital, networks each focused on different aspects of the operation of the telescope and each with their particular requirements and specifications. The networks are:

Science Data Network

This is probably the most visible of the three elements and as the name suggests is dedicated to the delivery of data from the distributed antenna. This in itself is comprised of three different elements:

1. Shipping data from the distributed antenna to the local correlators
2. Transporting that data to the locally sited SKA supercomputer centre
3. Providing access to this data to users around the world

This third element is outside the consortium's remit but the team have taken the overall needs for onward global data transport into account within the overall design of the SADT work.

One of the key constraints of the Science Data Network is the environment in which the network will operate, with long distance, high data rate connectivity requirements within facilities with limited power and cooling ability, and the need to be extremely quiet across the RF spectrum used by the antenna.

Once the data is transported to the local correlators the data needs to be sent to the remote supercomputer facilities. For SKA Low (in Australia) this requires a data network supporting over 8Tb/s from Murchison to Perth – a distance of 820Km. For SKA Mid (in South Africa) the network will transport 9.5Tb/s from Karoo to Cape Town - a distance of 912Km. These data requirements are extremely challenging and are at the current limits of networking technology – particularly when taking into account the terrain involved.

Non-Science Data Network

The antenna for each telescope are distributed across an extremely wide area and have to be a long distance from areas of population to avoid RF noise affecting the signals. Mobile phones and Wi-Fi are of course banned locally to the antenna. Therefore there is a need to monitor and manage the equipment at the antenna and correlators remotely and this is where the Non-Science Data Network is involved.

Unlike the Science Data Network which is a largely one-way, high capacity network, the NSDN is a relatively low capacity two-way network enabling support teams to monitor and hopefully fix problems remotely without the need to physically visit the antenna. Again reliability, low power and quietness are essential constraints for this network.

Frequency and Time Distribution

The design of the SKA relies upon many hundreds of distributed antenna working together to provide data that is equivalent to one huge antenna. In order for this to work it is essential that the individual data streams from the antenna are coherent or 'synchronised'. This 'synchronisation' requires that each antenna knows not only the time but also the phase of that time signal so that the data can be correctly combined.

This time and frequency synchronisation will allow data with a very low signal to noise ratio to be extracted – essential when these telescopes are listening to the most distant and ancient signals in our universe.

Two different technologies have been developed to support this time distribution (one for each telescope) and this ability to distribute extremely accurate time information over long distances is likely to be one of the first technological advances from the SKA to benefit the wider commercial world. All three of these data elements have been delivered across separate networks but each uses the same fibre-optic infrastructure to reduce costs to the SKA.

The Signal and Data Transport consortium has shown a great deal of excellent collaboration across the team in three very different and equally challenging design elements and in particular the experience of and collaboration with the local NRENs (SANReN and TENET in Africa and AARnet in Australia) has been key to the design and delivery of high capacity networking services in extreme environments.

In collaboration with AARnet, CSIRO and SANReN, GÉANT has led the design of the long haul Science Data Network from the core of the telescopes to their supercomputer centres, provided experience and advice for the network connecting the distributed antenna, assisted with the Non-Science Data Network, and provided concepts and an architecture to the SKAO for the Global connectivity that will be required by SKA. GÉANT is proud to be a key member of this consortium and to have been able to use the skills and experience acquired over many years in designing and operating the GÉANT network to support this leading-edge network design and to support the design, build and operation of the SKA.

The Square Kilometre Array (SKA) is a large multi-radio telescope project to be built in Australia and South Africa. When built, it will have a total collecting area of approximately one square kilometre. It will operate over a wide range of frequencies and its size would make it 50 times more sensitive than any other radio instrument. It would require very high performance central computing engines and long-haul links with a capacity greater than the global Internet traffic as of 2013. It will be able to survey the sky more than ten thousand times faster than before.

With receiving stations extending out to a distance of at least 3,000 kilometres (1,900 mi) from a concentrated central core, it exploits radio astronomy's ability to provide the highest resolution images in all astronomy.