GMRT Operations

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Outline of the talk

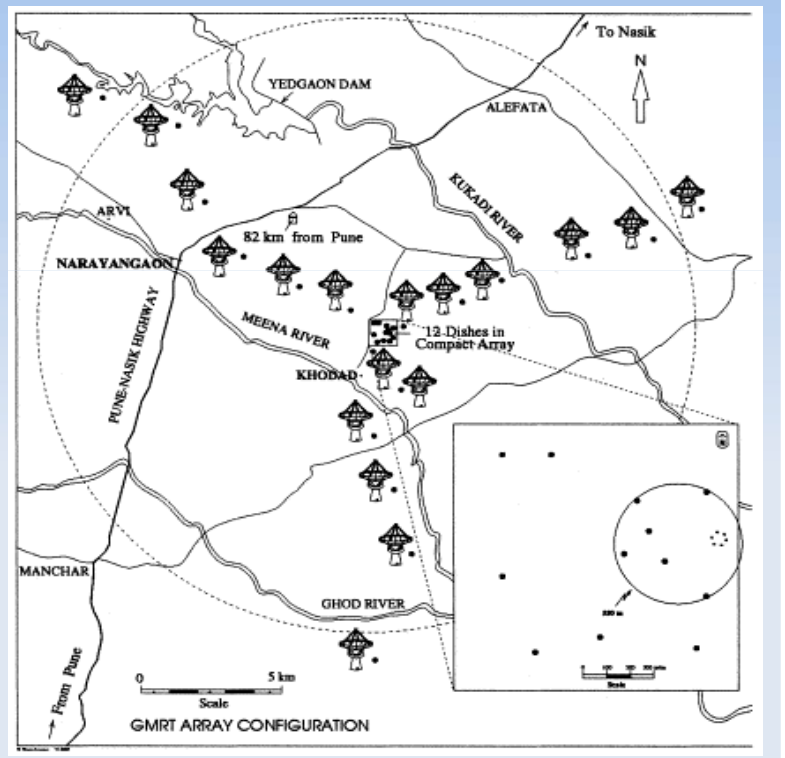
- Introduction to GMRT Monitor and Control (M&C) System
- M&C System : Hardware Up-gradation
- M&C System : Software Up-gradation
- GMRT Online Version 2.0
- Next Generation M&C System : Industrial Collaboration
- GMRT Sentinel System
- Summary

GMRT Monitor & Control System

GMRT M&C Features :

- Central Supervisory system
- provide User Interface
- Sub-arrays : for Concurrent science/maintenance activity
- Execute scheduled observing session in batch mode.
- Safety measures
- Sufficient interlocks are implemented in the servo system
- Alarms/Alert
- Archive and retrieve the logged information.

Existing M&C system is successfully operational since last ~ 15 yrs (Prof. A.P. Rao/R.Balasubramanain)



Motivation and Objectives

- **GMRT Up-gradation :**

  Wide-Band Feeds (150 to 1500 MHz), Broad-band Fiber Link, Servo Systems, GMRT Analog Base-Band (GAB) and GMRT Wide-Band Back-end (Correlator) Systems.
  All Sub-system provides 100 Mbps Ethernet Interface

- **OBJECTIVES :**

(i) Develop end to end Radio Telescope Software.

(ii) Support for Remote Observing

(iii) Develop a generic Specification driven Frame-work for M&C System

M&C System Hardware Up-gradation

M&C	Link	Ant. Base Computer	Control Cards	Device Interface	OS and Software	User Interface
New/Up-gradation (2012-)	Ethernet 1 Gbps	High end EMI/EMC protection PC	MCM: Rabbbit RCM 4300 Labjack UE9 SERVO: PC104	Ethernet TCP/IP 100 Mbps	Linux/Unix Java tech. , EPICS, CSS based. Dynamic C, Propriotry s/w	GUI, web-browser, terminal, batch mode.

- **Salient M&C System Hardware Features :**

- **High end Server Class machines in CEB**

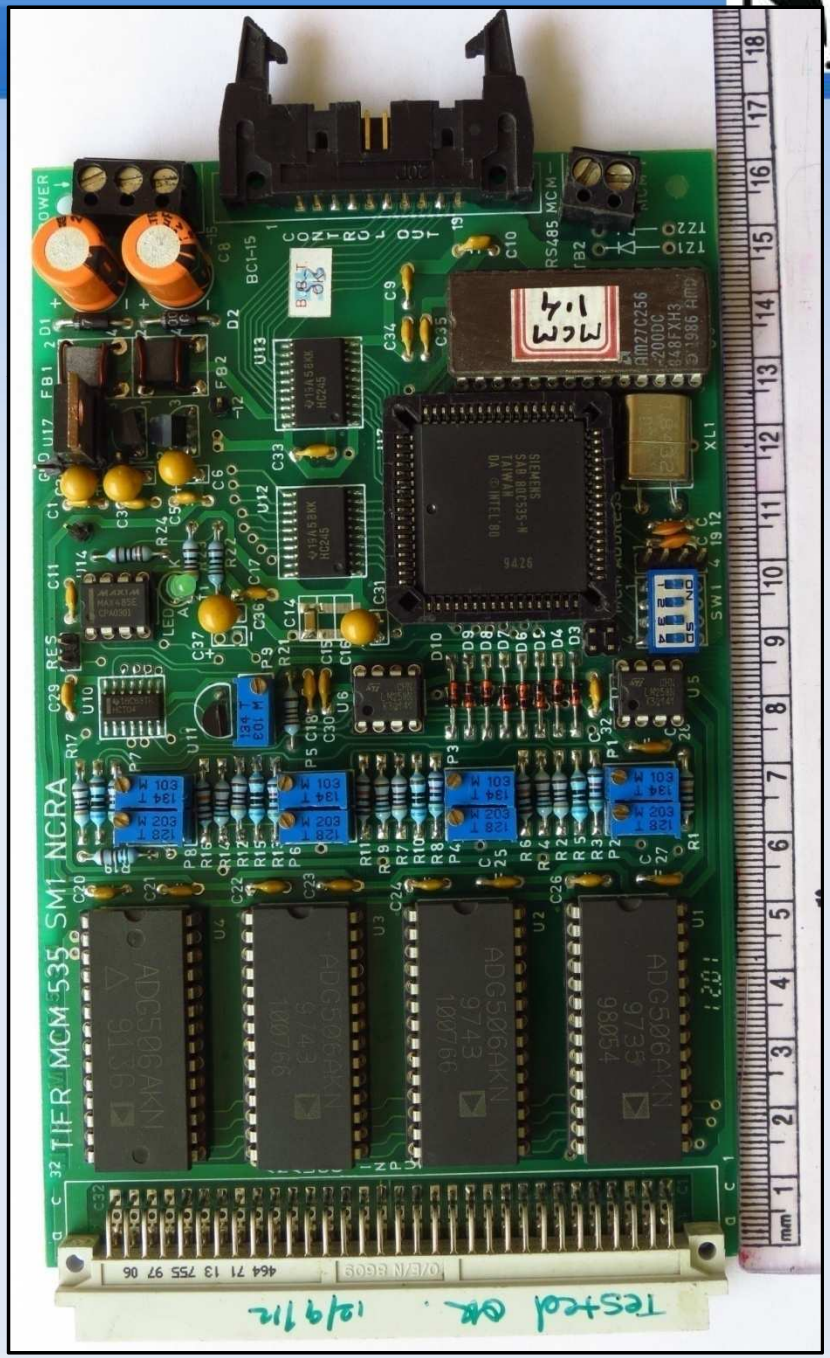
- **Dedicated Ethernet/Optical Fibre Link (1 Gbps) to all thirty antennas spread over Radial distance of ~ 15 km**

- **Modern Monitor & Control Modules based on Rabbit RCM 4300 processor and PC 104 embedded computer at each antenna.**

- **100 Mbps Base Ethernet Port**

Total ~180 Sub-system to be control and supervise.

Monitor & Control Module (MCM)



New MCM

Old MCM

New MCM Vs Old MCM

Feature	New MCM	Old MCM
Processor	RCM 4000	8051 based 80535
Operating Frequency	60 MHz	1.8 MHz
Memory	SRAM : 1Mb (512Kb + 512Kb) Flash : 1Mb Micro SD : up to 1Gb	RAM : 256 bytes ROM : 64 Kb
ADC	11 Bits, 8 Channels	8 Bits, 8 Channels
Real Time Clock	Yes	No
Battery Back Up	Yes – 3.3V	No
Monitoring Channels	64	64
Control Bits	32	16
Communication Channels	Serial (RS485) @ 9.8Kbps Ethernet @ 10/100Mbps, 2 SPI ports	Serial (RS485) @ 9.8Kbps
Programming Method	Serial Programming	EPROM burning
Programming Language	Dynamic C	Assembly
Command Structure	ASCII Structure Based	Protocol Based
MCM Address setting	Hardware + Software IP Based	Hardware
Access from Online	Direct or via ABC	Via ABC Only
Configurable for RFI parameters	Yes – Using Spectrum Spreader and Frequency divider	No

Performance Improvement

- New MCM is 30 times faster than the existing one.
- Higher program and data memory and 1GB storage
- Higher ADC resolution
- Double control bits
- Ethernet, RS485 and SPI connectivity
- High level programming language and method
- 20dB less EMI
- Additional features like : Real Time Clock, Battery Backup
- ASCII structure based Command structure
- Failure rate will be minimum

M&C System Software Up-gradation

- M&C Software Development :
  Two parallel development activities are in progress

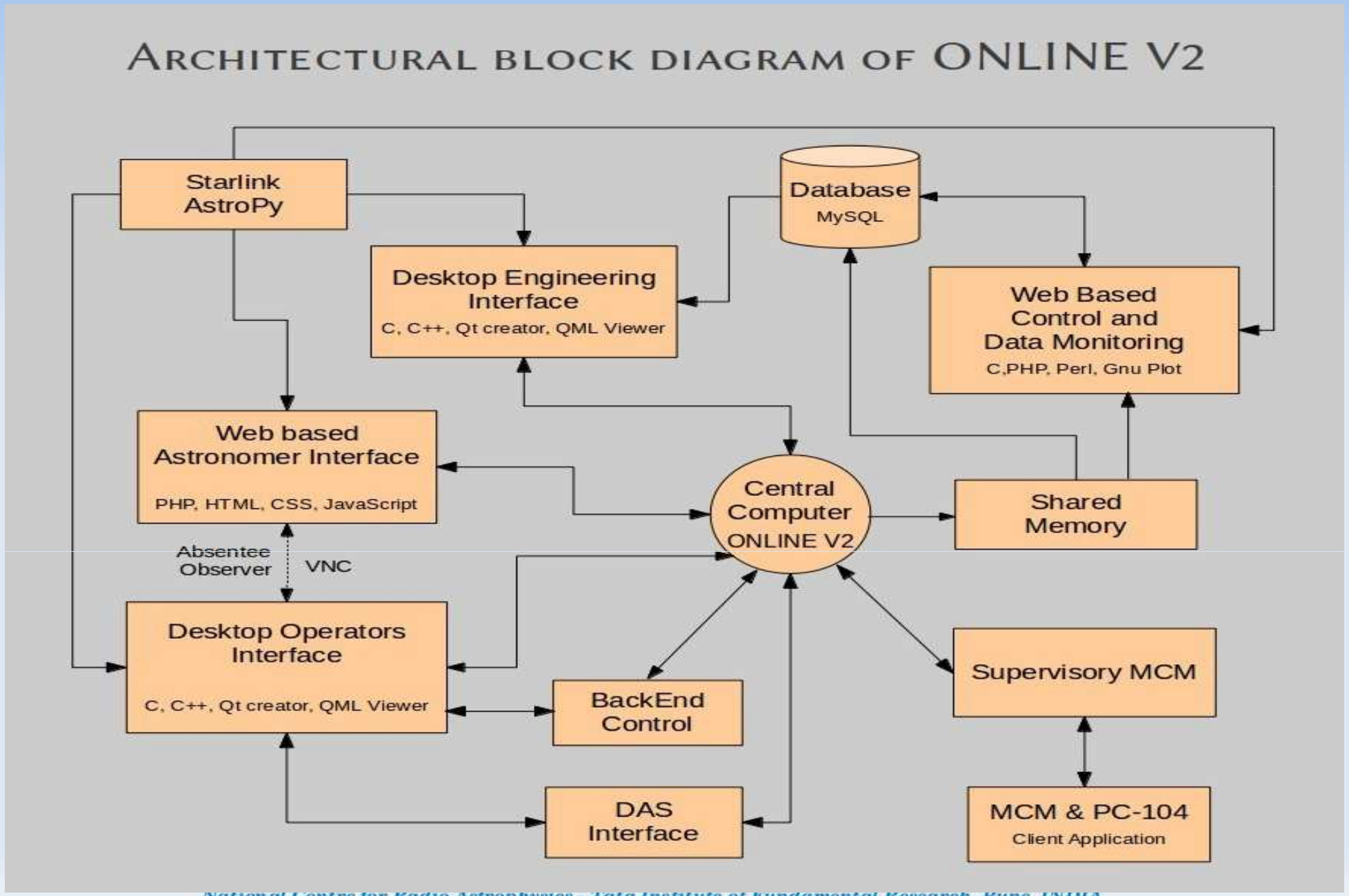
- **In House M&C System Development : ONLINE_V2**

  Aim to support Up-gradation testing activities and smooth change over from existing M&C (ONLINE) System to New M&C System (ONLINE_V2)

- **Modern M&C System Collaboration with Industry Partner (TCS, Pune)**

  Developing **Next Generation M&C System** for the Radio Telescope, test specification driven frame-work approach for SKA1 like telescope.

ARCHITECTURAL BLOCK DIAGRAM OF ONLINE V2



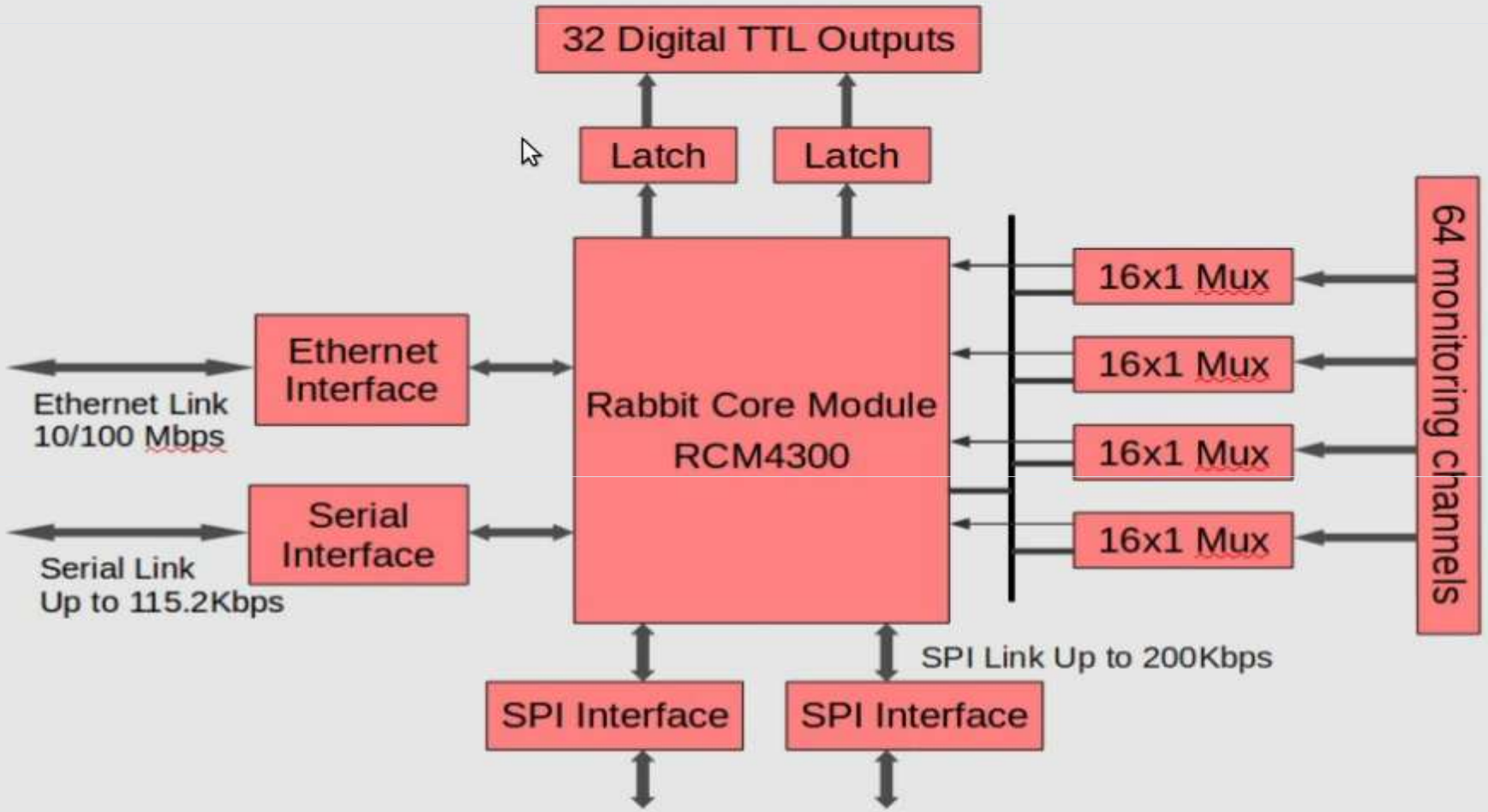
Features of Online V2

- The Online_v2 will directly communicate with Antenna based sub-systems using TCP/IP based socket communication, eliminating the need of ABCCOM (Antenna base computer).
- Online_v2 communicates with Antenna sub-system using structure based protocol with most of the intelligence shifted to the lower level MCM program.
- Online_v2 has been successfully tested with two antenna four sub-systems each in Telemetry lab
- Online_V2 is successfully monitoring Antenna C03 shell temperature for last three months.
- Online_v2 Provides QML Web-based GUI for Control & Monitoring.

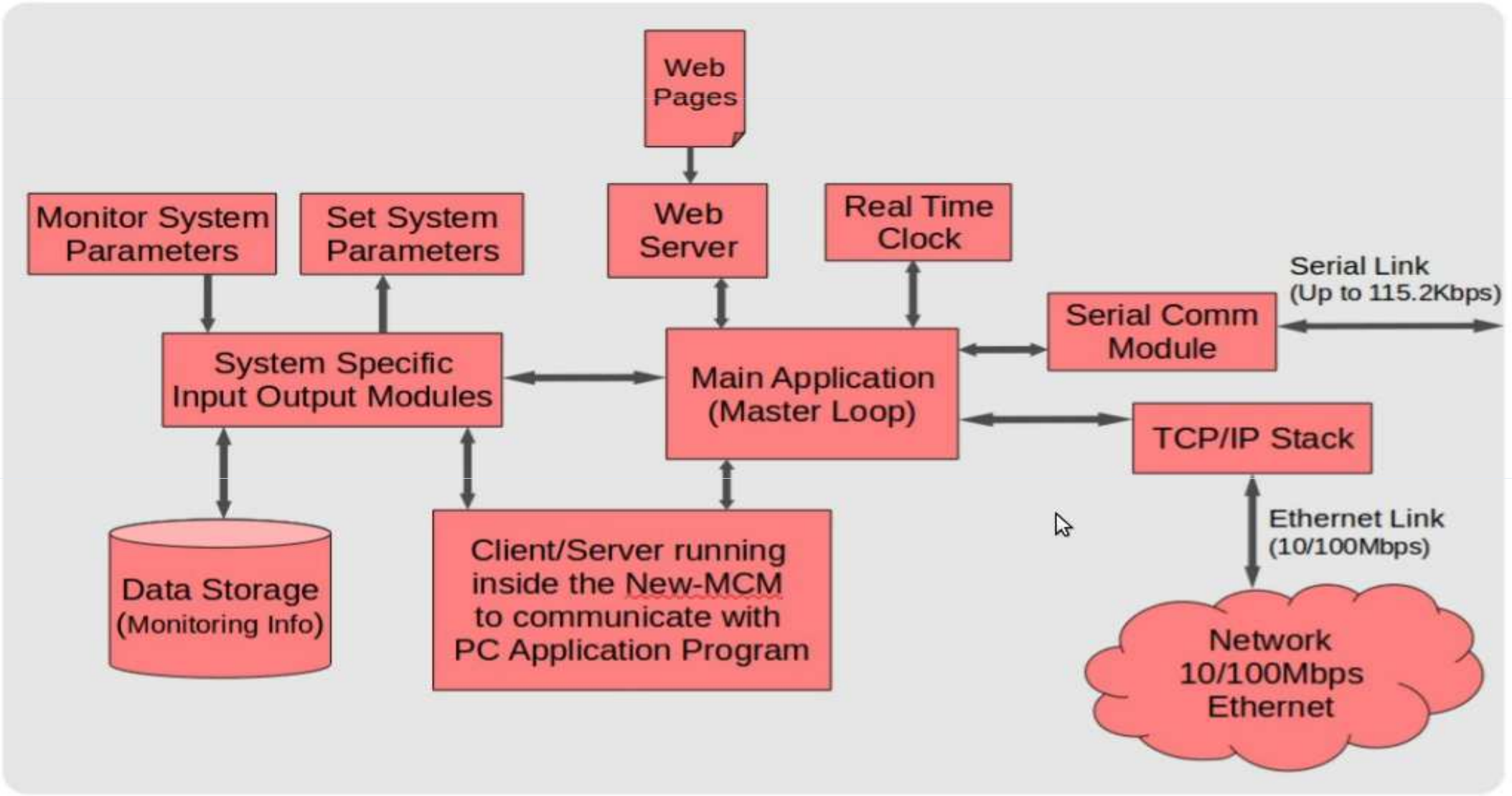
Milestones of Online_V2

- Online_v2 has been successfully tested with 8 Rabbit MCM antenna setup in Lab along with 1 L3 Network switch.
- Online_v2 has been successfully tested in C06 antenna during April-2014 maintenance period for two sub-system Sentinel & optical fiber.
- Online_v2 has been successfully tested in C01,C04 & C06 antenna during October-2014 maintenance period for two sub-system Sentinel & optical fiber.
- Online_V2 is successfully monitoring Antenna C03 shell temperature for last three months.
- GWB correlator has been successfully interfaced with Online_v2. It has been thoroughly tested during April-2014 maintenance period.
- Servo system with PC104 card has been successfully interfaced & tested with Online_v2 with actual hardware setup in SSL Lab.
- Online_v2 has been successfully interfaced with QML Web-based GUI for Control & Monitoring, Readline library based terminal as well as Python environment.
- Online_v2 has been successfully tested with FPS system & Servo system in C06 & C02 antenna respectively.
- Online_v2 has been successfully tested with 15 antennae two sub-system configuration during April 2015 MTAC.

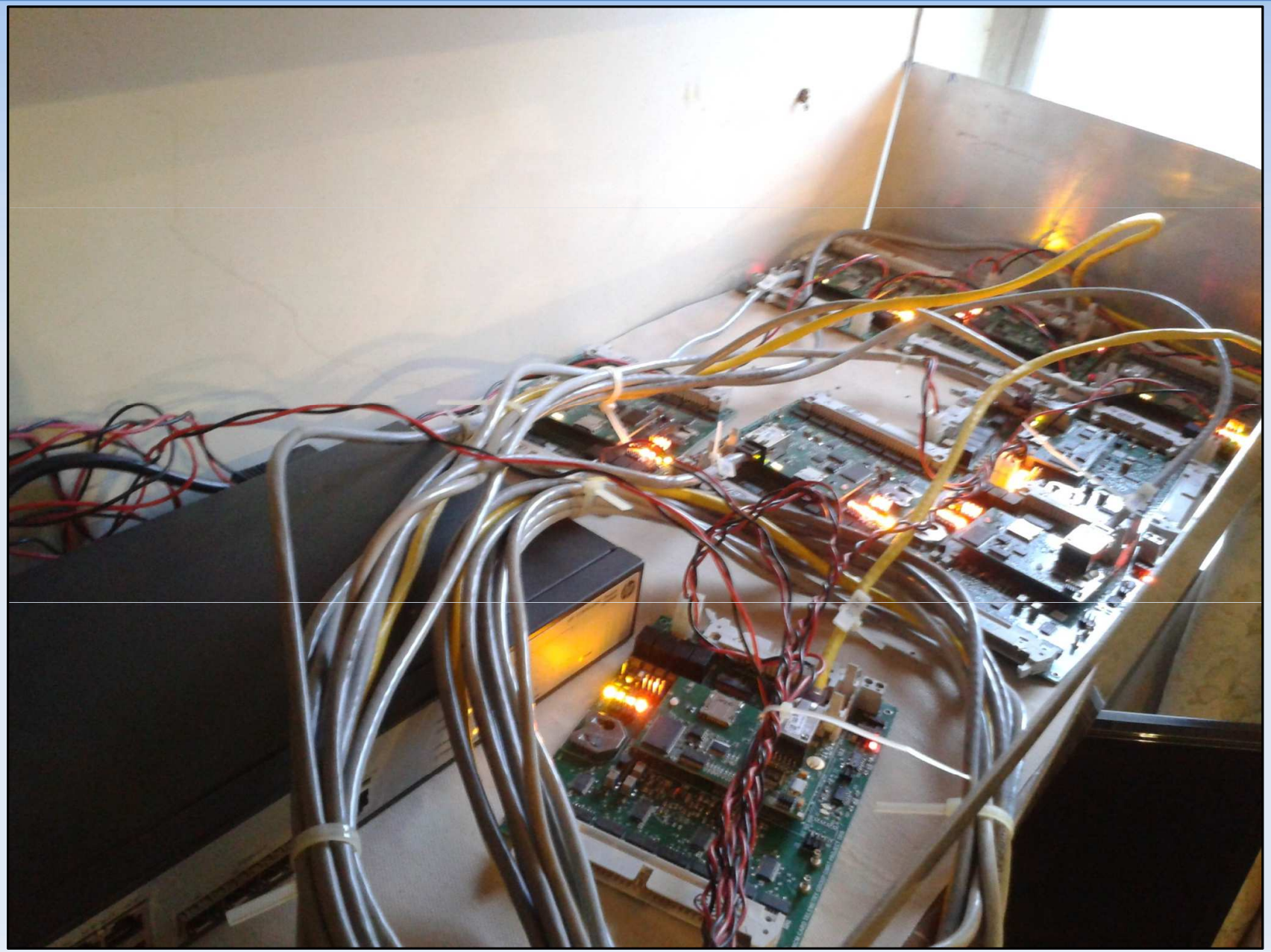
New MCM Hardware Architecture



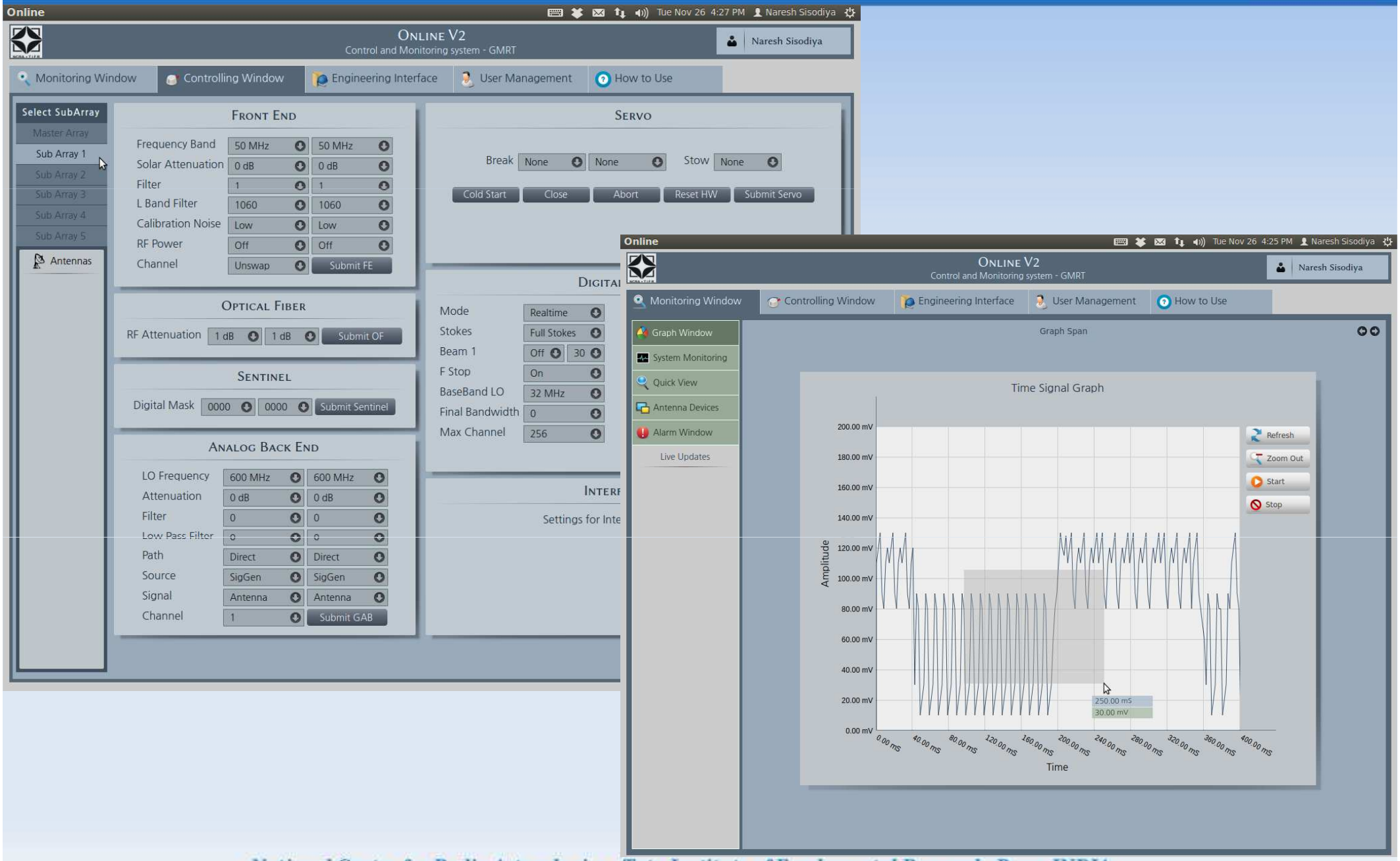
New MCM Software Architecture



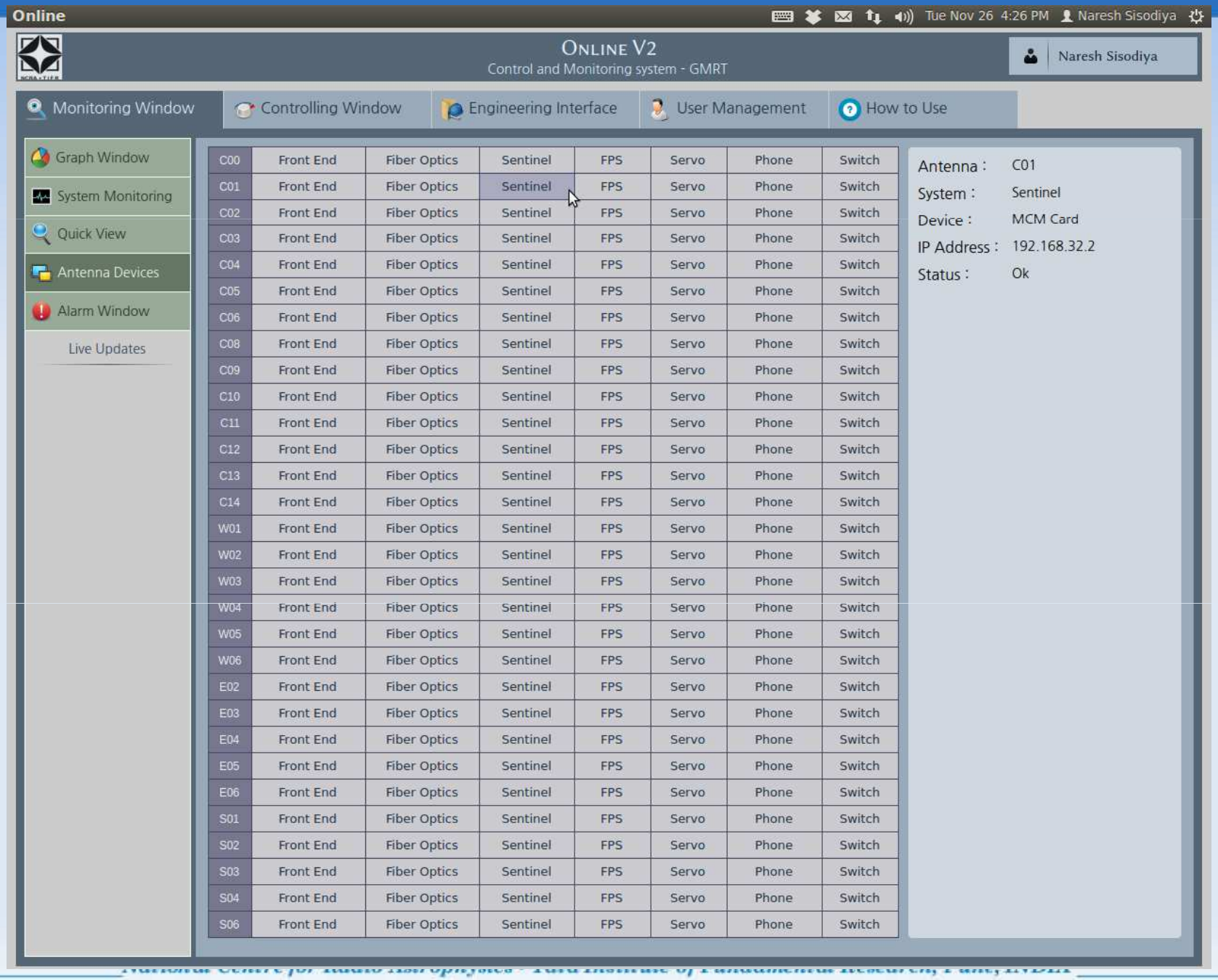
Lab Test Set Up



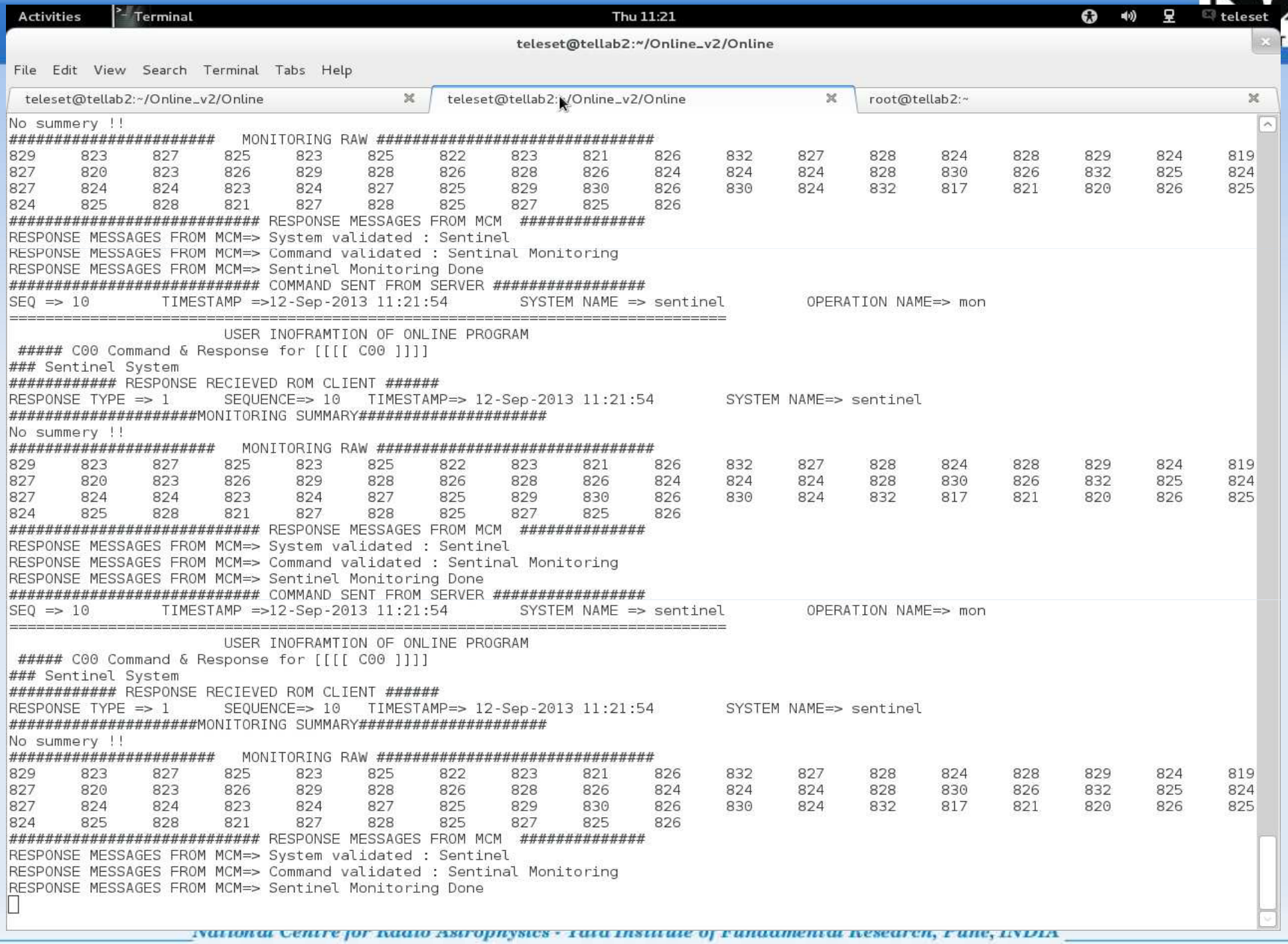
QML Based M&C GUI (Online_V2)



QML Based M&C GUI (Online_V2)



Shared Memory Display of Online V2 (Lab Set Up)



GMRT Upgrade : M&C Challenges

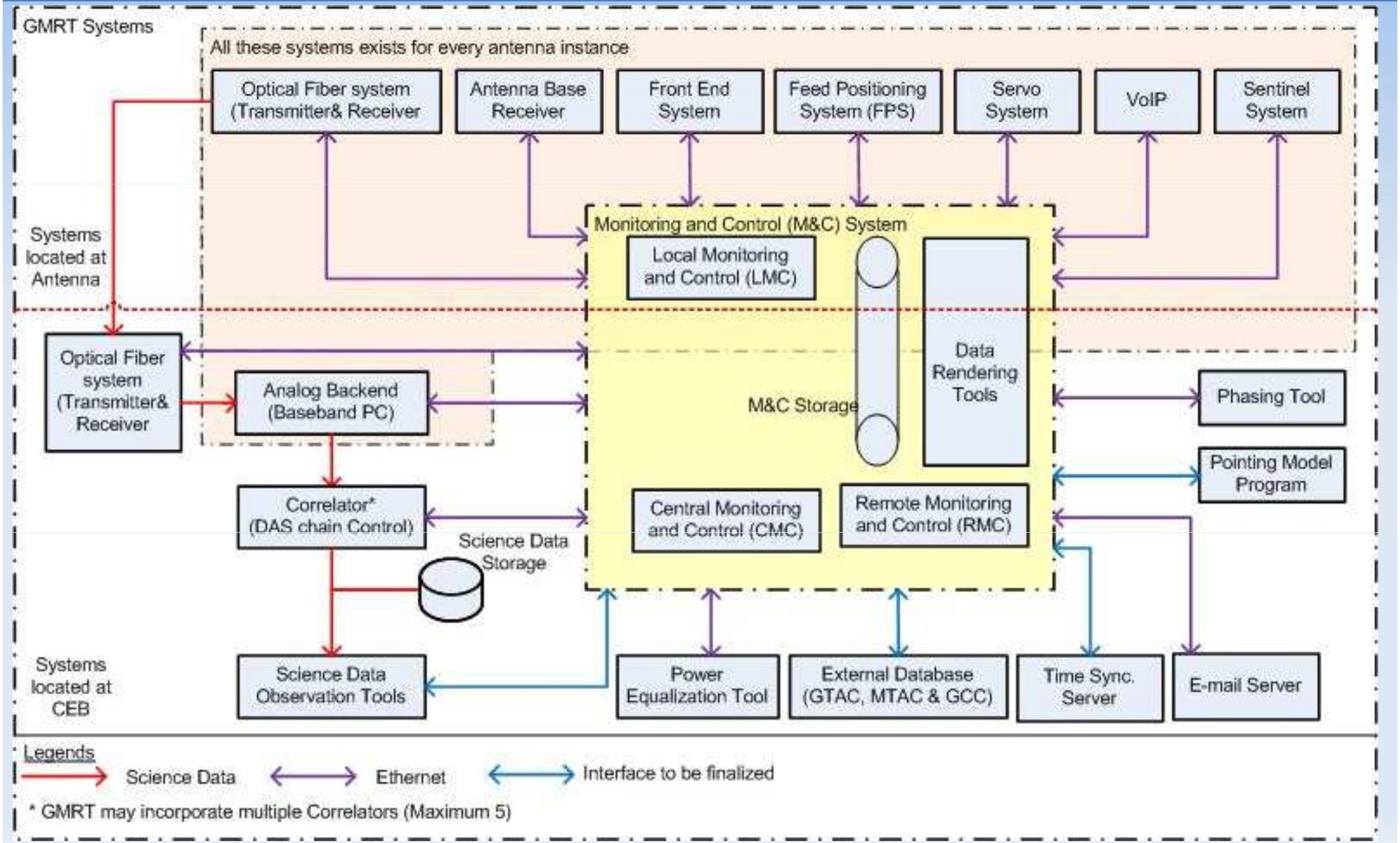
- **Aims to develope a Generic Specification Driven M&C frame-work to support evolution or upgrade phase over next decade (Instead of developing device specific bespoke solution)**

- **End-to-end Radio Telescope M&C software which processes and execute scheduled Observing proposal in auto mode and supports science data analysis by providing meta-data (Observation log, bad-data flagging, M&C system and metrology data Logs etc)**

- **Modern M&C System, industry collaboration (TCS, Pune) to leveraging the technlogy trends to upgrade the M&C Hardware and Software.**

- **Showcasing the capabilitites of NCRA for handling the Telescope Manager (TM) Package for SKA1**

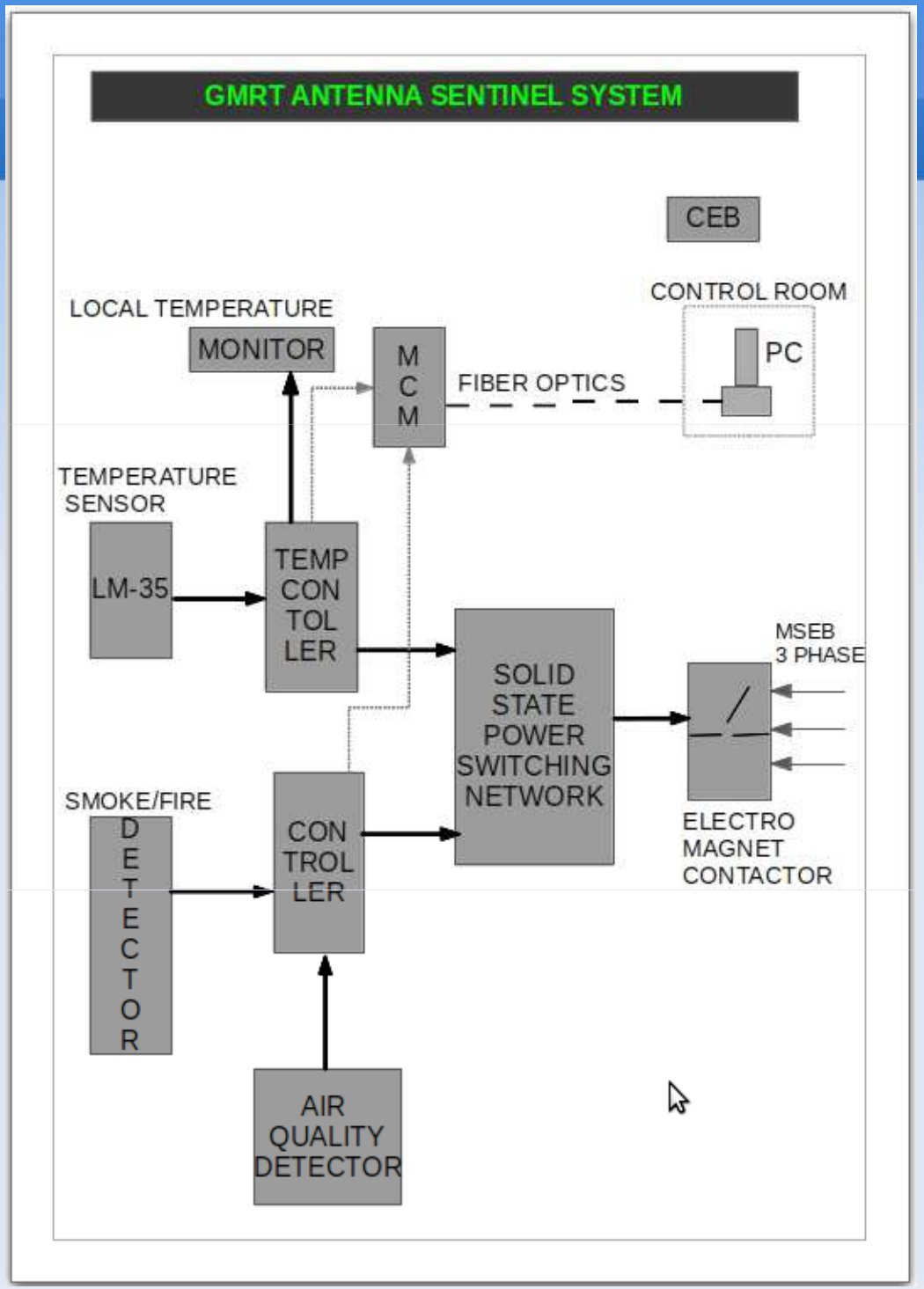
GMRT M&C System Upgradation Block Diagram



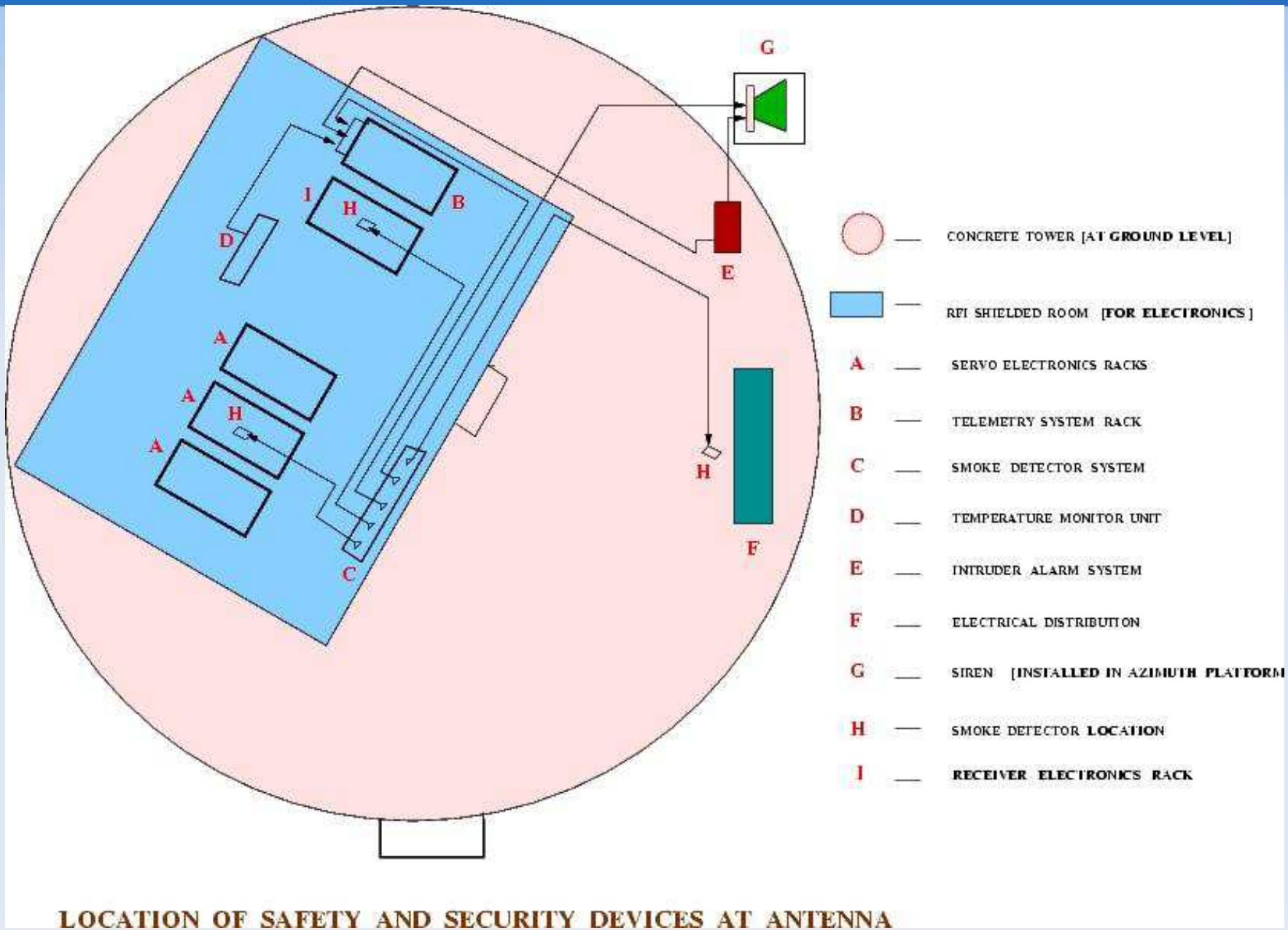
GMRT SENTINEL SYSTEM

Salient features of this sentinel systems:

- Low cost design approach – components are available readily in the open market in Pune/Mumbai
- It is very compact due to simplified design approach.
- It is completely RFI free system.
- Self intelligent and fully automatic
- Fully independent and unaffected due to failure of external communications (OFC/Telemetry).
- Automatic Power shutdown in case of over-temperature, smoke and fire.
- Automatic Power Switch-ON in the normal conditions.
- Communicating with the existing online and online-V2 of the Telemetry system of the GMRT.
- Local as well as remote monitoring facility
- Air quality monitoring system
- Very reliable and working satisfactorily more than a decade.

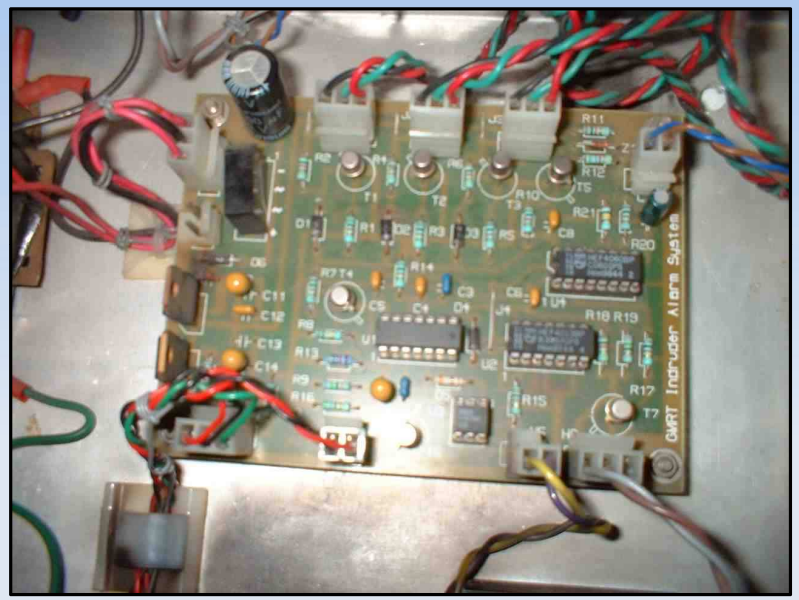

GMRT ANTENNA SENTINEL SYSTEM
CEB
CONTROL ROOM
LOCAL TEMPERATURE
MONITOR
M
C
M
FIBER OPTICS
PC
TEMPERATURE
SENSOR
LM-35
TEMP
CON
TOL
LER
SOLID
STATE
POWER
SWITCHING
NETWORK
MSEB
3 PHASE
SMOKE/FIRE
D
E
T
E
C
T
O
R
CON
TROL
LER
ELECTRO
MAGNET
CONTACTOR
AIR
QUALITY
DETECTOR

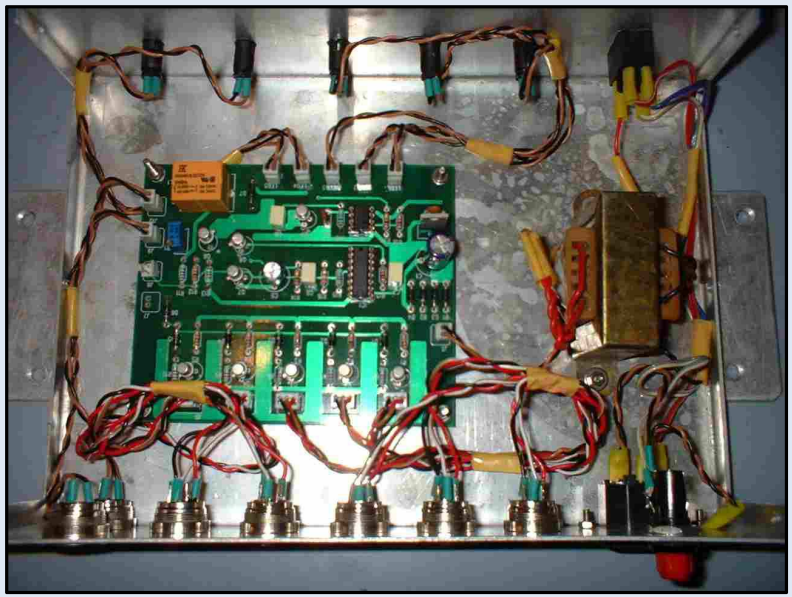
LOCATION OF SAFETY AND SECURITY DEVICES AT ANTENNA



LOCATION OF SAFETY AND SECURITY DEVICES AT ANTENNA

ELECTRONIC SAFETY DEVICES INSIDE THE ANTENNAS

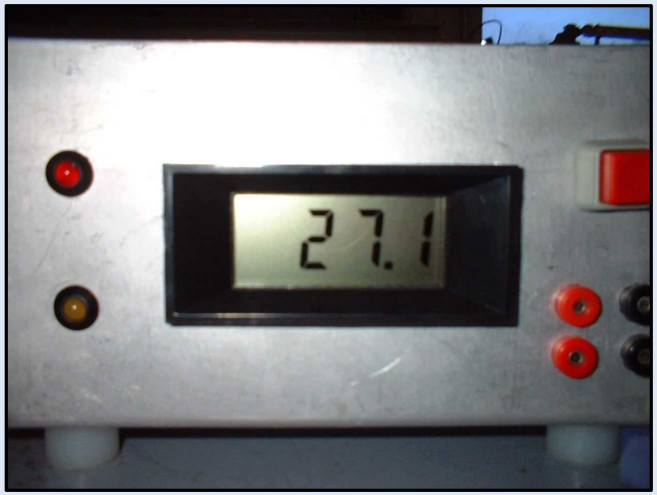




Installation and commissioning of Electronics Safety System in the 15 metre antenna at NCRA, Pune.

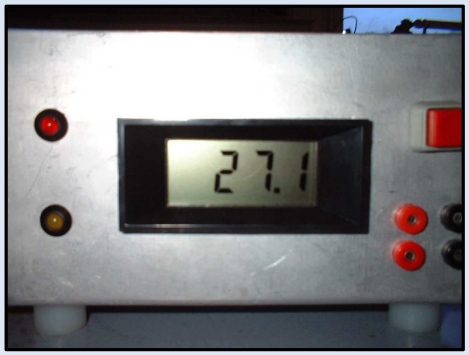
This challenging new project is headed by Prof J. N. Chengalur. This important instrument is dedicated for frontline research on Radio Astronomy as well as an educational tool for enthuses young scientists and engineers leading to study on Radio Astronomy and Astrophysics.

Like GMRT, here also there are electrical and Electronics sub systems i.e. servo, receiver, telemetry and fibre optics. All these sub systems do not have their own safety system. Hence it is a prime responsible for me to provide total safety to all these sub systems from the critical parameters like over temperature, smoke, fire etc. for smooth and successful running of the antenna. Therefore, I have successfully installed Electronics Safety System for the 15 metre antenna at NCRA, Pune

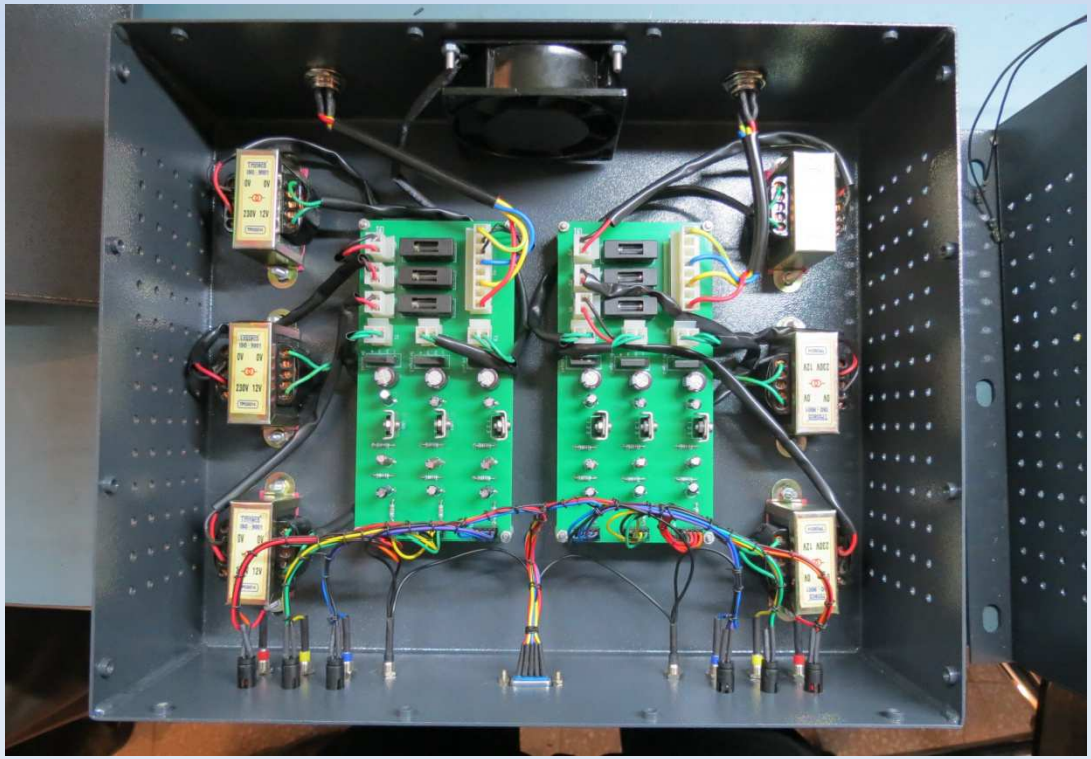


Installation and commissioning of Electronics Safety System in the Utility Building at Narayangaon Housing Colony.

Utility Building at GMRT Housing Colony at Narayangaon is well equipped with high speed date/internet link and hub between NCRA and GMRT with optical fibre connectivity. Over temperature, smoke and fire is very critical inside the room. Therefore, I have successfully installed and commissioned Electronics Safety System in the Utility Building.



Three Phase Status Monitoring for the D-G Set/MSEB of the remote GMRT antennas.

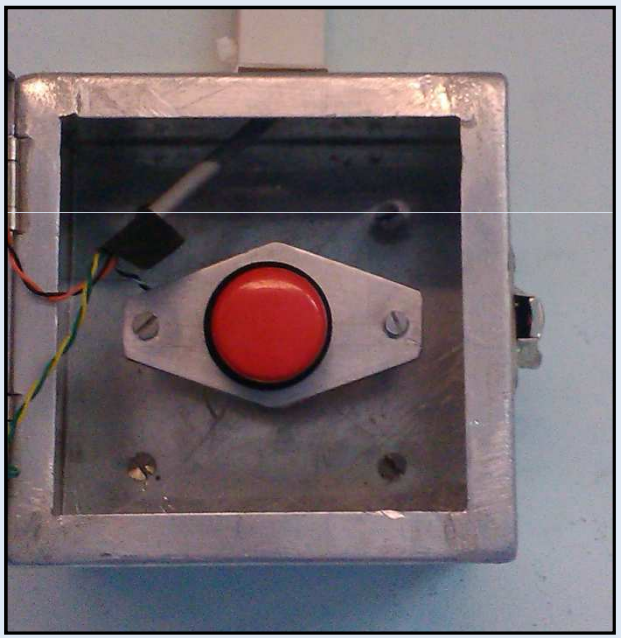


Installation of Panic Alarm System in the Control Room at the CEB.

Control Room is heart of the GMRT Observatory. It is fully functioning throughout the years, day and night.

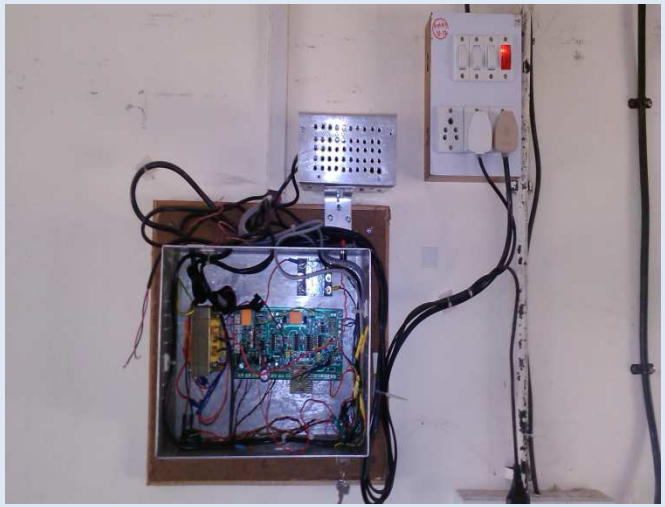
A *Panic alarm system* is provided in the control room for operators working in the night shift in the control room to provide instantaneous/emergency help when any uncomfortable situations arising in the night especially for women.

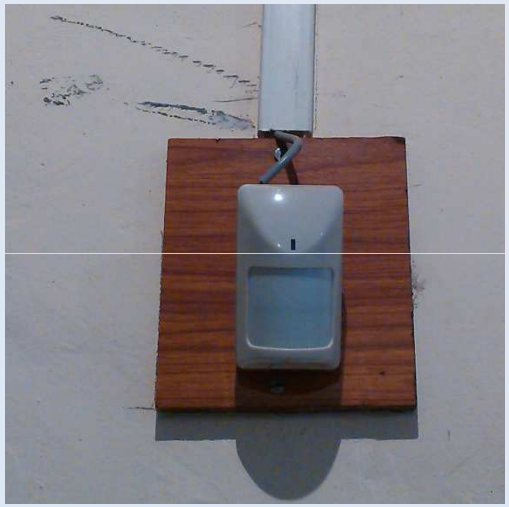
Therefore, we have provided this additional safety measure called " Panic Alarm System" in the Control Room at GMRT. Its design approach is very simple, low cost, reliable and RFI free system and it is working satisfactory.



Installation and commissioning of Electronics Safety System in the SSL shed.

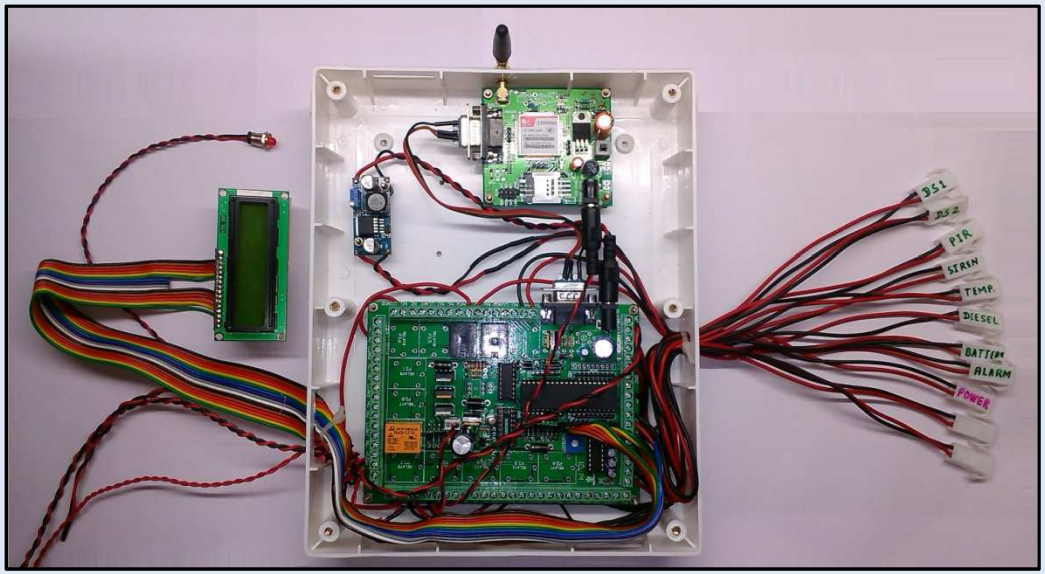
Servo Group has initiated the Lab activities in the SSL shed especially for Brushless motor and drives. Servo system is storing very valuable and high value items for retrofitting 30 antenna brushed motor drives with brushless motors and controllers in the SSL shed. Since this shed is located away from the main building it is necessary to provide safety and security of the place from pilferage. So we have developed and installed temperature monitor, smoke , intruder, fire and camera.





Installation and commissioning of Electronics Safety System in the High Lift Platform (HLP)

In the GMRT Observatory, High Lift Platform (HLP) are very important tools for the GMRT antenna woks for smooth functioning of the telescope. HLP consists of a heavy vehicle and it has inbuilt fuel tank, high capacity batteries and other valuable items also. Hence we have provided electronics security and safety system in the HLP to avoid thefts and any damage to it. This system is working successfully and it will activate only if there is a measure breakdown of HLP in a very remote location.



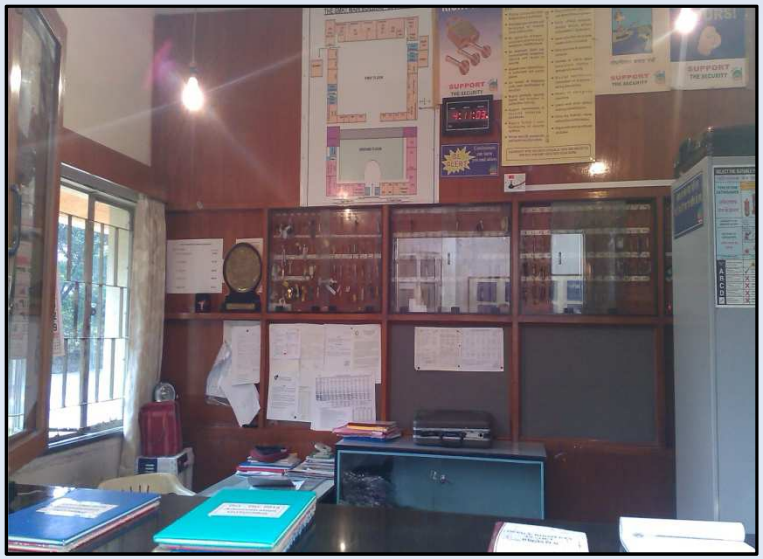
Installation and commissioning of Smoke and Fire Alarm System in the Telemetry Lab.

Up-gradation activities of Telemetry System are in progress in the Lab. Various tests are in progress and system is running for 24 Hr. (day & night) including communication with other system and sub-systems in the other Lab as well as antenna shells. Over temperature, smoke and fire are very critical inside the Lab. Therefore, I have successfully installed and commissioned Electronics Safety System in the Telemetry Lab.

Very soon we are extending this Electronics Safety System to the other Labs.

Installation and commissioning of Video Surveillance System at the GMRT CEB.

We have successfully installed this system at the GMRT CEB . It is IP based video surveillance system. Therefore, it is possible to monitor and record the video information even remotely (anytime and anywhere).



Installation and commissioning of Video Surveillance System at 15 metre antenna at NCRA.

We have successfully installed this system at 15 metre antenna at NCRA. It is an IP based video surveillance system. Therefore, it is possible to monitor and record the video information even remotely (anytime and anywhere).

Thank you...