# Data Transport and Signal Processing at the GMRT

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**Abstract**

The Giant Metrewave Radio Telescope (GMRT) is a multi-element earth rotation aperture synthesis radio telescope designed and constructed by the National Centre for Radio Astrophysics of the Tata Institute of Fundamental Research (Swarup et al 1991). Located about 80 km from the city of Pune, it consists of 30 antennas, each of 45 metre diameter. Fourteen of the antennas are concentrated in a "central square" region of 1 km by 1 km and the remaining 16 antennas are distributed along the 3 arms of a roughly Y-shaped structure with a maximum arm length of 14 km. The GMRT operates at five different radio bands : 150 MHz, 235 MHz, 325 MHz, 610 MHz and 1420 MHz, with an instantaneous maximum bandwidth of 32 MHz. Originally conceived in the late eigthies, the GMRT was completed in 1999 and commissioned for international use in 2001.

Traditionally, antennas in such arrays are connected to the central receiver system via cables, waveguides or microwave links. The GMRT was one of the earliest radio telescope arrays to use optical fibres for linking the antennas to the central processing station. As a consequence, this aspect of signal transport in the GMRT has several concepts that were relatively new in radio astronomy. This talk will describe some of the techniques employed and discuss what we have learnt from these.

The other part of the GMRT receiver system where significant new signal processing techniques have been used are the digital back-ends. The GMRT supports two modes of operation : the aperture synthesis interferometry mode and the array mode; each mode requires specialised signal processing which is implemented using dedicated hardware and real-time software processing. For the interferometry mode, the GMRT has a fully pipelined 30 antenna FX-type correlator that produces the visibilities for the all the 465 baselines, with 256 spectral channels per baseline, and is equivalent to about 100 GFlops of sustained computing power. This talk will detail some of the special signal processing and data transport aspects of the GMRT correlator.

The array mode of the GMRT is used for the study of compact celestial sources, especially those which are expected to show significant temporal fluctuations of their flux on time scales of a second or faster (e.g. pulsars). Here, the digital hardware allows one to add the signals from any selected set of antennas to give a single output as from one large antenna. The design allows for both an incoherent array mode where the addition is done at the power level as well as a coherent (or phased) array mode where the voltage signals from each antenna are added together. These outputs from the array combiner are fed to specialized, DSP based pulsar receivers for further processing. A description of the pulsar signal processing used at the GMRT will be provided.

Recently, new facilities for real-time processing of the signals acquired by the data acquisition systems have been added to the digital back-end systems of the GMRT. This talk will touch upon some of these features. Finally, some views on future directions of growth for the GMRT, in the above areas, will be projected.

**References:**

Swarup, G., Ananthakrishnan, S. & Kapahi, V. K., et al. 1991, Current Science, 60, 95