

Upgradation and Modernization of The Tango based GMRT Control (TGC) System



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Operation Group, GMRT-NCRA members, India

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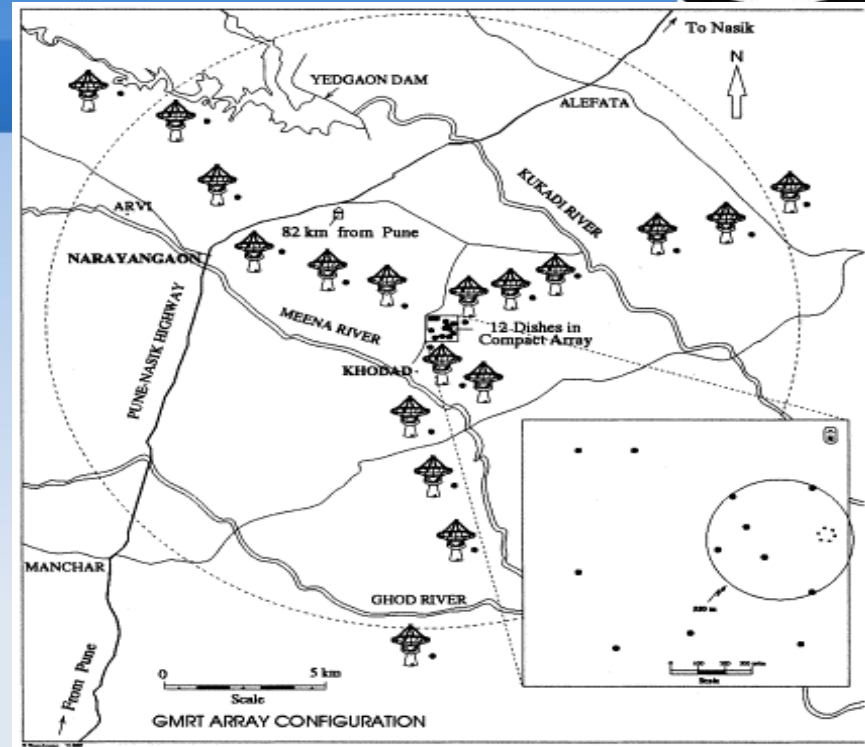
uGMRT (Giant Metrewave Radio Telescope)



- Located at Khodad (Lat 19.1° N , Long 74.05° E) Pune, India.
- Total 30 Parabolic Dishes each of 45 diameter.
- 14 Antennas in Central Sq. area of ~ 1 x 1 km
Remaining spread over ~30 km diameter
Shortest baseline ~ 100 meter.
- Observing Frequency bands are 150 to 1500 MHz with instantaneous bandwidth of 100-400 MHz.
- Support Interferometry and Beam forming modes.
- Accorded the status of SKA pathfinder.

Observations are scheduled twice in a year each of ~5.5 month duration.

More than factor of 2 oversubscribed, ~50% users are from outside India.



- Introduction : **T**ango Based **G**MRT Control (**TGC**) System
- Upgradation & Modernization Goals
- Feasibility Study
- Methodology
- Functional & Validation Testing
- Tango Client-Server : Aggregation Node Problem resolving
- Conclusion

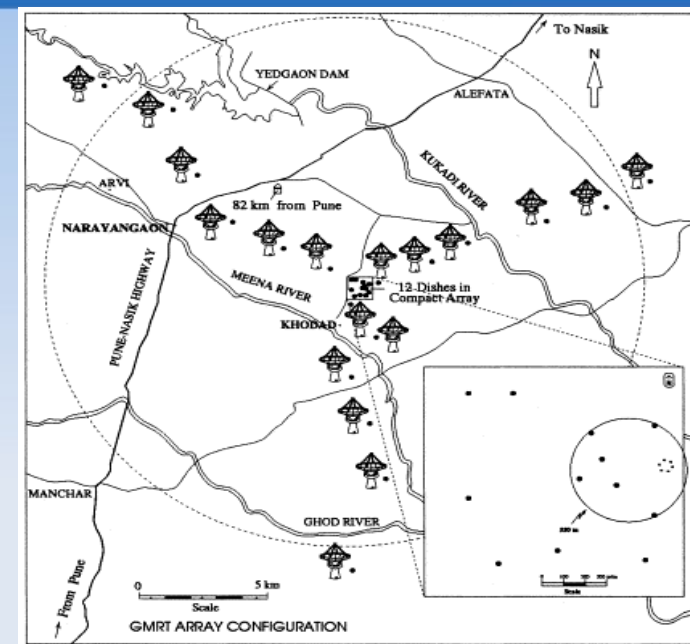
Introduction : TGC System



- 30 GMRT antenna comprises 30 x 5 = 150 subsystems :
 - Two servo systems : For antenna, and Feed rotation (FPS).
 - RF Receiver chain systems – FECB, OPT-FIBER, SENTINEL

At the GMRT Central Electronic Building ~ 40 Subsystems :

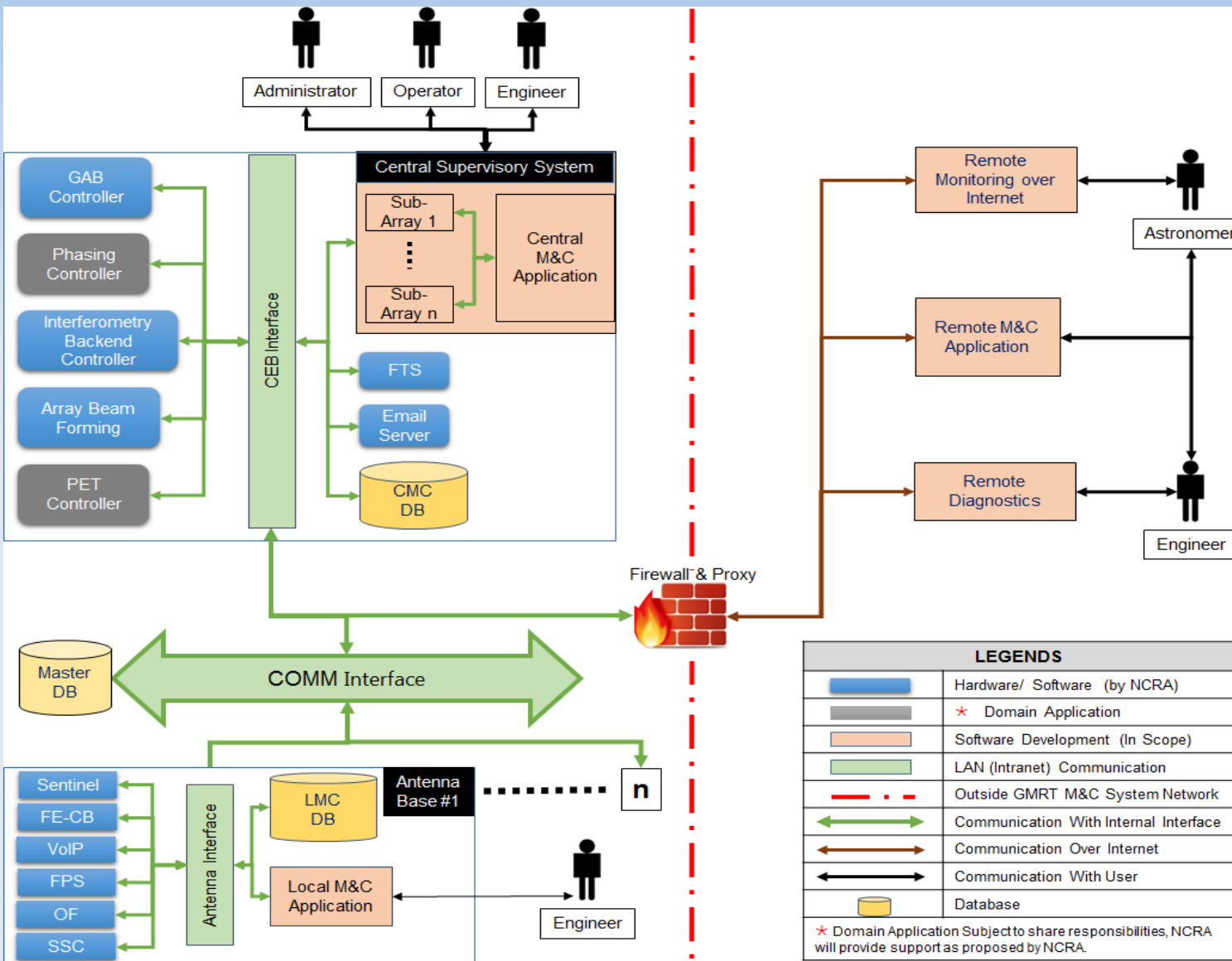
- 30 GAB (GMRT Analog Backend) control Units, one per antenna
- GMRT Wideband Backend : 1 correlator + 4 beam former(s)
(Each Backend unit consist of separate data Acq. System.)



- Total ~190 GMRT sub-systems are being monitor and Control by the TGC system in real time.

Link	Device Interface	Control Cards	Central and Local M&C machines	OS and Softwares	User Interface
Ethernet 1 Gbps	(i) Ethernet TCP/IP – 100 Mbps / 1 Gbps (i) USB/RS 485	(i) Rabbit 4300 (ii) Servo PC104	(i) Dell precision Tower 5810 (Application & Data server) (i) Dell Optiplex 7000 Series	Ubuntu 16.04 / 18.04 LTS, TANGO frame work, C++, Java and Python	GUI – Taurus, PyQt4, PyTango CLI – python Scripting Environment

Next Generation GMRT M&C System (Overview)

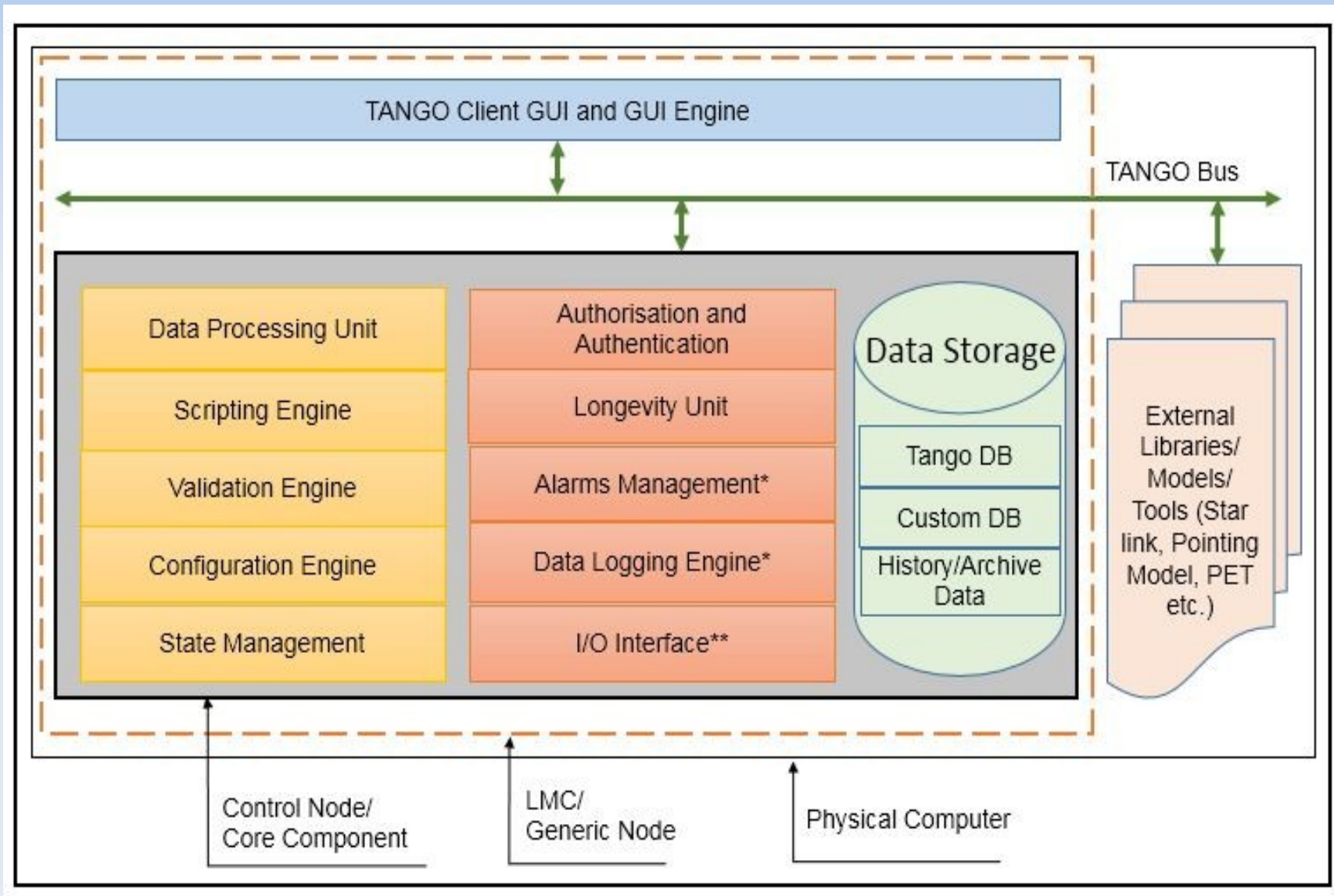


- Role Based GUI with A&A
- Supports Five Observation arrays and one Maint. array
- Support Local M & C
- Automated Observing schedule Execution
- CLI with Python Scripting Environment
- Auto Alarm & Exception Handling
- M&C System data Archiving/Retrieving
- Web Interfaces for Absentee observing

A Generic Control-Node Architecture



Quality Attributes : Modular, Configuration driven, Reusability, Modifiability
(*Component based Architecture - Segregation of Interface and Implementation*)



Tango based M&C System implementation

(Continued..)



Tango Host	Number of Tango-Devices/ Servers per Machine	Devices	Attributes
Local M&C Machine	23	LMCs , FECB, FPS, OPFSNT, Servo, GAB, HDB++ (ES, CM) , PyAlarm, Scripting, and Starter	~450 to 500 (polling 1-3 sec)
Central Application server	40	AGN(0-6), CPX, HDB++ (ES, CM), Scripting , Starter, Pyalarm	~1200 (Polling 1-3 sec)

- **M&C Comprises, at present at 33 LMCs**
- **Total DS = LMC DS ~759 + CMS DS 40 = 799**
- **Total Attributes : ~ 17000**

TGC Features : Observability



Central Monitoring & Control : Operator Station 0 (on cmsserver)

Super Operator@cmsserver

IST Date: 27-10-2023 IST: 10:50:26 LST: 12:37:54 UTC: 05:20:26 Server Status: **Server Up** State: **Manual Mode** M&C Status: **OK**

Current Observation: NA Backend Status Subtask Owner No of Operator Arrays: 7 **GMRT Alarms** Alarm Wind Alarm
 Next Observation due: NA GSB NA NA Operator Station 1 Maintenance Array Antennae: 1 Smoke Alarm Temperature Alarm
 Next Observation at: NA GWB NA NA Operator Station 1 No of LMC Configured: 34

View Control Monitor Utilities Recent

Dashboard -> CMC Status

DrillError CPX IST: 10:50:26 **Aggregation Nodes** Introspect

AGN0[M] AGN1[M] AGN2[M] AGN3[M] AGN4[M] AGN5[M] AGN6[M]

CPXSys[M]

Dashboard -> AGN1 -> C02 -> Status

DrillError C02 IST: 10:50:26 **Subsystem Status** C02 Introspect

FECB FPS OFCSNT SIGCON **SERVO** GAB C02 LMCsys

Name: alarmToolMsg (LMC/C02/FECB/ALARMTOOLMSG)

Dashboard -> AGN Status -> AGN1 -> Status

DrillError AGN1 IST: 10:50:26 **Antenna/LMC Nodes** Introspect Filter

C00[R] C01[R] C02[R] C03[R] C04[R] C05[R] C06[R] C08[R]

C09[R] C10[R] C11[R] C12[R] C13[R] C14[R] E02[R] E03[R]

E04[R] E05[R] E06[R] S01[R] S02[R] S03[R] S04[R] S06[R]

W01[R] W02[R] W03[R] W04[R] W05[R] W06[R] GNsys[M]

DrillError Servo IST: 10:50:26 **Detailed View** Introspect

status		Az Axis		El Axis	
systemStatusMsg	OK	az_tp	-135:05:15	eL_tp	+073:05:25
time	10:50:22	az_cp	-135:05:16	eL_cp	+073:05:31
mode	REMOTE	az_err	+0.00	eL_err	+0.00
w50	0	az_motor1_current	+1.4282	eL_motor1_current	+0.6157
w80	0	az_motor2_current	-0.7426	eL_motor2_current	+1.7709
pos		az_brk	0	eL_brk	0
trk	TRK	az_ac	1	eL_ac	1
slw		az_tacho1	+38.9648	eL_tacho1	-24.7957
ssc	1	az_tacho2	+17.7112	eL_tacho2	+3.5422
dc	0				
az_state	Tracking				
eL_state	Tracking				
wind_vel1	9				
wind_vel2	11				
servo_state					

Activity Messages:

27-10-2023 10:50:24: [Response] [CPX] [AGN1] [W05] [W05] [Fps, 'runpreset', '81083']

27-10-2023 10:50:24: [Response] [CPX] [AGN0] [W05] [W05] [Formed Command String]:

27-10-2023 10:50:25: [Response] [CPX] [AGN0] [W05] [W05]

27-10-2023 10:50:25: [Response] [CPX] [AGN1] [W05] [W05] ['12345', '40', 'False', '2a3705b6', '27-10-2023 10:50:24', 'w05', '0:00000000000000000000000000000000', 'runpreset', 'target_encoder', '81083']

27-10-2023 10:50:26: [Response] [CPX] [AGN0] [C13] [SERVO] Track sent to servo with B 10:51:29 -135:41:28 +073:28:31

27-10-2023 10:50:26: [Response] [CPX] [AGN1] [C13] [SERVO] Track sent to servo with B 10:51:29 -135:41:28 +073:28:31

27-10-2023 10:50:26: [Response] [CPX] [AGN0] [W05] [FPS] runpreset is not allowed in DISCONNECTED

27-10-2023 10:50:26: [Response] [CPX] [AGN1] [W05] [FPS:11:runpreset is not allowed in DISCONNECTED

27-10-2023 10:50:26: [Response] [CPX] [AGN0] [W05] [FPS:11:runpreset is not allowed in DISCONNECTED

Notifications:

AGNO_alarmStatus	ALARM	alarm for AGN0	Thu Oct 19 14:09:35 2023
AGNO_OFCSNT_fire_detected	INFO	alarm for AGN0 - OFCSNT intruder	Thu Oct 19 14:09:30 2023
AGNO_Subsystem_OFCSNT	ALARM	alarm for AGN0	Thu Oct 19 14:09:34 2023

TGC Features : Usability, Functional suitability



Operator@cmsserver

IST Date: 30-10-2023 IST: 10:50:21 LST: 12:49:38 UTC: 05:20:21 Server Status: **Server Up** State: **Manual Mode** M&C Status: **OK**

Operator1_Array: 33 Backend Status Subtask Owner Observing Prog: <File name> GMRT Alarms

Mode: **Manual Mode** GSB 99.99 NA **Operator Station 1** PI: <Name of observer> Alarm Wind Alarm

GWB 99.99 NA **Operator Station 1** Smoke Alarm Temperature Alarm

View Control Monitor Utilities Recent

Subarray : Antenna Tracking

IST Date: 30-10-2023 IST: 10:50:21

Select AGN: **AGN1** Flags Description

AGN1 Sub Array 0

Mode: NA
Phs-Center (GWB) : NA
Phs-Center (GSB) : NA
Target : J1639+4340
RA(hms): 16:39:50.52 , DEC(dms) : 043:40:3.71 , Epoch: 2001
Rise Time(HMS): 9:3:54.1 , Set Time(HMS): 20:17:20.83
Tracking: AZ(dms): -130:38:38.48 EL(dms): 36:13:58.27
Track Mode: IN
TrackCorr: NA
OFFSET: RA: 0 DEC: 0
AZ: 0 EL: 0

TRK ERRORS																
	C00	C01	C02	C03	C04	C05	C06	C08	C09	C10	C11	C12	C13	C14	E02	E03
AZ	3'52"	45'23"	2'53"	31'53"	27'6"	0'5"	25'27"	3'42"	21'30"	16'33"	2'13"	6'30"	3'2"	24'28"	7'39"	6'50"
EL	0'36"	12'24"	12'18"	5'23"	9'36"	1'6"	4'39"	3'24"	3'5"	0'7"	4'10"	3'40"	0'32"	2'35"	4'29"	6'48"
Flag					N					N						

	E04	E05	E06	S01	S02	S03	S04	S06	W01	W02	W03	W04	W05	W06
AZ	8'9"	33'22"	25'8"	0'14"	9'58"	0'54"	49'1"	2'23"	44'54"	10'7"	7'9"	17'52"	3'22"	3'52"
EL	7'12"	2'1"	11'25"	15'42"	1'16"	6'22"	12'8"	6'52"	4'14"	3'5"	6'48"	8'31"	4'0"	11'39"
Flag														

Observation Scripts Status: ViewLog Pause Resume Abort

Script Name	Script Id	Status	User Name	Time
/opt/cmsserver/cmd/45_039/45_039_30Oct2023_0600_cmd.py	NWQENLXO	running	Test_Operator	2023-10-30 06:00

CMD Status: 30-10-2023 10:47:18 : Selected Log to View/opt/tangoworkspace/CentralNode/MNCLogs/Scripting/Logs/NWQENLXO.log

stopLog

```

23-10-30 10:48:10 :
23-10-30 10:48:10 :None
23-10-30 10:48:11 :CMD EXEC TIME IS
23-10-30 10:48:11 :
23-10-30 10:48:11 :0
23-10-30 10:48:26 :30-10-2023 10:48:26 : fstart_proj end 19 sec
23-10-30 10:48:26 :30-10-2023 10:48:26 : sysCmd start
23-10-30 10:48:27 :sshpas -p gmrt.123 ssh tgcuser@192.168.70.103 "espeak 'GWB Started scan on J1639+4340 for sub array 1 '" &
23-10-30 10:48:27 :30-10-2023 10:48:27 : sysCmd end 0 sec
23-10-30 10:48:27 :30-10-2023 10:48:27 : fstrtdas end 20 sec
23-10-30 10:48:27 :Total number of antennas: 30 in Subar array: 0
23-10-30 10:48:28 :Total number of antennas: 30 in Subar array: 0
23-10-30 10:48:28 :.list -
23-10-30 10:48:28 :
23-10-30 10:48:28 :['W04', 'S02', 'C02', 'C10', 'S01', 'C05', 'E04', 'S06', 'C01', 'E03', 'S04', 'C06', 'C04', 'C09', 'W06', 'S03', 'C00', 'W01', 'C11', 'C03', 'W03', 'E06', 'C08', 'W02', 'E05', 'C12', 'C14', 'C13', 'E02', 'W05']
    
```

Activity Messages:

```

4037390##W01:10:W01:10:Exiting /opt/tangoworkspace/
529866##E05:10:E05:10:Exiting /opt/tangoworkspace/
3719##W06:10:W06:10:Exiting /opt/tangoworkspace/
24107##W05:10:W05:10:Exiting /opt/tangoworkspace/
14258##C01:10:C01:10:Exiting /opt/tangoworkspace/
20881##C02:10:C02:10:Exiting /opt/tangoworkspace/
5724##C08:10:C08:10:Exiting /opt/tangoworkspace/C
15754##S01:10:S01:10:Exiting /opt/tangoworkspace/C
not received for child command within timeout: 60 sec
30-10-2023 10:48:25 : [Response] [AGN1] [FSTARTSCAN
    
```

GMRT M&C System Version : 3.3

Observing script Log

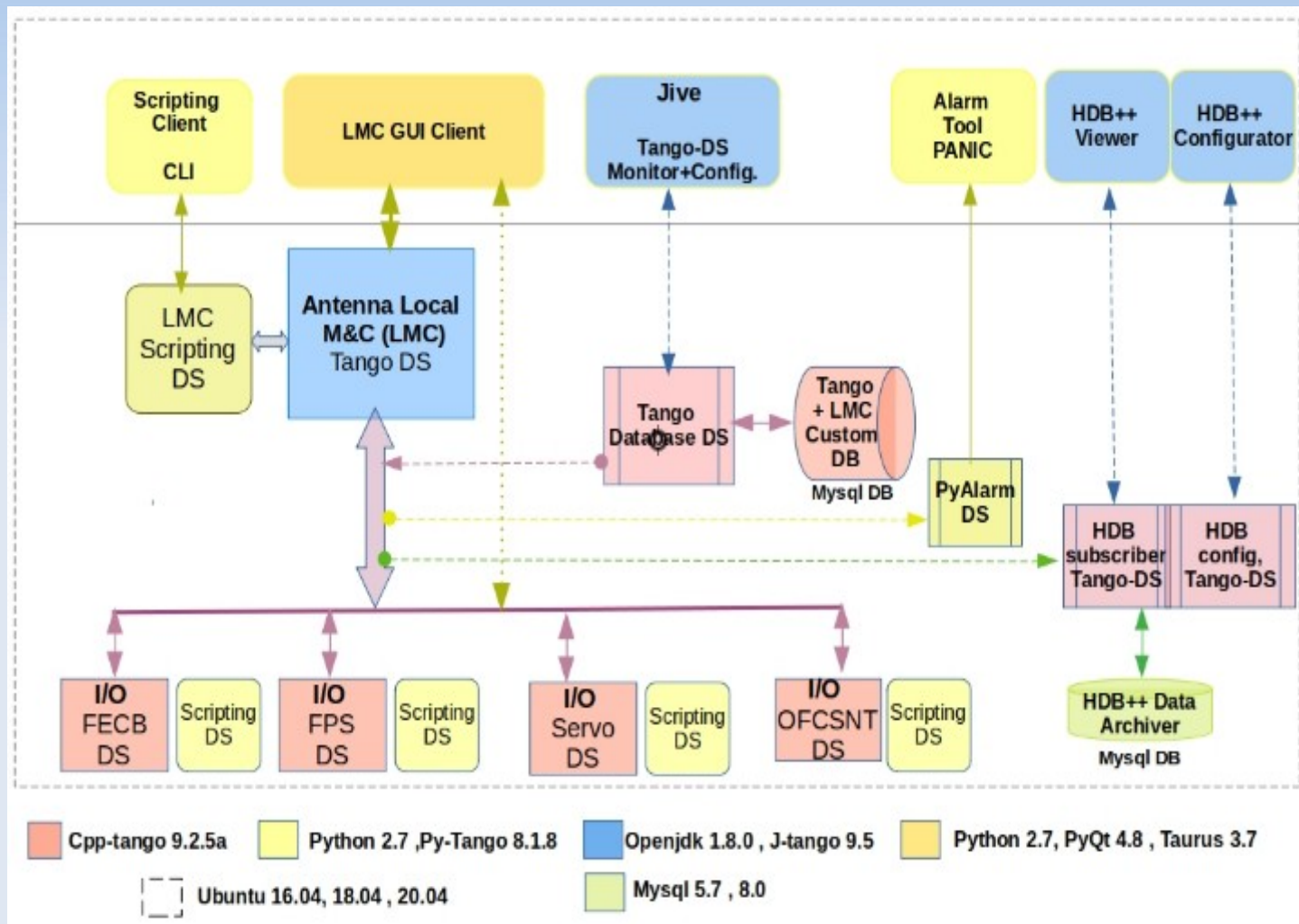
Alarm	Time
alarm for Agn2 - OFCSNT intruder	Fri Oct 27 23:50:35 2023
alarm for AGN1	Fri Oct 27 23:27:52 2023
alarm for AGN1	Fri Oct 27 23:50:57 2023

Upgradation and Modernization Goals



TGC Components Comprising the LMC of GMRT Antenna

- OS : Ubuntu 16.04 LTS
- Tango 9.2.5a (Release 2017)
- Python 2.7.18 support Ended at Jan, 2020
- PyQT4 reached EOL Aug, 2018
- Taurus 3.7 relied heavily on Python 3.7 (EOL Jun 2023)
- OpenJDK8 public updates ended in 2019 (Officially ends in Nov 2026)



Current TGC platform is based on Tango 9.2.5a (2017) and legacy Python 2 / OpenJDK 8 technologies, creating maintainability, security, and long-term support challenges.

Upgradation and Modernization Goals

(Continue..)



Objective :

Support GMRT's long-term operational goal for conducting Science observations through reduced downtime, easier maintenance, and the future-ready architecture of the TGC system.

Ensure Compatibility , Long-term support, and Maintainability :

- ◆ TGC S/W shall be compliant with modern Linux environments.
- ◆ Migrate **Python 2** → **Python 3, PyQt5/6, Taurus 5**
- ◆ Upgrade **OpenJDK 8** → **Latest OpenJDK platform**
- ◆ Upgrade Java libraries: Hibernate ORM/JPA, Apache Networking, Log4j, Jython etc.

Tango Ecosystem Upgradation :

- ◆ Upgrade Tango 9.2.5a (Jan 2017) to the latest supported version.
- ◆ Update Jive, Astor, POGO, Archiving etc. toolkit components to the latest OpenJDK.
- ◆ Refactor TGC code to current Tango C++ / Python / Java standards.

Performance, Scalability & Security (Python-3 and Latest OpenJDK platform) :

Feasibility Study



Machine : Dell Optiplex SFF 7020 with Ubuntu 24.04 LTS OS

Tango 10.x Vs Tango 9.4.x Selection :

- ◆ **Tango 10.X** : Release with C++17, includes Stricter APIs for PyTango.
Recommended for the New projects or Upgrade.
- ◆ **Tango 9.4** : is more flexible with Non-Method based Function calls for Attribute Access.
For Backward Compatibility with older style APIs, avoid breaking changes.
- ◆ Hence, **Tango 9.2.5a → Tango 9.4 Framework is selected.**

Python 2 to 3.9 Change Impact :

- ◆ **Python 3 → PyTango >= 9.4 → cppTango >= 9.4**
- ◆ **Python 3 → PyQt5** (PyQt4 Compatible upto Python 3.7, deprecated now)
- ◆ **Python 3 → PyQt5 → Taurus 5** (Taurus 4 is no longer supported since Jul 2021)

Java OpenJDK 1.8 to OpenJDK 17 :

- ◆ **OpenJDK17** Java platform is a balance of modern features and long-term support.
- ◆ Java 21 not selected as it offers virtual thread & thread concurrency which may be difficult to handle in the old code.
- ◆ **To avoid package dependency errors, we find OpenJDK 17 is a viable option.**

Feasibility Study (continue..)



The CONDA is identified as a most suitable Package-Manager and Environment Management Tool.

- ✓ Provides broad package availability for the Tango Control System.
- ✓ Simplifies installation by automatically managing dependencies.
- ✓ It enables reproducible development environments, and allows the same configured environment to be shared across multiple Tango-related projects and tools.
- ✗ To down-grade or up-grade packages, or Sub-package :
Lot of complexities because of dependency verification tree, some time make it impossible.
- ✗ **MySQL Library Integration problem :**
 - ◆ Installing the Tango via Conda also installs MySQL Libraries as a dependencies which conflicts with the Ubuntu's default MySQL libraries.
 - ◆ To resolve this, Ubuntu's MySQL Libraries were removed, and the CONDA provided MySQL libraries were configured as the system default by reconfiguring the *AppArmor* Security Module.

Feasibility Testing Performed :

- ◆ Created and tested multiple Conda Env. to resolve dependencies among already installed packages.
- ◆ Successfully validated Tango database, and device communication using the Jive and PyTango.
- ◆ Verified PyQt/Taurus functionality with simulated Tango devices for application migration and development.

Feasibility Study (continue..)



- **Using CONDA ver.24.11.3 (anaconda3) :**

- ◆ Around ~90 S/W Tools, Libraries, and Packages were installed in the 'tangodefault' environment
Basic (Compiler tools, libraries, MySQL) – 37, Tango (cpp, python, java, Qt) - 46, Taurus- 9

TGC Application	Tango Library/Tools	New	Old
Common for all apps	MySQL	8.3.0	5.7
Sub-System I/O at antennas + TangoBaseDS +All tango tools/apps	Tango-Controls (cpp)	9.4.2	9.2.5a
	OmniORB (cpp)	4.2.5	4.2.1
	zeromq	4.3.5	4.0.0
Scripting Manager (DS) + CLI & GUI	Python, cpython	3.9.22	2.7.x
	PyTango	9.4.2	8.1
	Boost, boost-cp	1.78.0	1.58
Antenna Local M&C DS, HDB++ archive	OpenJDK	17.0.3	1.8
	Jtango, JtangoServer lib	9.7.4	9.5
GUI, PANIC Alarm	Qt	5.15.8	4.8.x
	PyQT	5.15.9	4.11.x
	Taurus	5.2.1	3.7

Methodology for the Upgradation



Python-2 to 3 Code Migration :

(TGC System code: MNCScriptManager DS, QT-GUI, Script Environment, and Astronomical Libraries)

2to3-3.9 -W -o /opt/tangoworkspace/ControlNode/Scripting # -W keep backupfiles.

Classification	Manual Code corrections in Python3 files
Code Formatting	<ul style="list-style-type: none">• Indentation and Spaces were corrected to avoid logical execution errors, or misleading method execution.• “from . import <module-name>” → import <module-name>• For documenting, “” replaced with double quote “””
Data Type Errors	<ul style="list-style-type: none">• division() return type casted to int• filter() and map() return type casted to list # returns objects
API Changes	<ul style="list-style-type: none">• sort() → sorted() ; for dictionary iteritems() → dict.items()• Log4py APIs : get_instance() → Logger() ; I/O Stream buffer : sys.stdout.encoding = sys.getdefaultencoding() → sys.stdout.reconfigure('utf8')
Unicode 'utf-8' Data-types changes	<ul style="list-style-type: none">• For split(), find(), match() methods byte code comparison is required, hence string prefixed with b”....”• str(obj).rstrip('\n') return type changed : byte-data to 'str'

Around 66 python files corrected manually.

Methodology for the Upgradation



PyQT4 to PyQT5 Migration : Total 37 PyQT5 and Taurus files corrected manually.
(TGC System code: GUI , PANIC Alarm Tools)

```
pyqt4topyqt5 -nolog ./<pyqt4_code> -o ./<pyqt5_code>
```

(i) PyQT4 to PyQT5 Signal Handling :

The method associated with the GUI Object (*such as button*) can be called using the connect call.

```
# PyQT4 - for the 'button' widget , upon clicked() event, on_button_click() method is called.  
self.connect(self.pushButton, SIGNAL("clicked()"), self.on_button_click)  
  
# In PyQt5 new style of signal-slot connection is used  
self.pushButton.clicked.connect(self.on_button_click)
```

- Signal Connect : `self.connect(obj, SIGNAL(...))` → `obj.signal.connect(...)`
- Signal Emit : `self.emit(SIGNAL("sig"), args)` → `self.signal.emit(args)`

(ii) Phonon library removal in Qt5 : Multimedia framework for Audio/Video playback, replaced with `QMultiMedia /QmultiMediaWidgets` code

(iii) Widget SuperClass changed in PyQT5 : In converted code, many QTWidget Objects were missing their super/parent class. The GUI widget objects parent class found using the PyQt5 documents' web-sites or with the google-help.

(iv) Attribute Model in PyQT5 + Taurus 5.x : Required FQDN for the attributes.

viz. `attributeModel= tango://<hostname>:1000/domain/family/<attribute_name>`

Methodology for the Upgradation



Java OpenJDK 8 to OpenJDK 17 :

(TGC System Code : LMC DS , HDB++ Archive, Astronomical Libraries)

Using the ANT builder, the TGC code was compiled successfully, but run-time Bugs were occurred :

(i) MultipleBagFetch Exception Errors : Bug arised due to the Hibernate's confusion about whether duplicate records are suppose to be there in the DB , or it has become multiple due to the cartetian products when **@ManyToOne / @OneToMany** relations are used.

The entity relationship mappings in the **"DatabaseTx"** modules were updated by changing the fetch strategy from **FetchType.EAGER** to **FetchType.LAZY**.

e.g. `@OneToMany (mappedBy = "argIdInstanceFrmCmdAssocArgJpa", fetch = FetchType.LAZY)
private List < CommandAssocArgumentJpa > cmdAssocArgObjFrmArgJpa;`

(ii) 'ANTLR' (ANother Tool for Language Recognition) Upgrading from 2.7.x to 3.x :

BUG : java.lang.NoClassDefFoundError: antlr/collections/AST

Jtango-9.7.4.jar consist the AST (Abstract Syntax Tree) class, but it was clashing with the Hibernate's and Maven-repository antlr-2.7.7.jar.

(iii) Database Exception Handling : Incomplete Data transactions is rollback() first before closing the Hibernates EntityManager instance i.e. this.em.close() This avoided stale connections.

Functional & Validation Testing



Functional Testing done at the Lab, and at the “C01” GMRT Antenna

- TGC-LMC Communicated with the antenna Control H/W.
- All subsystems (FPS, Servo, GAB, OFCSNT) control & Monitoring response checked.
- Antenna Tracking was verified with the correct Astronomical to Alt-Az coordinate conversion on 3C48 source.
- Receiver configuration to the desired observing band with expected power-level checked,
- Data Archiving, Alarming validation testing done.

The screenshot displays the 'Local Monitoring & Control : C01 (on c01)' interface. At the top, it shows the user 'Lmc Engineer@c01' and system status: 'Server Status: Server Up', 'State: operationalManual', and 'M&C Status: OK'. Below this, there are buttons for 'Alarm', 'Wind Alarm', 'Smoke Alarm', and 'Temperature Alarm'. The main interface is divided into several panels:

- LMC Master Control:** Shows 'GMRT Status: OK' and 'IST: 12:21:45'. It includes buttons for 'Park', 'HALT-Emergency', and 'HALT-Normal'. The 'LMC Mode' is set to 'Local' and 'Change Mode' is set to 'Remote'. There are 'Start', 'Stop', and 'Restart' buttons for LMC Services.
- LMC Services Table:**

Service	Status	Description	Date/Time
Alarm	OK	Alarm service	12:21:45
Archiver	OK	The logger service	12:21:45
Batch	NOT OK	The Scripting service	12:21:45
- LMC Subsystems Table:**

Subsystem	IP Address	Status
SERVO	192.168.32.3	OK
FPS	192.168.32.2	OK
OFCSNT	192.168.32.4	OK
FECB	192.168.32.2	OK
GAB C01	192.168.30.40	OK
IFLO	192.168.32.2	OK
- Activity Messages:** A log of commands and responses, including '[Command] [C01] [INITFPS] command received at LMC' and '[Response] [C01] [SET_LRPM_LMT] Command Executed Successfully'.
- Notifications Table:**

Alarm Name	Alarm Type	Alarm Description	Date/Time
1 OFCSNT_alert	ALARM	Laser_Bias_voltage	Thu Feb 12 10:51:49 2026
2 OFCSNT_fire_detected	WARNING	OFCSNT_fire_detected	Thu Feb 12 10:51:48 2026
3 OFCSNT_intruder_detected	ALARM	OFCSNT_intruder_detected	Thu Feb 12 10:51:48 2026
4 Subsystem_OFCSNT	ALARM	Aggregate alarm for subsystem ...	Thu Feb 12 10:51:48 2026

Functional & Validation Testing



Central Monitoring & Control : Operator Station 2 (on cmsserver)

Operator@cmsserver

IST Date: 12-02-2026 IST: 13:22:25 LST: 22:18:08 UTC: 07:52:25 Server Status: **Server Up** State: **Manual Mode** M&C Status: **OK**

Operator Test_Operator

Operator2_Array: 4 Backend Status Subtask Owner Observing Prog: <File name> GMRT Alarms

Mode: **Manual Mode** GSB 99.99 NA Operator Station 0 No Alarm Wind Alarm

GWB 99.99 NA Operator Station 1 Smoke Alarm Temperature Alarm

PI: <Name of observer>

View Control Monitor Utilities Report

Qt Operation Control

SUBAC Multi Subarray Data Control

CMC LMC No. of Antenna: 1 Select All Sub Array 0

C01

Source: 3C48 Catalog

* GTS-Time : 2026-02-12 13:13:43
 * Source Name : 3C48 ,Catalog Name :vla_pntg
 * Precessed out to epoch :2026.11781
 * RA(hms) :01:37:41.30 , DEC(dms) : 33:09:35.13
 * Source Current Az(dms) : 62:1:14.63 , EL(dms) : 41:24:13.44
 * Rise time(hms) :11:16:37.33 , Set time(hms) :22:9:10.90

IN/OUT Track: **OUT** Array AZ Track Track Array Stop Array

Offset: RA-DEC 0 0 degree Track Off

Axis: **AZ** AZ: EL:

Axis Correction: Use Model Position Hold Stop

Power Eq.: Config Equalize Phasing: Config Phase Apply Clear

Subsystem: Select Subsystem

CMD Terminal: Execute

CMD Status: 12-02-2026 13:16:32 : [TRACK_ARRAY] Command Fail

12-02-2026 13:16:32 : [Response] [AGN2] [TRACK_ARRAY] C01:11:Response not received for child command within timeout :- 60 seconds

Qt Sky Plot

IST Date: 12-02-2026 IST: 13:22:25

Sky Plot Polar Plot Array Status

Select AGN: **AGN2** Current Time: 13:22:21 Legend Options Filter

Current available antennae

x=17.4657 y=12.796

Alarm Name	Alarm Type	Alarm Description	Date/Time
2_OFCSNT_intruder_detected	ALARM	alarm for agn2 - OFCSNT intruder	Thu Feb 12 10:24:13 2026
AGN2_OFCSNT_fire_detected	ALARM	alarm for Agn2 - OFCSNT intruder	Thu Feb 12 10:24:13 2026
AGN2_OFCSNT_alert	ALARM	alarm for AGN2	Thu Feb 12 10:24:22 2026
AGN2_Subsystem_OFCSNT	ALARM	alarm for AGN2	Thu Feb 12 10:24:17 2026

Tango Versions implementation at various facilities



#	Facility	CPP_TANGO	PyTANGO	JTANGO	OS
1	ALBA Synchrotron	7.2.x/8.1.x/9.2.x/9.3.3	7.2.x/8.1.x/9.2.x	7.2/8.1.x	Linux/Windows
2	DESY	9.2.5	9.3.2	9.1.x	Linux
3	ESRF Accelerators	9.3.6-rc2	9.3.6	9.6.6	Linux/Windows
4	MAX-IV Laboratory	9.3.5	9.3.3	9.3.x	Linux
5	NSRC Solaris	8.1.x/9.2.x/9.3.3	9.2.X	-	Linux/Windows
6	SKA Organisation	9.3.4-rc	9.3.2	-	Linux
7	SOLEIL	6.x/7.2.x/9.2.x	9.2.x	9.5.x	Linux/Windows
8	SKA	9.3.3	9.3.1	9.5.x	Linux
9	IJCLab	9.2.5	9.2.0	9.2.5	Linux <input type="button" value="v"/>
10	GMRT	9.4.2	9.4.1	9.7.4	Linux Ubuntu 24.04.3

Tango Client-Server :

Aggregation Node Problem resolving



AGN (Aggregation Node) :

- ◆ AGN is a Top-Level Controller managing antenna groups (**subarrays**) for Observations and experiments.
- ◆ Java-based Tango DS, but acts as a Tango-client for the remote LMC nodes at the GMRT antennas.
- ◆ **AGN hang observed every 2-3 days whenever there is LMC communication timeouts because of the network disconnections, Power supply failures, or LMC host PC issues.**

Tango Client-Server :

Aggregation Node Problem resolving



Solutions :

(1) Tango client–server communication simulation performed to investigate the root cause. Result is documented on the Tango Community Forum.

set_transparency_reconnection(Transparency=<bool>) controls automatic reconnection.

- ◆ **Transparency = true (default) :**

- Automatically retries to establish connection when the server is unavailable.
- Client may hang for several minutes during reconnection attempts.

- ◆ **Transparency = false :**

- Immediately throws a **CommunicationFailed** exception if the device is unreachable.
- Prevents client hangs. Requires application-level exception handling.

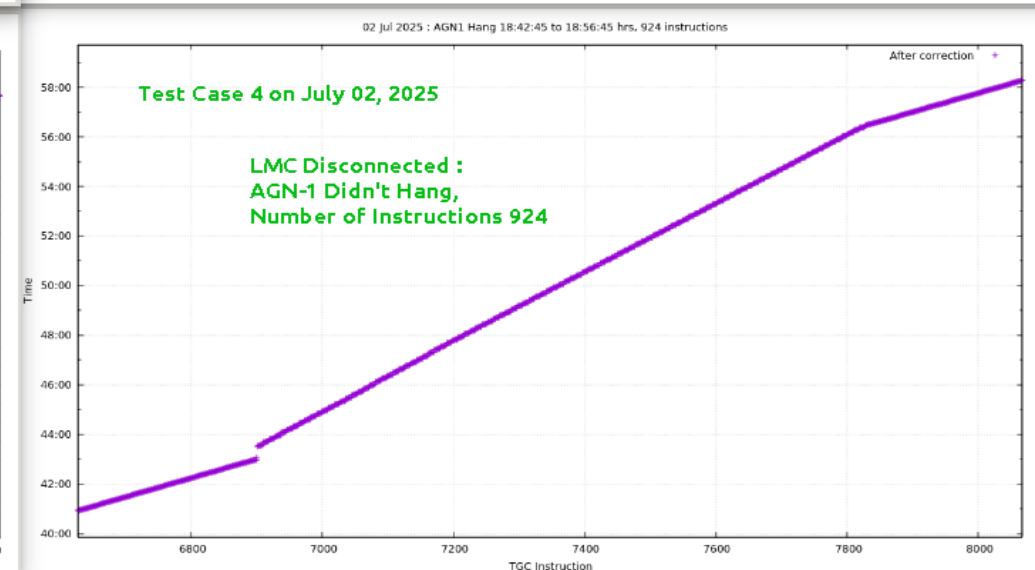
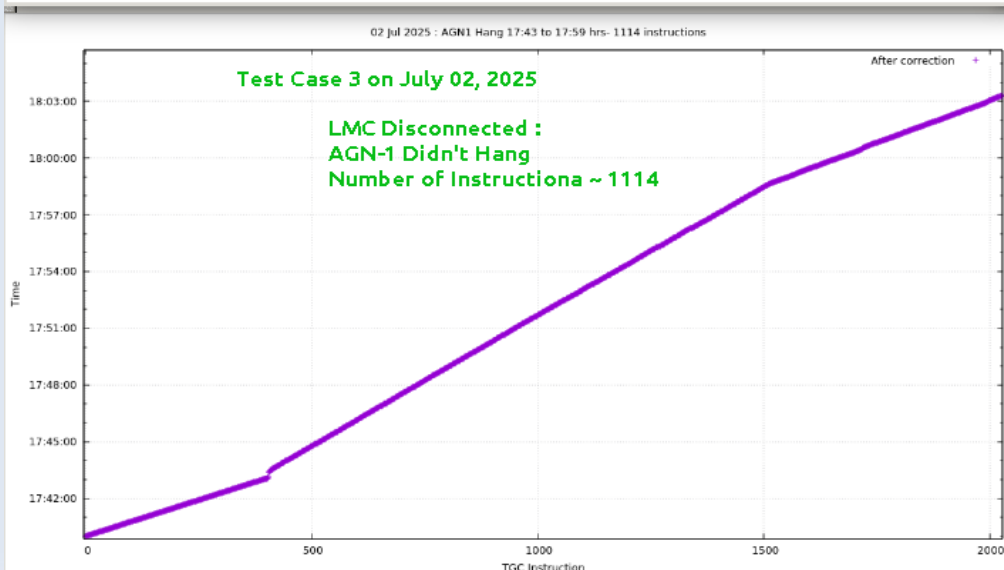
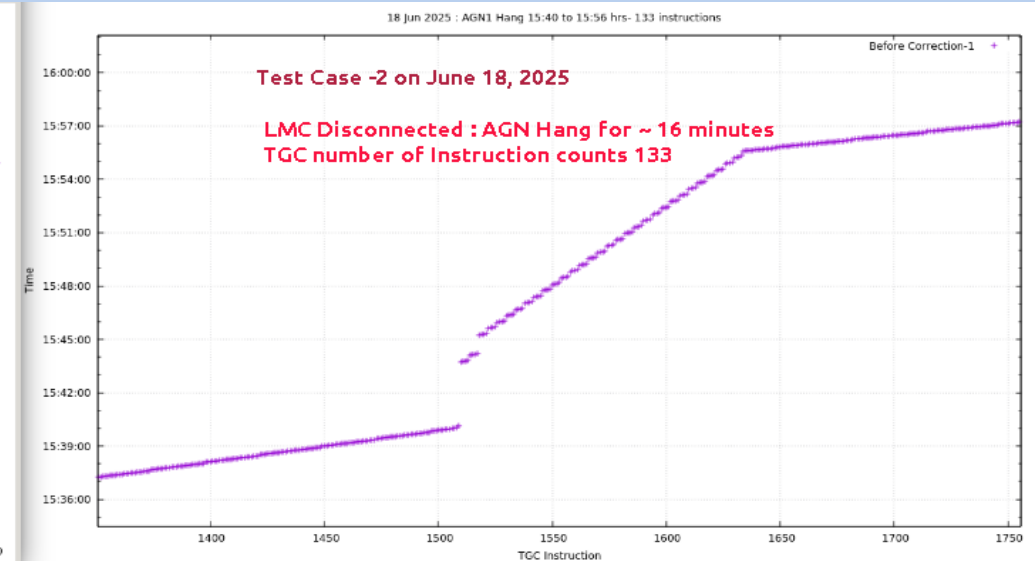
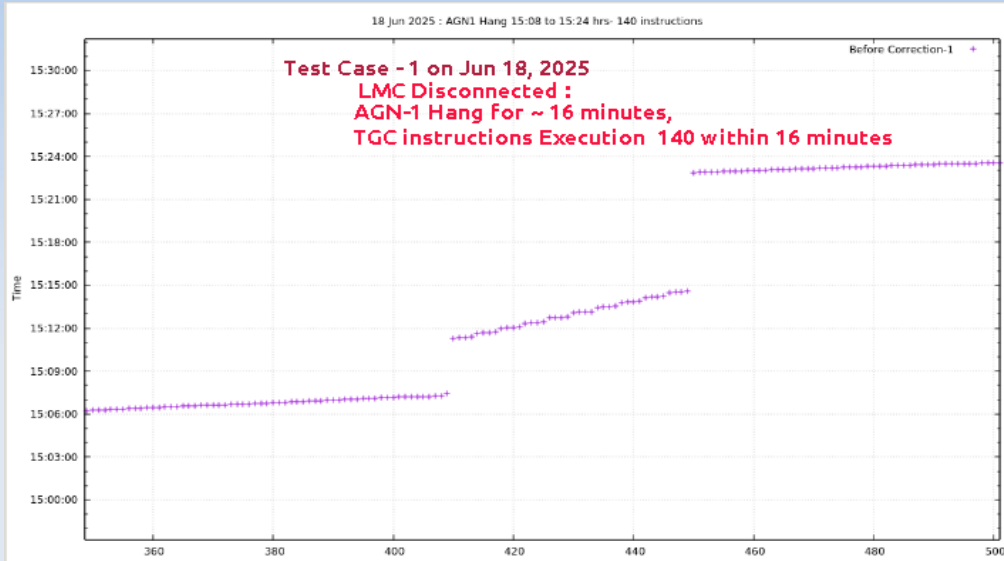
(2) MySQL Database Configuration tuned for Maximum Connections, InnoDB cache memory increases, connection timeout etc.

(3) In the DatabaseTx (Database Engine) Transaction management code, a careful exception handling taken care with a rolled back of pending transactions before closing the Hibernate EntityManager instance in the **Final loop of Try-Catch**.

Tango Client-Server : Aggregation Node Problem resolving (Continue..)



LMC Timeout Test case study **without code correction (Jun 18, 2025)** and **With Code Correction (July 02, 2025)**

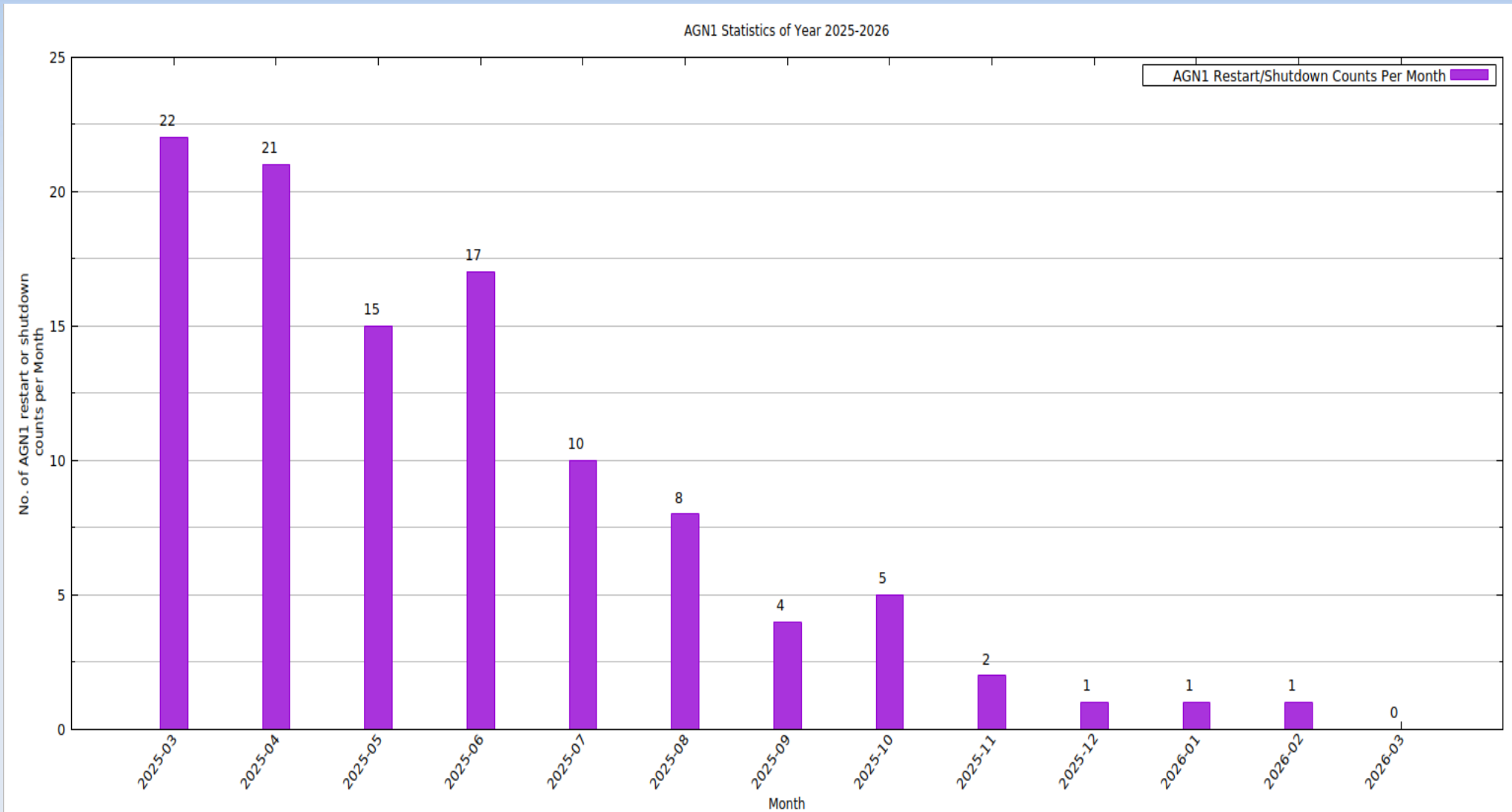


Tango Client-Server :

Aggregation Node Problem resolving (Continue..)



AGN Restart/Shutdown Counts per Month March 2025 to March 2026



- The TGC Local Monitoring and Control (LMC) software was successfully upgraded to the latest Linux distribution, Tango 9.4 framework, Python 3, and OpenJDK 17, ensuring long-term maintainability and compatibility.
- In the TGC system, Aggregation bug resolving increased MTBF from ~50 hours to ~372 hours, and thus reduced agn1-hang frequency from 15–21 times per month to 1–2 times per month.

Thanks...

- References :
- [1] Development of Next Generation Monitor & Control System for Radio Telescopes, 2013 IOP Conf. Ser.: Mater. Sci. Eng. 44 012026
 - [2] GMRT M&C System Software Architecture Description Document, December 2014
 - [3] Report On Tango Control System Framework Evaluation, Version 1.3, October, 2015
 - [4] Tango Controls, <http://www.tangocontrols.org>
 - [5] <https://tango-controls.readthedocs.io/projects/pytango/en/stable/versions/migration/to-9.4/deps-install.htm>
 - [6] <https://wiki.python.org/moin/PyQt4>
 - [7] https://conf1.ncra.tifr.res.in/event/5/attachments/87/186/ngmnc_demo_nov15_2019-Jitendra.pdf
 - [8] <https://www.geeksforgeeks.org/python-introduction-to-pyqt5/>
 - [9] <https://github.com/rferrazz/pyqt4topyqt5>