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New monitor and control system for the upgraded GMRT

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Abstract. We present the details of the new Monitor and Control (M&C) system that is being developed for the upgraded GMRT. The new system is based on modern micro-controllers that are connected via ethernet links to the central control computer that will run high level software based on modern architectural principles.

Keywords : GMRT – Monitor and Control System – Software Architecture

1. Introduction

The GMRT (Swarup et al. 1991), which has been in operation for over a decade now, is being upgraded (Gupta, this volume) to allow wide-band frequency observations covering the frequency range from about 50 to 1500 MHz, along with other improvements such as a modern servo system for the antennas and feeds. Development of a next generation Monitor and Control (M&C) system is also an integral part of the upgrade. This is motivated by the considerations that the existing M&C system hardware and software, is now becoming obsolete and needs to be upgraded to match the new requirements. The M&C system plays a vital supervisory role in coordinating the various subsystems of the observatory, which are spread out in geographically distant locations. It ensures smooth conduct of astronomical observations by synchronising the operations of the receiver chain electronics, data acqusition backends and electromechanical systems like servo, feed positioning system etc. The new M&C system will have modern hardware and software architectural features, as compared to the existing M&C system. High end server class machines in the Central Electronics Building (CEB) will be used to run the central supervisory M&C system, which will communicate to all thirty antennas spread over a radial distance of up to 15 km using a dedicated ethernet over the optical fiber link at 1 Gbps.

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2. Design of the upgraded M&C system

2.1 Hardware components of the new M&C system

The new Monitor and Control Modules (MCM) developed based on the Rabbit RCM 4300 micro-controller are used to configure the RF signal receiver chain systems like front-end, signal conditioning and analog backend. The Rabbit processor supports 1 GB miniSD memory card, 10/100T base ethernet port for communication, along with configurable 32 bit TTL control and 64 analog channel input for monitoring. Dynamic C Integrated development environment support provided on the Rabbit processor is used to develop and run the embedded control software. This software handles low level M&C functionalities like implementation of control logic, interpretation of monitoring data, and safety of the instrument. Similarly, the servo system and feed positioning system of the antenna are planned to be controlled by PC104 embedded computer with lightweight Puppy Linux OS (Bagde, this volume). For the entire observatory, a total of 180 such sub-systems are to be controlled by the new hardware.

2.2 Software : Online Version 2 (Online_V2)

A new M&C system software called ONLINE Version 2.0 (Online-V2), developed in-house by the operations group members, is presently in testing phase. Online-V2 follows a client-server software architecture and the design is based on the TCP/IP communication protocol. A multi-threaded M&C application server program developed in C runs under the Linux operating system. The number of clients running on various sub-systems at the antenna base like front-end, servo and feed positioning system connects to the M&C application server via multiple communication channels using the TCP/IP protocol. The clients for each sub-system self-discover the connection automatically and send their ID to the server. The M&C application server is capable of handling the communication channels for all thirty antennas in real-time with a turn-around time of 1 to 3 sec. The M&C application software is integrated with a Qt and QML (Qt Meta Language) based Graphical User Interface which provides the user interface to astronomer, telescope-operator and engineers in the CEB. The M&C system provides multiple types of interfaces like command-line for debugging, Qt based thick clients and browser interface to view the data over internet. The M&C system logs all event and monitoring data using MySQL database, and alerts the user on occurrence of alarms. See Fig. 1 for a Online_V2 software Block Diagram.

Online-V2 has been tested with sub-systems of two antennas in the lab environment. Also, long-term stability tests done successfully for a period of three months, using the single antenna and sentinel system to monitor the temperature data. The new M&C system has improved performance with minimal time for configuring the telescope, alongwith a facility to restore the default values after power failure that will help minimise down time during operations. Unlike the inherent complexity of

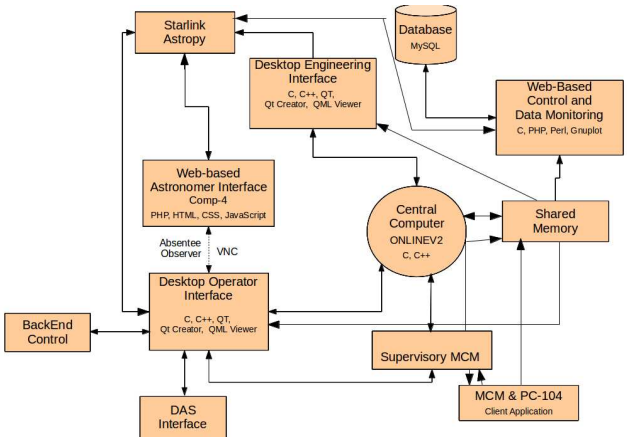

Figure 1. Block Diagram of the Online_V2 GMRT M&C System

the old M&C system due to dependencies on hardware systems like the Communication Handler and Antenna Communication PC, the new M&C system will be easier to maintain as dependency on such hardwares is reduced. Apart from this, the new M&C system plans to have VOIP phone for voice communication and video camera facility for security purposes. Additional safety measures are taken by implementing the sentinel system (comprising smoke and temperature detectors) which can switch off the antenna electrical power before the critical alarming condition raised.

2.3 The Next Generation M&C System

As part of the up gradation process, NCRA has carried out a feasibility study for a next generation GMRT M&C system, in collaboration with the System Research Laboratory, TRDDC-TCS, India (Kodilkar et al, 2013). A prototype M&C system based on a generic specifications-driven architecture called Sensor Actuator and Control Element (SACE), has been developed and tested successfully to control a sub-array of three GMRT antennas. Subsequently, User Requirements Specification (URS) and Software Requirement Specification (SRS) documents for a full fledged system for the GMRT have been completed in collaboration with TCS, India. These describe the functions of the system, operational & user-interface constraints and performance requirements of the final system, and will govern the design and development of the M&C system software. Since the GMRT is a specialised domain facility with complex astronomical observing capabilities and telescope functionality, the URS document was developed in close consultation with NCRA astronomers and engineers. Fig. 2 shows a high level block digram of the Next Generation GMRT M&C System that is planned to be developed.

A comparative study of various M&C systems used in other observatories and

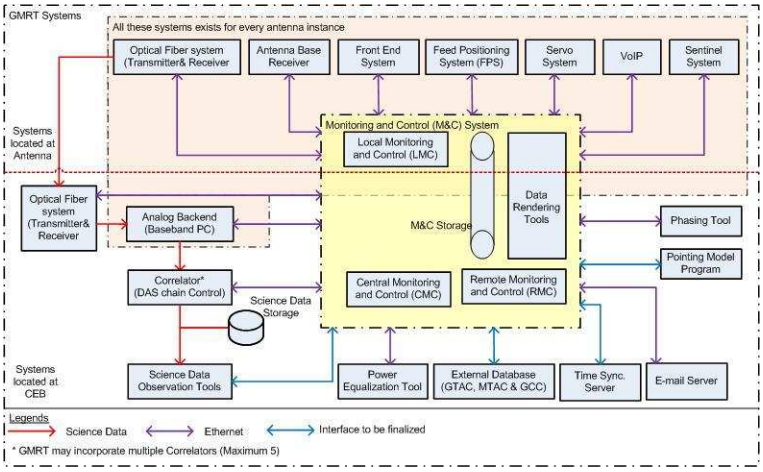

Figure 2. High level Block Diagram of the Next Generation GMRT M&C System

open source software frameworks like EPICS (Experimental Physics and Industrial Control System) has also been undertaken in collaboration with TCS. These activities have close synergy with participation of NCRA in the design of the Telescope Manager for the Square Kilometre Array (SKA).

3. Future Development

NCRA plans to develop an end-to-end M&C system software package which can execute the scheduled observing sessions and support collecting of the final astronomical data along with the meta-information and observation logs to improve the science data quality for the upgraded GMRT. The long-term aim is to develop a modern M&C system that is applicable to larger telescopes like the SKA.

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