Massive telescopes in the Murchison

Western Australia is rapidly becoming an international hub for radio astronomy. The Square Kilometre Array (SKA) is a global mega-science project to develop the world's largest and most sensitive radio telescope, essentially a network of linked antennas, with a total signal collecting area of one square kilometre. A large part of it (the SKA-low) will be built at the CSIRO's Murchison Radio-astronomy Observatory, 380 km north east of Geraldton, and will be the largest scientific facility Australia has ever hosted.

As part of the technology development towards the SKA, a consortium of international scientists and engineers have designed, developed and built a low frequency apeture array telescope at the same location, the Murchison Widefield Array (MWA). It is one of only three precursors worldwide that is developing the cutting-edge science and technology needed for the SKA. It is currently providing fundamental science and technology insights that will be incorporated into the final critical design for the first phase of the SKA. As a research instrument in its own right, it is being used to study the formation of the early Universe, and allows astronomers to look further back in time and further out in space than we have been able to do previously.

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ENABLING REMOTE RADIOASTRONOMY

Smoothing the path to the SKA

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Remote control

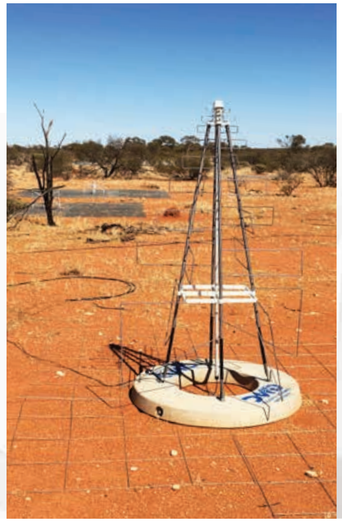
The MWA is currently made up of 128 tiles, each with 16 antennas, clustered within a three kilometre diameter. Each set of 16 antenna signals are collected and beamformed for each tile. Each tile output must then be correlated against all of the other tile outputs to allow for real-time imaging of the sky. Like most radio telescopes, the signal correlation occurs in a shielded control room near the antenna array. The resulting data and images are then transmitted on a dedicated optical fibre data link to Perth, where they are stored at the Pawsey High Performance Computing Centre for SKA Science.

However the MWA is in an extremely remote location, a hostile environment that is off the main electricity grid. The cost of power and continuity of supply makes operating a signal correlator on site less than optimal. It is also a long way to travel if something fails. The MWA (and future SKA), with millions of antennas and exabyte-scale data sets to correlate, needs a more workable solution.

Long distance data transfer and correlation

Within the Cisco Internet of Everything (IoE) Innovation Centre, Cisco, Nvidia and the Curtin Institute of Radio Astronomy are working together to demonstrate that SKA-scale data transport and remote software correlation is feasible. With the assistance of the CSIRO and AARNet, they are providing a 100 gigabit optical fibre data link from the MWA to Curtin University and are developing new software correlators to deal with the streamed data. As a validated proof-of-concept, they plan to take raw data from the MWA, transport it to Perth, run the signal correlation and compare the output with what is currently arriving at the Pawsey Centre.

Proving the viability of this architecture on a SKA-scale will reduce power costs and the need for radio-frequency shielded control rooms on site. Co-locating the signal correlator with the downstream science data processor and image processors in Perth will also achieve economies of computational scale.



Putting the pieces together

'Part of the reason for doing this project in the Cisco IoE Innovation Centre is because the Cisco networking expertise is here. They are bringing in the expertise and resources that fundamentally enable the project – they know how to move data around efficiently at scale. Similarly, the experts at Nvidia know how to get the most out of their processing hardware and are best positioned to build the most power-efficient software correlator. That then matches up with the radio astronomy signal correlation expertise coming from Curtin. Between the three of us – Cisco, Nvidia and Curtin – there is a critical mass of expertise to create the remote correlator and demonstrate SKA-scale operations.'

Randall Wayth, Curtin Institute of Radio Astronomy

'The high-speed 100 gigabit link will also be used to demonstrate the level of detail of the remote telemetry of the MWA, which is an order-of-magnitude greater than current remotely-managed telescopes. Providing high-speed connectivity from remote operations allows us to develop high speed visualisations in applications that support remote operations, such as oil and gas plants.'

Tom Goerke, CIIC

'The nice thing about software correlation is that it naturally takes advantage of improvements in hardware performance that are being driven across the field of computing. Faster switches, more network performance, better GPUs – because all of these things are relatively standard pieces of infrastructure, it will be easy for us to upgrade the correlator over time, steadily improving data volume and capability.'

Charles Smith, Cisco.

About the Cisco Internet of Everything Innovation Centre

Accelorating innovation in next generation technologies

The Cisco IoE Innovation Centre Perth is a new industry and research collaboration centre established at Curtin University by Cisco with foundation partners Curtin University and Woodside Energy. With links to advanced facilities and a global industry network, the centre brings together start-ups and small to medium enterprises, industry experts, developers and researchers in an open environment to create groundbreaking and innovative solutions that foster growth, provide jobs and help build sustainable economies.

The centre is creating a state-of-the-art connected community focused on leveraging cloud, analytics, cybersecurity and the Internet of Everything network platforms. It provides a productive and experimental environment for collaboration; a hub where innovative minds and diverse skill sets come together.