



User Evaluation Report on the LMC-PC : Dell Optiplex 7000

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Objective : The existing ‘MILTEC’ made LMC (Local Monitoring & Control) PC at every antenna-base plan to be upgraded by the new machine. This technical note gives user evaluation report on the fitment of “Dell Optiplex 7000 SFF” PC as a GMRT antenna LMC node. The Small Form Factor PC fits inside a legacy Miltec’s RFI shielding box. The Dell PC in use-condition over a longer duration don’t show any heating issues inside the legacy Miltec box. The LMC hardware and software performance was monitored for more than one month at C11 antenna, no hardware or software related problems detected. As per the RFI group test report, the Dell PC with RFI shielding box doesn’t show any significant RFI in a range of 0 to 2 GHz.

The PC BIOS configuration, and OS level changes were also customized successfully by us to enable the Wakeup on LAN (WOL) facility, and for resolving the PC Suspend problem in case of ideal condition.

Revision	Date	Modification/ Change
Ver. 0.9	Jan 17, 2023	Rough draft shared for author contribution
Ver 1.0	Feb 1, 2023	Report Completed.
Ver 1.1	Feb 14, 2023	Final report with temperature measurement without top-case .

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1. Objective :

In the upgraded Tango based **GMRT Control & Monitoring (TGC)** System, the MILTEC PC is installed at each antenna base to control an antenna locally or remotely. The MILTEC PC (4U Military/Industrial grade PC make by Hyderabad based company¹) were procured during 2016-17 at all 30 antenna(s). These PCs are in use with great reliability, but now after six years of usage, PCs are indicating some problems like hard-disk failure, RAM problem(s), and CPU heating issues. Therefore, to evaluate a possible new PC for the antenna shell as a LMC (Local Monitor & Control) , recently telemetry lab purchased a small form factor **(SFF) DELL Optiplex 7000** machine (now onwards referred as Dell or Dell Optiplex PC).

This report aims to give user point of view evaluation and testing information on fitment of Dell Optiplex PC as a GMRT antenna Control PC by **(i)** Verifying h/w specification requirements. **(ii)** Checking acceptable RFI limits, CPU cores' temperature data etc. **(iii)** Remote Control facility to switch ON/OFF PC over Ethernet. **(iv)** Usability at the antenna shell **(v)** Performance checking of LMC software by testing the PC at antenna-base for longer duration.

2. LMC verification of Technical Specifications :

2.1 Following requirements were envisaged for the LMC-PC at the antenna base :

- (i)** The CPU should have an inbuilt power surge suppression mechanism. Device should directly consume the 230V AC at 50Hz.
- (ii)** PC shall be able to fit in the ABR rack with less than 4 U size after RFI shielding enclosure.
- (iii)** PC shall match the EMI/EMC, and RFI compliances of the GMRT standard so that it doesn't affect antenna receiver signal or other electronics system (and vice versa) at the antenna-base.
- (iv)** PC hardware should have a provision to expand inbuilt memory (RAM and permanent storage).
- (v)** PC shall operate continuously for 365 days, 24 Hrs (Without having to restart/reboot). PC shall have high MTBF (overall reliability of 95% for a period of 320 days if operated for 24 Hr per day).
- (vi)** PC shall be able to communicate with all interfacing subsystems of an individual antenna at all the time i.e. using USB-RS485 interface for the old MCM(s), and Ethernet interface over network.
- (v)** PC shall work in Operating range of minimum 15 degree C to Maximum 80 degree C (Ambient temperature is around 19 to 24 degree C at the antenna base.)
- (vi)** PC shall be able to support a minimum of five years of operation at antenna shell.

(vii) The indicative configuration requirements are:

- RAM (Random Access Memory)- 16 GB
- Permanent Storage (Physical Memory)- 500 GB
- Cache memory- 1MB (per core)
- Processor speed- 2.7 GHz
- Multicore Processor (at least quad Core)
- Four USB Ports (USB 3.0)
- Dual Ethernet Ports- 1 GB

¹ <http://www.miltec.in>

- Dual VGA Output
- DVI and or High Definition Media Interface (HDMI) (Optional) interface
- Support for Open Source 64-bit Operating System (OS)

2.2 Dell Optiplex 7000 SFF Technical Specifications :

- As per the hardware requirement specifications mentioned in section 2.1 , Dell Optiplex 7000 Small form factor PC was selected. The Dell Optiplex 7000 SFF machine specifications are given in **Table-1** below :

Table 1 : Dell Optiplex 7000 PC technical specifications

Description	Values
Processor	12th Gen Intel® Core™ i5-12500 (18 MB cache, 6 cores, 12 threads, 3.00 GHz to 4.60 GHz Turbo, 65 W)
Operating System	Ubuntu® Linux® 20.04 LTS , 64 Bit
Memory	16 GB, 2 x 8 GB, DDR4
Hard Drive	M.2 2230 256GB PCIe NVMe Class 35 Solid State Drive (EM)
Additional Hard Drive	Additional M.2 2230 256GB PCIe NVMe Class 35 Solid State Drive
Network	logical name: enp0s31f6, Ethernet Connection (17) I219-LM capacity: 1Gbit/s, clock: 33MHz
Serial Port Adapter	Available
Ports	DisplayPort, USB, Ethernet,
Temperature range	Low = -0.1 deg C, High ~ 80.0 deg C, critical 84.8 deg C for SSD , and 100 Deg. C for CPU

- The Following table lists the height, width, depth and weight of Dell Optiplex Machine :

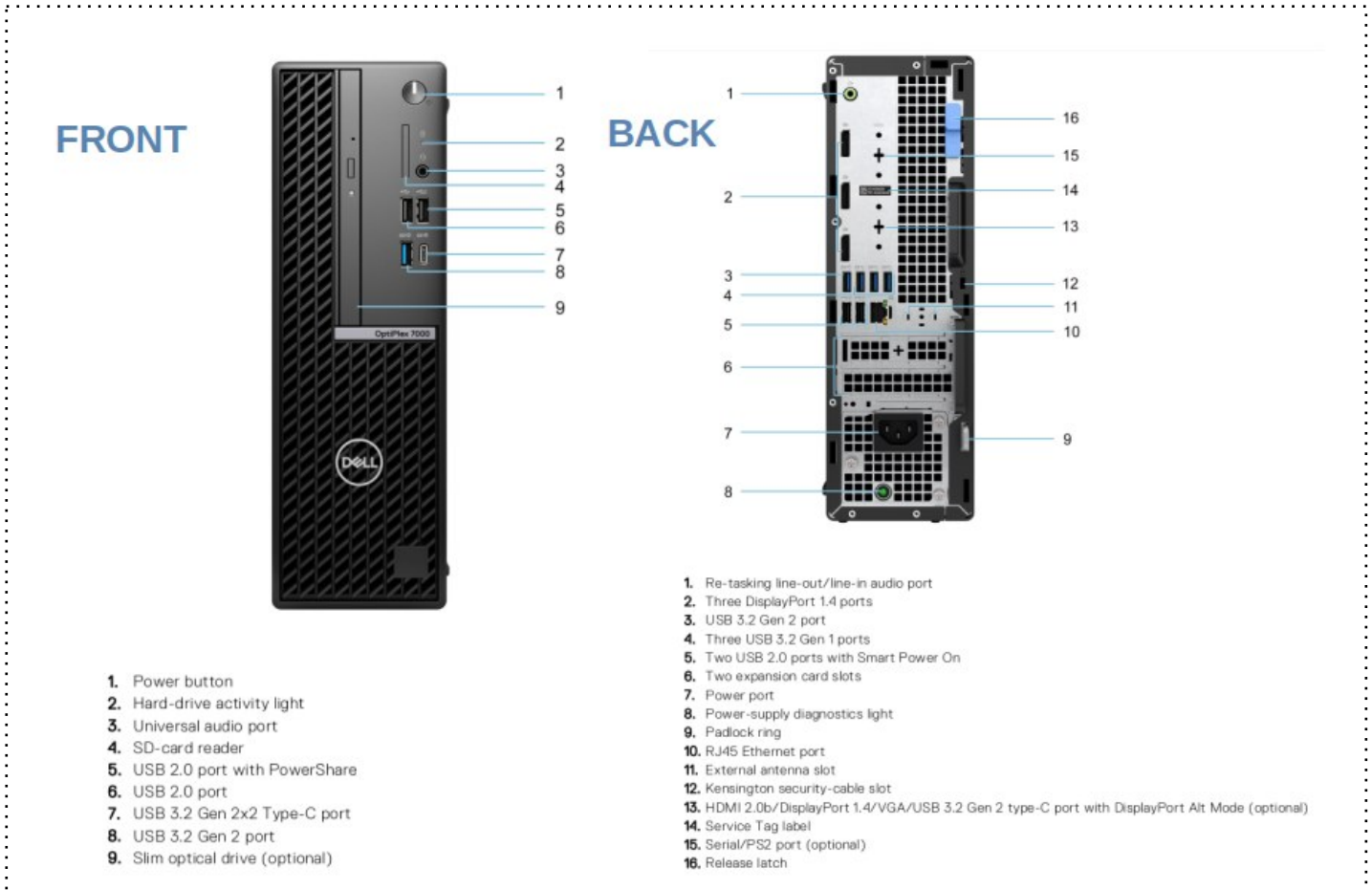
Description	Values
Height	290.00 mm (11.42 in.)
Width	92.60 mm (3.65 in.)
Depth	292.80 mm (11.53 in.)
Weight	<ul style="list-style-type: none"> ● Minimum: 3.85 kg (8.50 lb) ● Maximum: 5.30 kg (11.69 lb)

- Views of Dell Optiplex 7000 SFF Machine (Front and Back) are shown in **Figure -1**.

3. Hardware Modifications and testing :

To accommodate the new Dell machine into the existing MILTEC machine RFI enclosure cabinet, C-clamps were designed with the help of a mechanical team. The PC assembled inside the box is shown in **Figure -2** . Other Hardware modifications like AC Fan (2 In , 2 Out), USB , Ethernet, Power cord, Serial port wiring/connections were done by Telemetry Team.

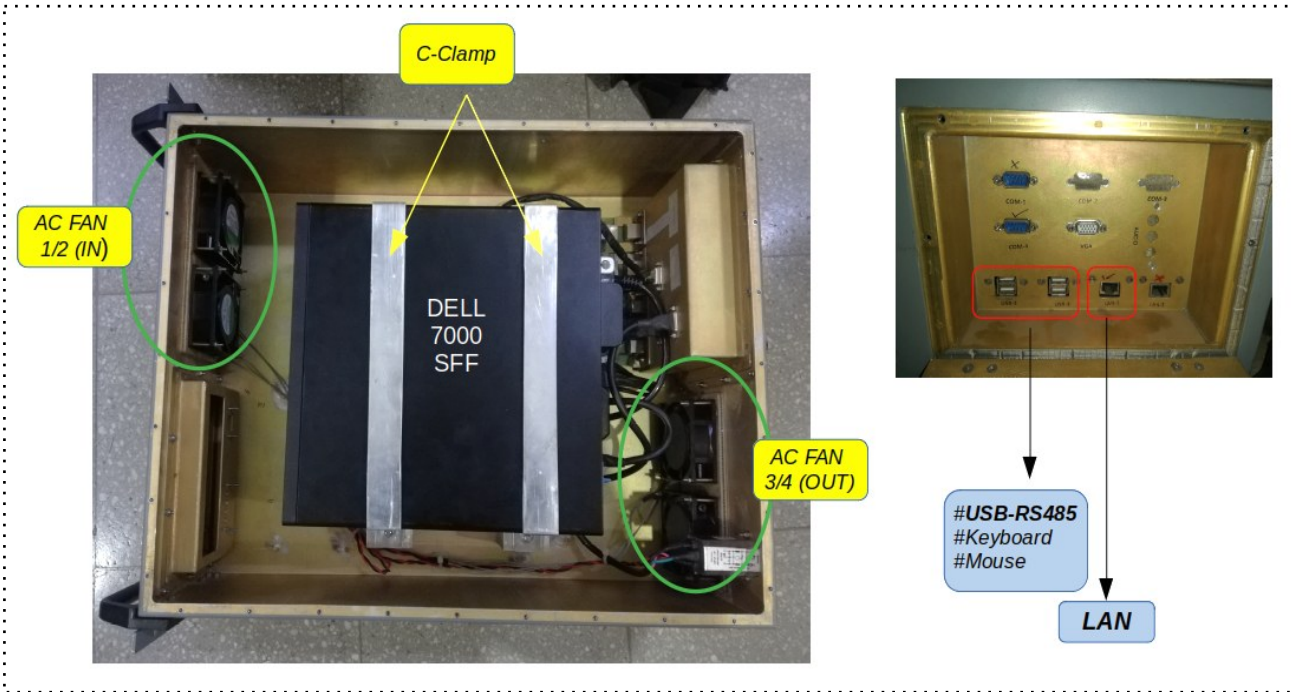
Figure - 1 : Dell Optiplex 7000 SFF Front & Rare view



3.1 Miltec Box Shielding :

The existing Miltec based LMC machine's Cabinet was used for the RFI Shielding, so that possible RFI associated with the new Dell Optiplex machine can be alleviated. More details about RFI tests conducted by the RFI department , and RFI results (Dell machine RFI test with Box , Without Box etc.) are discussed in Section 3.2.

Figure 2 : The Dell 7000 SFF assembled in the MILTEC Shielding-box



3.2 RFI Reports with Box and without Box :

RFI team measured radio frequency interference of the Dell Optiplex 7000 PC. **The measurement test reports show no significant RFI from the PC in 0 to 2500 MHz range.** The RFI was measured in a variety of PC-ON conditions viz. the Dell-PC outside, without outer or top cover, without outer-cover but inside the shielded box, and with outer-cover, outside and inside the shielded box. Following table list results from the RFI test report provided by shri. S. Kumar et al. (*NCRA Internal technical report GMRT/RFI/1 –29th Nov., 2022*).

Table 2 : RFI Test summary (Reference : *NCRA Internal technical report GMRT/RFI/1 29/11/2022*)

#	Test Condition	Frequency (MHz)	Noise Level (dB)	Discrete Lines
1	CPU ON without shielded enclosure and top cover plate removed	0-2750	2-35	Present
2	CPU ON inside the shielded enclosure and top cover plate removed.	0-2000	2-8	Single line at 2412.6 MHz
3	CPU ON without shielded enclosure, With top cover plate	0-2500	2-30	present
4	CPU ON with shielded enclosure, With top cover plate	0-3000	No increase in noise	No

3.3 CPU Temperature measurements :

The new Dell PC was kept at 'C11' antenna during 24-26 Dec 2022 for LMC testing without a Miltech Box. On Jan 12th, 2023, Dell PC installed with Miltech-Box having clamps with a care of completely RFI enclosure at 'C11' antenna again. We logged CPU processes, and temperature data without Miltech-box, and With the Miltech-Box². For this purpose, a bash shell-script was written to acquire CPU consumption, CPU core temperatures, and hard-disk temperature data per 20 second. To compare with other legacy Miltec machines, Miltec PC antenna data at the C10 antenna was also collected. A short summary on analysis of this data is as follows :

(i) Dell PC shows temperature rise of 4 to 6 degree C With Miltec-Box as compared to without box. Please refer to **Figure - 3 (a)** plots for 14-15 Dec 2022 (Without Box) and **Figure - 3 (b)** 14-15 Jan 2023 (With Miltech Box).

(ii) Dell PC with Box shows lower temperature than the Miltech-PC at C10 antenna in-use by 4 to 5 degree C, refer **Figure - 4**.

(iii) When the Java process for LMC is taking CPU consumption 100 % due to some reason (c11 antenna was functioning correctly, sometimes data-connection may have been more), at that time temperature rose suddenly which is from 33-38 to 55-70 degree C. Refer to **Figure - 5**. Therefore, temperature may rise up to 77 degrees which is not desirable but may be sustainable (85 degree C is the highest limit to shutdown PC).

(iv) As per the RFI group suggestion, we took temperature data without Dell Optiplex top-case cover but inside the Miltec RFI shielding box. **The data was collected from Jan 27th to 29th, 2023. Without top-case cover, CPU temperature seems to be reduced by 2 to 4 Deg C (Refer to Figure - 6) .**

² Using 'lm-sensors' and 'nvme-cli' tools in Ubuntu 20.04 LTS, and monproc.sh bash script written by J. Kodilkar

Figure 3 (a) CPU Core temperature without Box (NoBox,24 Dec 2022), and with Miltec box (MBox, 14 Jan 2023)

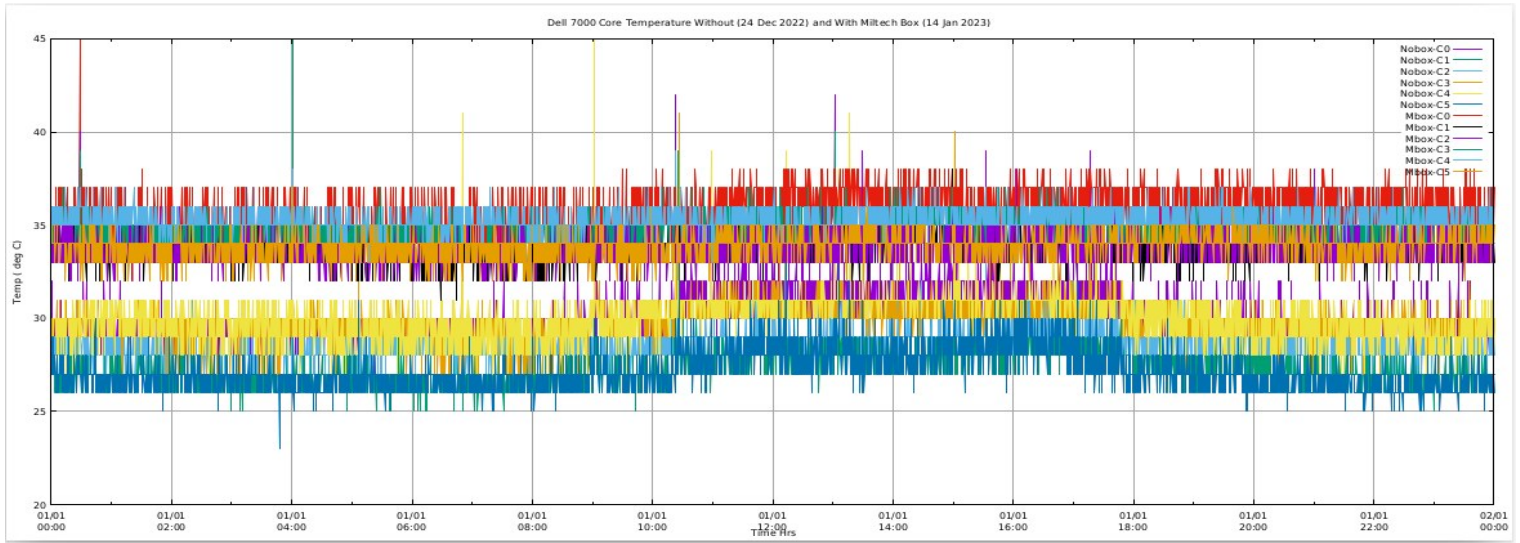


Figure 3 (b) CPU Core temperature without Box (NoBox,25 Dec 2022), and with Miltec box (MBox, 15Jan 2023)

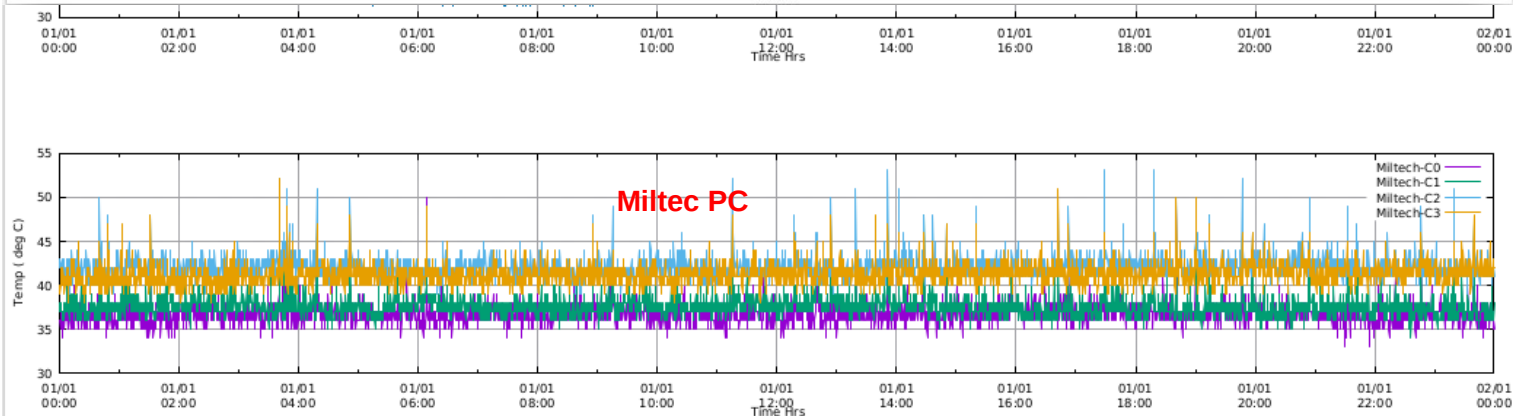
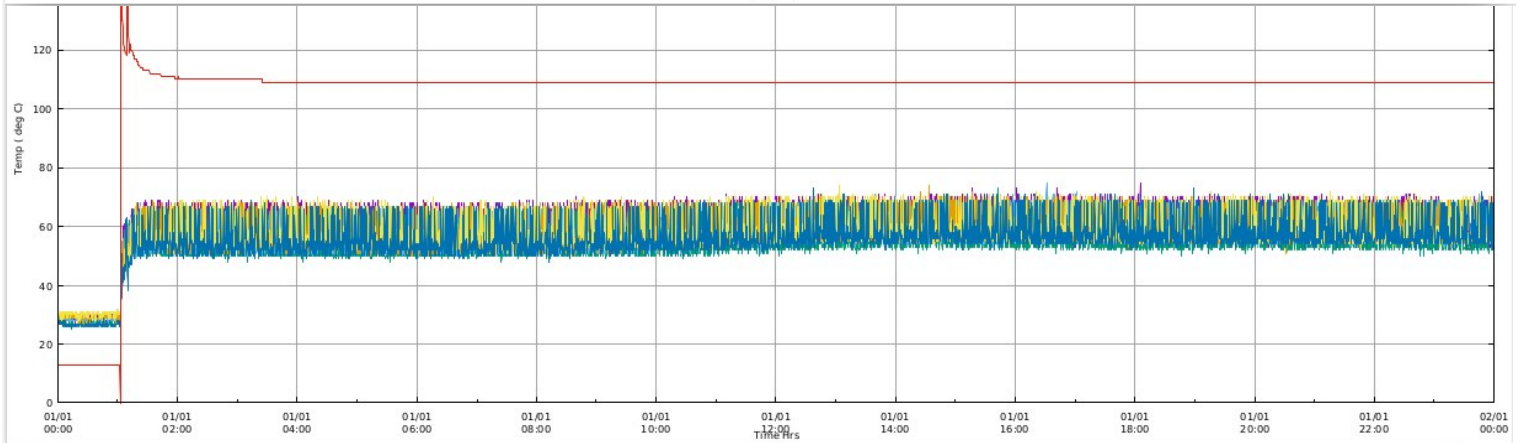
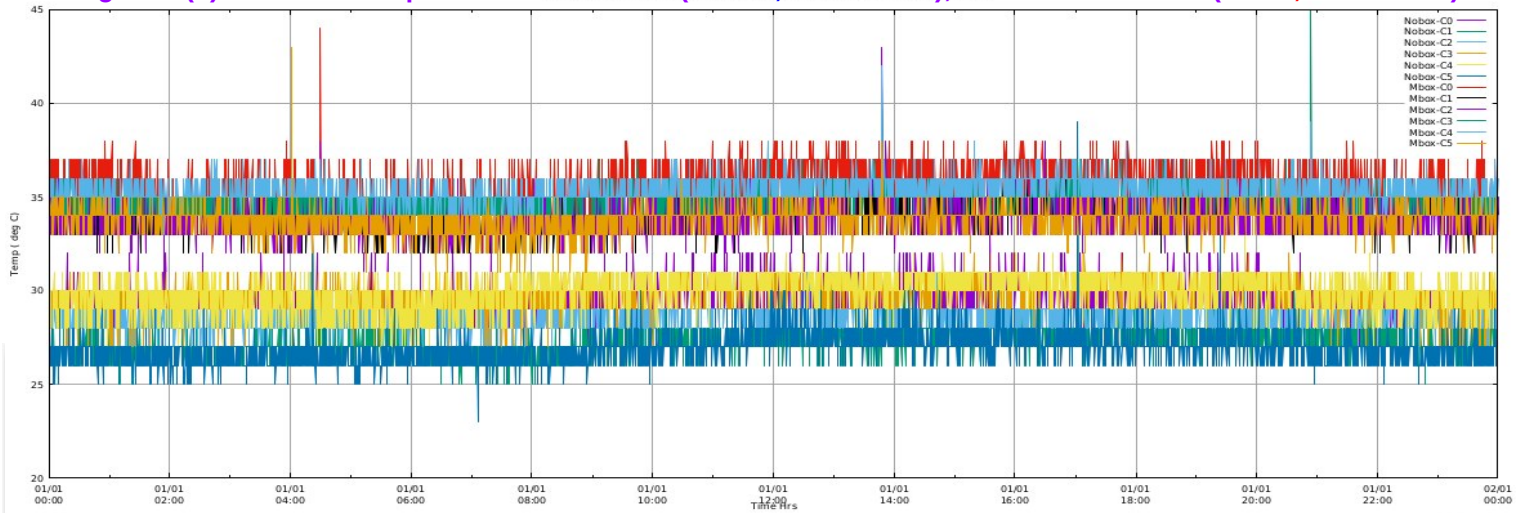


Figure 5 : Dell 7000 Core temperature without Miltec Box (Dec 26, 2022) raised due CPU 100 % busy

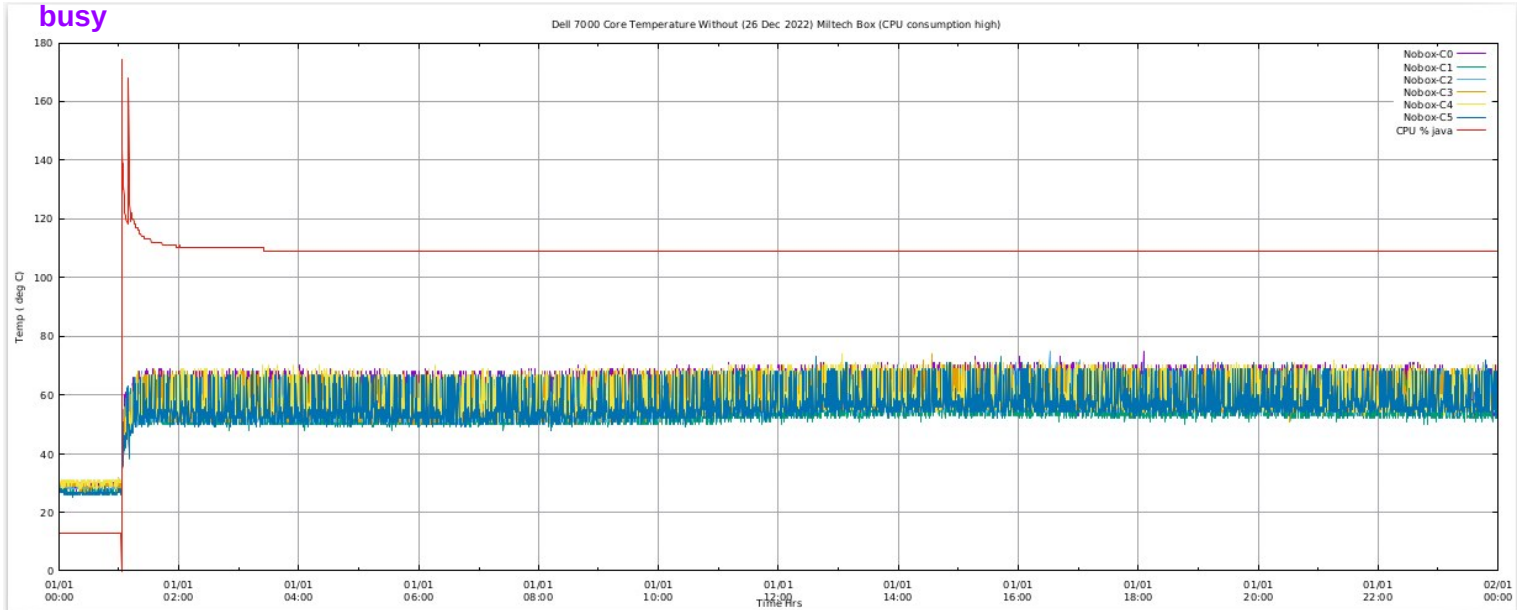
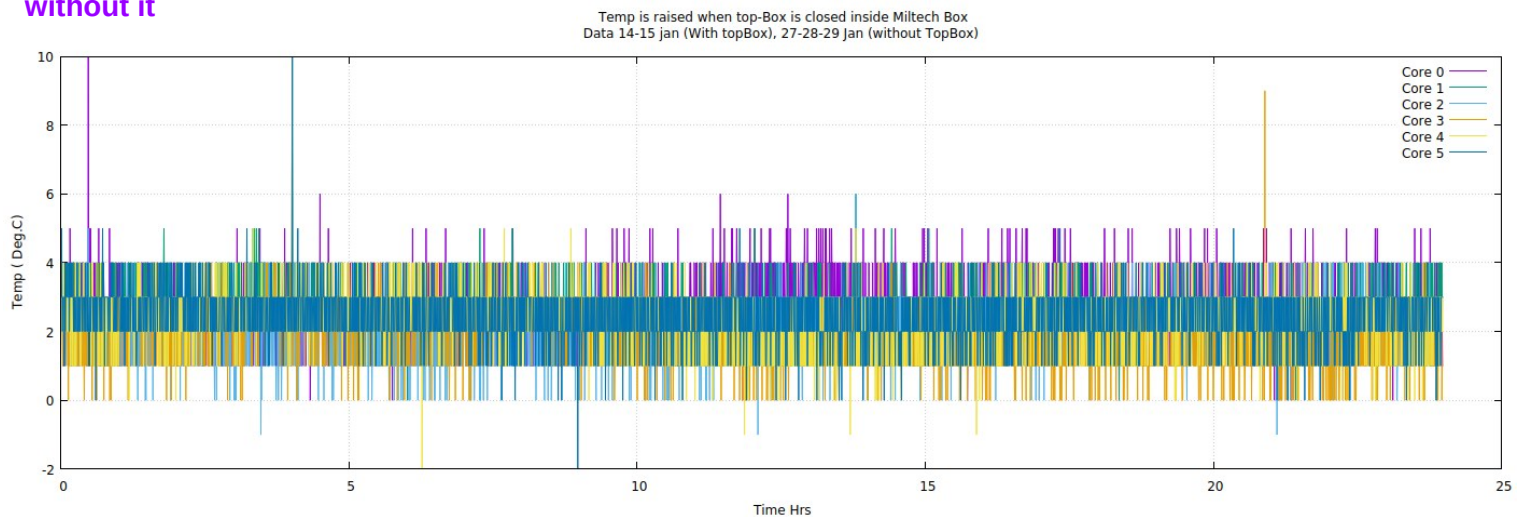


Figure 6 : Temperature difference inside the Miltec shielding box with Dell-PC top-case cover and without it



4. Software changes in the OS :

4.1 Remote PC On over WAN(WOL)

Wake-on-LAN (WOL) is a feature that allows one to turn on a PC from another machine via the network. It does this by sending a tiny “magic” packet of data from a host computer. The network driver of the receiver computer can receive this data and signal the device to power ON. To enable the WOL feature, following changes are needed in the BIOS and at software level.

(a) BIOS Settings (DELL Optiplex machine)

Enable Wake ON LAN (WOL) in the System Management Section. Option to select in System management is as below:

- **LAN Only:** Option allows the system to be powered On by special LAN Signal from a network host computer .
- **Disable 'Deep sleep control'** in the Power Management section.

(b) Setup for Wake ON LAN (DELL Optiplex machine)

(i) For Wake-on-LAN to work, a remote/target machine Ethernet card needs to support this feature. Every Ethernet interface card has a unique name found with the following terminal command. In Terminal, the ip address and other information are displayed with the following command:

```
>> ip a // To check ethernet card ID and MAC address]
           Ethernet card network interface name : enp0s31f6
           MAC address: 74:86:e2:27:46:a4
```

(ii) To view and change the Wake-On-Lan settings, the "ethtool" package must be installed. Ethtool is an open-source application that allows you to change network driver settings. For wake-on-LAN, it will allow your PC to understand the data it's receiving. The command to install ethtool is:

```
>> sudo apt install ethtool
# Next, find out if the network card supports wake-on-LAN:
>> sudo ethtool enp0s31f6
# In command result find below lines,
  -> Supports Wake-on: pumbg
  -> Wake-on: g
```

The first line tells you whether Remote PC supports Wake-On-LAN. There might be other letters along with the g. For now, we only need the "g." The second line shows whether Wake-On-LAN is enabled, if not then it will show **Wake-on: d**. Run the following commands to enable wake-on-lan on your network card:

```
>> sudo ethtool --change enp0s31f6 wol g # Where " enp0s31f6" is Remote machine
           # Ethernet Card ID
```

(iii) Install Wake ON LAN (Wakeonlan) package On Host machine:

'wakeonlan' is a client software, which is used to send magic packets to the Remote/target machine. To install WOL on the host machine run below commands.

```
>> sudo apt-get install wakeonlan

# To Power ON machine using this features type following command in host machine terminal :

>> wakeonlan -i <IP Address> <MAC Address> ,
           # IP Address of target machine (Dell Optiplex machi
           # MAC Address of Dell machine
```

For Example to switch ON C11 Dell Optiplex based LMC machine command is,

```
>> wakeonlan -i 192.168.41.2 74:86:e2:27:46:a4
```

Sending magic packet to 255.255.255.255:9 with 74:86:e2:27:46:a4, Command Result with Success or failed

4.2 PC Suspend problem :

During the user evaluation period, Dell PC was automatically used to suspend after 15 to 30 minutes of interval. To overcome this problem, the Linux desktop “utility” tool is used to “cancel” the suspend mode. Even after that suspend problem was not resolved (in spite of some BIOS settings). After making the following changes, the problem was resolved.

The SOP to follow for the new Dell PC to overcome suspend problem is

(a) BIOS Settings :

- Disable ‘CSTAT’ option to go CPU in “**sleep mode**”.
- Select the ‘**Power**’ option to save the “**last power setting**”. (So that if the PC was manually switched Off it will remain in Off condition, OR if it was ON it will be powered on automatically once electrical power supply is resumed.)

(b) OS settings :

```
>> In “/etc/systemd/logind.conf” file enable option “IdleAction=ignore”
```

```
# Execute systemctl command to mask the sleep, suspend, hibernate related arguments.
```

```
>> sudo systemctl mask sleep.target suspend.target hibernate.target hybrid-sleep.target
```

5. LMC Software Testing :

The LMC software was installed on Ubuntu 20.04 OS, and tested in the lab (Dec 2022) . The LMC software comprises several basic packages for the Tango, Scripting interface, GUI, Archive, and Alarms notification services. The LMC software installed for the C11 antenna was tested at the Lab, and then tested at the C11 antenna shell (From Dec 22 to Jan 22, 2023). **Table-3** gives LMC Software packages, and **Figure-7** gives CPU performance for running the software LMC.

Table 3 : Details of the LMC Software component(s) installed on Dell-PC at C11 antenna

#	Software packages	Component	Version	Remark
1	Java LMC	node.jar	3.8.60	LMC Java based Tango Device Server
		Java	1.8	openjdk version "1.8.0_352"
		JTango	9.5.0	Tango implementation in Java
		JacORB		CORBA Framework in JAVA For the Tango
		TANGO³	9.2.5a	Tango Control Tool Kit
		omniORB	4.3.0	CORBA Framework in C++ For the Tango
		zeromq	4.3.0	Message Queue library with broker (0)
		log4cpp	1.1.3	Logger (information, debugging, etc.)
		doxygen	1.9.2	Tango Class documentation Lib
2	Database	MySQL	8.0.31	MySQL database
3	python		2.7.0	Scripting language
4	MNCScriptManager	PyTango	9.3.3	a python module which exposes "Tango C++ APIs" to Python.
		Boost	1.76.0	a framework for interfacing Python
		protobuf	3.17	Protocol buffer to serialized structured data which is platform and language independent
		NumPy	1.1	To store arrays at one continuous place in memory for faster access (unlike lists).
		Six	1.10	a Python 2 and 3 compatibility library
		Sphinx	1.8.6	Document Generator
5	GUI	PyQt4	4.4.12.1	PyQt4 exposes the Qt4 API to Python
		pyqt4-dev-tools	4.12.1	PyQt4 Development Libraries
		python-qt4-phonon	4.4.10.0	The Phonon module of PyQt4 provides bindings for the Phonon Multimedia library to Python
		libqwt5-qt4	4.5.2.3	Python version of the Qwt5 technical widget library PyQwt is a set of Python bindings for the Qwt C++ class library which extends the Qt framework with widgets for scientific and engineering applications.

³ <http://www.tango-controls.org> (Telescope and Accelerator Controlled Objects - **TACO** **N**ext **G**eneration **O**bjects)

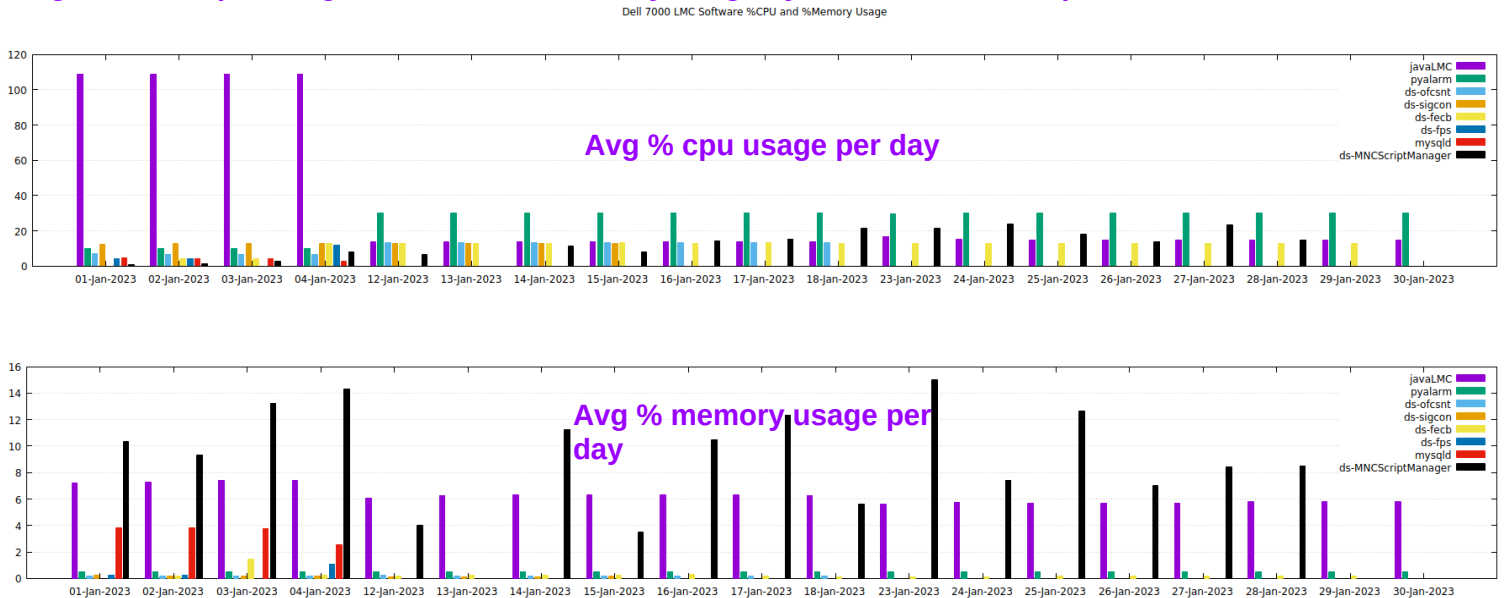
				It provides a widget to plot 2-dimensional data and various widgets to display and control bounded or unbounded floating point values.
		Taurus	3.7.3	A framework for scientific/industrial CLIs and GUIs
		taurus_pyqtgraph	0.3.0	Taurus extension providing pyqtgraph-based widgets
6	Alarm Archiver	ArchivingRoot	16.2.4	Collect tango attributes and insert them in a DataBase at fixed rate (Old HDB data for logging Alarm information.)
7	HDB++ Archiver	HDB++		To Archive LMC Tango attributes
		libhdbpp	1.0.0	Interface library for the HDB++ archiving system
		liphdbpp-mysql	1.1.0	Library for HDB++ implementing MySQL schema
		Hdbpp-cm	1.0.0	Tango device server for the HDB++ Configuration Manager
		Hdbpp-es	1.0.2	Tango device server for the HDB++ Event Subscriber
		hdbpp-configurator	3.10.0	Java GUI configurator client for TANGO HDB++
		hdb++Viewer	1.7.0	HDB++ Viewer is a standalone JAVA application designed to monitor signals coming from HDB++ .
9	Panic Alarm Suite	Panic	7.6.2	a python Alarm System for TANGO
		Fandango	14.14.1	a Python library for developing functional and multithreaded control applications and scripts.
10	Positional Astronomy	Novas	3.1.1.3	Naval Observatory Vector Astronomy Software : ANSI C functions for computing many commonly needed quantities in positional astronomy
		calcnova	Mar 2017	Routines Used for GMRT Track (J. Kodilkar), uses gNovas Wrapper Library (Deepak Bhong)
		scaled_format	2.1	to validate and convert user-friendly input-string of ANGLE and TIME to the required format string for the GMRT Control-system (J. Kodilkar)
11	Authentication and Authorization	Krb5-admin-server,	1.17	Kerberos is a system for authenticating users and services on a network.

	(Kerberos_v5)	kdb5_util, krb5-kdc		
12	Network and Time	ntpd	4.2.8	sets and maintains the system time of day in synchronism with Internet standard time servers
Low level GMRT Sub-system Control				
13	SubSystem Tango Devices	Pc104, rabbit_card	Jul 15, 2022	C++ Tango Device Servers
14	MCM Driver	mcmtest	Jun 2012	USB to RS485 converter driver for the MCM communication (Rajsingh Uprade)
15	MCM DeviceClient	deviceClient(s) [FPS,FECB, IFLO, OFCSNT]	Apr 2019	FIFO based DeviceClients to issue commands to the GMRT Subsystems (R. Uprade, J. Kodilkar, Amol Chavan, Bhavesh)

5.1 CPU performance

Over a month, LMC software was tested on the Dell PC at C11 antenna for real-time performance testing by running the LMC software. Sometimes the LMC java process was showing 100% CPU usage, in spite of that LMC was running OK. However, most of the time, LMC processes don't show much CPU consumption which results in normal CPU core operating temperatures 33-37 deg C. Figure - 7 shows the %CPU , and %MEM usage for the data taken over a month. Data was recorded per 20 seconds, and averaged over a day for the top processes which consume CPU time.

Figure - 7 : Top average %CPU, and %Memory usage by the LMC software processes



6. Conclusion :

The Dell Optiplex 7000 SFF PC as a GMRT antenna Control PC in the TGC system may be used based on evaluation and testing results and findings which are as follows :

- The configuration of Dell Optiplex 7000 SFF PC matches the indicative specification requirements of the LMC-PC in the TGC system for controlling an antenna viz 12th Gen Intel® Core™ i5, 16 GB RAM, SSD 512 GB drive, and 1 GPS network with WOL facilities.
- The small form factor (SFF) fits into the legacy Miltec PC RFI shielding box.
- There are no heating issues of the Dell PC when the PC is enclosed in a RFI shielding box with the PC top-case cover or without it. The temperature range is around 33 to 37 deg C.
- As per the RFI testing report by RFI personnel, no significant RFI is noticed when the PC is enclosed side the shielding box with or without top-cover in frequency range of 0 to 2 GHz.
- The PC BIOS configuration and OS level changes were customized successfully to enable the Wakeup on LAN (WOL) facility, and resolved the PC Suspend problem in case of ideal condition.
- The LMC software performance was monitored for more than one month at C11 antenna. No PC hardware or software related problems detected.