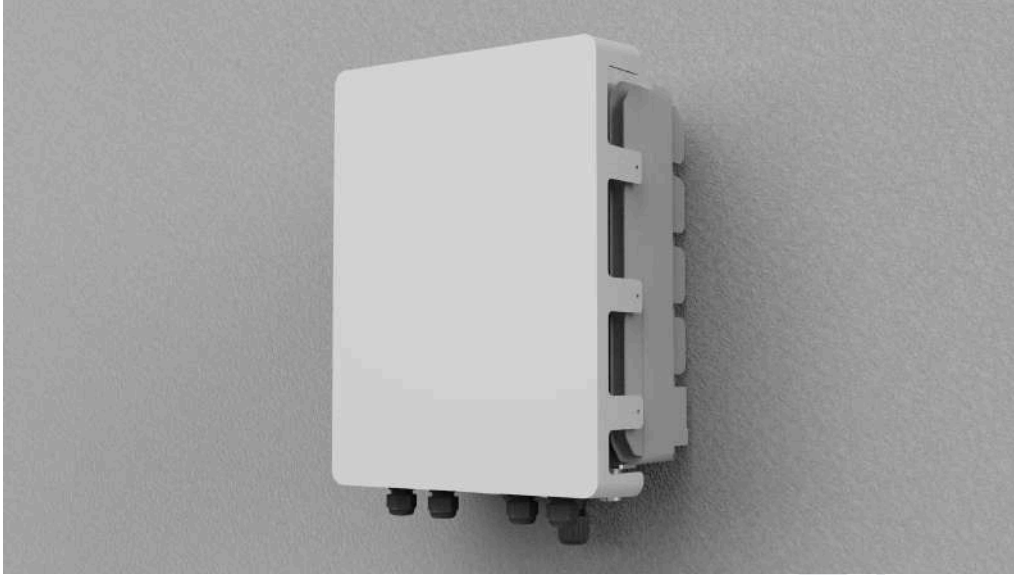


VVDN MPRU



Medium Power Radio Unit

USER MANUAL

Version Control

Name	Date	Version Number
VVDN_MPRU_Installation and Operating Guide	3 -Sep-2024	A0_03

Revision History

Created By	Reviewed By	Date	Reason for Changes	Version
VVDN TEAM	VVDN QA TEAM	June-2024	Revised M plane configuration summary	Revised Version-A0_01
VVDN TEAM	VVDN QA TEAM	August-2024	Mechanical details including mounting bracket updated	A0_02
VVDN TEAM	VVDN QA TEAM	Sep-2024	CLI,GUI,FAQ & Troubleshooting section added	A0_03

TABLE OF CONTENT

1. About This Document	8
1.1 Intended Audience	8
1.2 Document Conventions	8
2. Product Overview	9
2.1 Key Features and Specifications:	9
2.2 Device Specification:	10
2.3.1 RU Product Identification Format:	12
2.3.2 RU Product HW Identification Format:	12
3. What's in the Box?	12
3.1 Default Accessories List	13
3.2 Add-on Accessories List	13
4. Outlook	14
4.1 Dimensions of Product With Antenna	14
4.2 Dimensions of Product Without Antenna	15
4.3 Connectors Required for connecting the Antenna output port of MPRU	16
4.4 MPRU Basic Setup Diagram	17
4.5 MPRU LED Notification	17
5. Device Setup	19
5.1 Hardware Installation	19
5.1.1 Ideal mounting location	19
5.1.2 Ideal Installation Height:	19
5.1.3 Mounting Screw Holes:	19
5.1.4 Mounting the Device:	19
5.2 WEB GUI	20
Types of Logins	20
5.2.1 Device Information	20
5.2.2 Configuration	22
a) Sync	22
b) Fronthaul	23
c) ORAN	24
d) RF Calibration	24
5.2.3 Maintenance	26
5.2.3.1 Management	26
System	26
IP Management	27
Logs	27
5.2.3.2 Firmware Upgrade	29
5.2.4 Performance	30

5.2.5 System Measurements	31
5.2.6 Fault Management	31
5.2.7 About	32
6. Startup Configurations	32
6.1. Booting up the device	32
6.2. Remote Configuration	32
6.3. Prerequisite	33
6.5.Netconf Client Installation	33
6.5.1. Compilation and installation:	33
6.6 Procedure	36
6.7 Firmware upgrade via M Plane	37
6.7.1. Firmware upgrade using v7 yang modules	37
6.7.1.1. Software Download	37
6.7.1.2. Software Install	37
6.7.1.3. Software Activate	38
6.7.1.4. Software Reset	38
6.8. Performance management via M Plane	38
6.8.1.o-ran-performance-management.yang Module for V 7 Netopeercli yang.	38
6.9. U plane configuration via M Plane	41
6.9.1.o-ran-uplane-conf.yang Module	41
6.10. Interface configuration via M Plane	47
6.10.1.o-ran-interface.yang Module for V7 yang modules.	47
6.10.2.o-ran-interface.yang Module for V7 yang modules.	48
6.11. Processing element via M Plane	49
6.12. Transceiver configuration via M Plane	50
6.13. mplane-int.yang configuration via M plane	50
6.13.1. Mplane-int.yang for v7 yang modules	50
6.14. O-ran-troubleshooting configuration via M plane	52
6.14.1. Start Troubleshooting	52
6.14.2. Stop Troubleshooting	52
6.15.o-ran-trace configuration via M plane	52
6.15.1. Start Trace	52
6.15.2. Stop Trace	52
6.16. o-ran-supervision configuration via M Plane	53
6.17. o-ran-usermgmt configuration via M plane	53
6.18. o-ran-hardware configuration via M Plane	53
6.18.1. o-ran-hardware v7 yang modules.	53
6.18.2. o-ran-hardware v7 yang modules.	57
6.19. o-ran-operations configuration via M plane	58

6.20. O-ran-file-management configuration via M plane	58
6.20.1 o-ran-file-management configurationFor V7 based yang modules	58
6.20.1.1 O-ran-file-management: file-download	58
6.20.1.2 O-ran-file-management: file-upload	59
6.20.1.3 O-ran-file-management: retrieve-file-list	59
7.CLI MANAGER	60
Fig 28: CLI manager log in	60
Fig 29: CLI Manager Functions	61
Fig 30: To set RU IP static	62
Fig 31: To get and set RU interface status	62
Fig 32: To get RU sw version	63
Fig 33: To get HW information	64
Fig 34: FH MAC address	64
Fig 35: RU up time	64
Fig 36: 1G Status	64
Fig 37: 10G Status	65
Fig 39: Get and Set Bandwidth	66
Fig 41: Get and Set DU MAC address	67
Fig 43: Get and Set CU Plane VLAN	68
Fig 44: Set and Get UL compression	68
Fig 46: Help	69
8.FAQ	70
8.1 How to check if RU is properly booted or not?	70
8.2 How to check if RU is getting C,U,M & S plane packets properly or not?	70
8.3 How to check if the SFP port is Link Up or not?	71
8.4 Can I add Switch between O-RU and GM?	71
8.5 Can I add a Switch to connect O-RU and O-DU?	71
8.6 How to check if RU is PTP sync or not?	72
8.7 Which PRACH format does RU support?	72
8.8 How can we configure the DU MAC address ?	72
8.9 How to add a VLAN ID ?	73
8.10 How to change PCID for DL & UL carrier ?	73
8.11 How to Check & Select the MAC Address for fronthaul Interface ?	73
8.12 If you are using an INTEL E810 card, the below configuration needs to be installed.	74
8.13 How to change PCID for PRACH carrier ?	74
8.14 What is the O-RAN M-Plane specification version with which VVDN MPRU is compliant?	74
9. Troubleshooting	75
9.1 Why can DU not receive any data from RU?	75
9.2 If you have further queries about RU, where to reach ?	76

LIST OF TABLES

Table 1: Document Conventions	7
Table 2: Abbreviation	8
Table 3: Device Specification	8
Table 4: Product identification format	9
Table 5: List of Items in the box	10
Table 6: Device Accessories	11
Table 7: Add on Device Accessories	11
Table 8: Booting up led indication	15
Table 9: Network and status-led notification	15
Table 10: RU Login credentials	18

LIST OF FIGURES

Fig 1: Product Dimension With Antenna	15
Fig 2: Antenna and FH details	15
Fig 3: Product Dimension Without Antenna	16
Fig 4: Antenna and FH details	16
Fig 5: Setup Diagram	17
Fig 6: Pole Mounting	17
Fig 7: Mount Bracket	17
Fig 8: Device Mounting	19
Fig 9 : GUI Login Page	20
Fig 10: GUI Dashboard	21
Fig 11: PTP configuration	22
Fig 12: Fronthaul Configuration	23
Fig 13 : ORAN Configuration	24
Fig 14: RF calibration	25
Fig 15: Copy-config	26
Fig 16: System Management	27
Fig 17: IP management for Dynamic	28
Fig 18: IP management for Statis	28
Fig 19: System Logs	29
Fig 20: Temperature logs	29
Fig 21: Interface logs	30
Fig 22: Firmware Management	31
Fig 23: Performance Counters	32
Fig 24: system Measurement	32

Fig 25: Fault Management	33
Fig 26: About Page	33
Fig 27: ssh host key	65
Fig 28: CLI manager log in	66
Fig 29: CLI Manager Functions	67
Fig 30: To set RU IP static	68
Fig 31: To get and set RU interface status	68
Fig 32: To get RU sw version	69
Fig 33: To get HW information	70
Fig 34: FH MAC address	70
Fig 35: RU up time	70
Fig 36: 1G Status	70
Fig 37: 10G Status	71
Fig 38: RU counters	72
Fig 39: Get and Set Bandwidth	72
Fig 40: Get and set DL compression	73
Fig 41: Get and Set DU MAC address	73
Fig 42: Get and Set PXSCH PCID	74
Fig 43: Get and Set CU Plane VLAN	74
Fig 44: Set and Get UL compression	74
Fig 45: Get and Set PRACH PCID	75
Fig 46: Help	75
Fig 47: CUSM plane counts	76
Fig 48: ethtool command	77
Fig 49: GUI Device Information tab	78
Fig 50: DU MAC address	79
Fig 51: Vlan ID	79
Fig 52: eAxCID or PC ID	80
Fig 53: PRACH PCID configuration via GUI	80

1. About This Document

This document would help to understand and operate the Medium Power Radio Unit.

1.1 Intended Audience

The intended audiences for this document are End Users of this product.

1.2 Document Conventions

The different conventions used in this document are explained in the following table:

Table 1: Document Conventions

Convention	Description
	Do not touch/handle the board without proper ESD precautionary measures.
	The board is ROHS-compliant
	Do not turn ON the board without terminations (Not applicable if Antenna is connected)
	Alert! Hot, Do not touch Please wait for sometime for RU to get cool after turned OFF

Table 2: Abbreviations

Sl. No	Abbreviations	Long form
1.	DU	Distributed Unit
2.	ESD	Electrostatic discharge
3.	FPGA	Field Programmable Gate Array
4.	GPS	Global Positioning System
5.	JTAG	Joint Test Action Group
6.	LED	Light Emitting Diode
7.	PCB	Printed Circuit Board
8.	RF	Radio Frequency
9.	RU	Radio Unit
10.	SCS	Subcarrier Spacing
11.	UART	Universal Asynchronous Receiver-Transmitter
12.	USB	Universal Serial Bus

2. Product Overview

The Medium Power Radio Unit (MPRU) is a single-board Optical to Radio interface solution for 5G low-power RU applications, The RU has a digital and RF section realised in a single board, and the system can be used for improving 5G network coverage and can be cascaded into multiple stages.

2.1 Key Features and Specifications:

- Deployment Type: Outdoor RU
- Radio Configuration: **1 CC, 100 MHz, 4Tx4R**,
- IBW :200MHz
- OBW : 100MHz
- Supported Frequency bands 3400 - 3600 MHz, **3550 - 3700 MHz**,3600 - 3800 MHz, 3800-4000MHz
- Mode: Single Numerology, SCS 30KHz
- Antenna: External Snap on Antenna
- Front haul: 10G over SFP+
- Powered by DC (-40V to -57V)

- RF Power: 4x5W
- O-RAN Split: 7-2a

2.2 Device Specification:

Table 3: Device Specification

Radio Specification	
Band	3400 - 3600 MHz, 3550 - 3700 MHz, 3600 - 3800 MHz, 3800-4000MHz
Bandwidth	100MHz
Duplex Mode	TDD
Modulation	QAM 256/64/16/QPSK
Carriers	1
SubCarrier Spacing	30KHz
RF Output power	5 Watt/37dBm
Connectivity Specification	
Data Link	10G SFP+
Interface Protocol O-RAN	FH Split 7.2
Power Specification	
Powering	DC (-40V to -57V)
Power Supply Configuration for RU	DC (48 Volt 2.5 Amps)
Max Power Consumption	145W (max)
Mechanical Specification	
Design Shape	Rectangle
Product Dimension	342*253*157(mm)
Weight	10.1kg
Without Antenna	303*245*111(mm)

With Antenna	342*253*157(mm)
Antenna Specification	
Electrical Parameters	Values
Antenna Type	External Clip on antenna for RU
Frequency (GHz)	3.3-3.8
Gain (dBi)	13, +/-0.5
Azimuth Beamwidth (°)	60, +/- 5 °
Elevation Beamwidth (°)	20, +/-2 °
Polarization (°)	+/- 45 °
Electrical Fix Down tilt (°)	5° +/- 0.5 °
Upper Sidelobe Suppression / USLS (dB)	> 15
Return Loss (dB)	< -10
Port to Port Isolation (dB)	> 22
Front to Back Ratio (dB)	> 25
Cross Polar Discrimination (dB) Boresight 0°	> 20
Cross Polar Discrimination (dB) Sector ±60°	> 10
Impedance (ohm)	50
Power Handling (W)	> 50
Mechanical Parameters	Values
RF Ports at Bottom	4 X 4.3-10-M with pigtail 300mm
Dimensions in mm (L x W x D)	342 x 253 x 67.5
Number of Ports	4
Lightning Protection	DC Ground
Relative Humidity	5% - 95%
Operating Temperature Range	-40 ~ +50 °C
Clip-On provision	4 positions
Wind Loading @ Velocity, frontal	327.0 N @ 150 km/h
IP Rating	IP65
Environment Specification	
Ambient Temperature	-5 to 40C /-40 to 55C
Storage Temperature	-40°C to +70°C
Humidity	5% to 95%
Environmental	IP65
Operating Environment	Outdoor equipment
Thermal dissipation	Convection

Installation Type	Pole
-------------------	------

2.3.1 RU Product Identification Format:

SKU	FREQ RANGE	Version	Board Serial binary identification code
SKU 1	3400 - 3600 MHz	B2	100
SKU 2	3550 - 3700 MHz		110
SKU 3	3600 - 3800 MHz		101
SKU 4	3800 - 4000 MHz		111

2.3.2 RU Product HW Identification Format:

From the HW Side, Product Identification will be done through **Product Model No.**

Example:- If the Product model no is **VMRU-Gen1-3436-XX-AI**. In this model, “**VMRU**” shows Project Name, “**Gen1**” shows Hardware Generation, “**3436**” shows RU Band, and “**XX**” shows AE(Antenna External) or AI (Antenna Internal). “**A**” shows the RU revision. “**I**” shows the environmental condition (**E** - Operating Temperature 5°C to 45°C & IP31, **I** - Operating Temperature -40°C to 55°C & IP65).

MPRU Series Model Number		
Customer	Band	Model Number
V- - VVDN ¹	3436 - Band 3400 - 3600	VMRU-Gen1-3436-AE-AI
	3537 - Band 3550 - 3700	VMRU-Gen1-3537-AE-AI
	3638 - Band 3600 - 3800	VMRU-Gen1-3638-AE-AI
	3840 - Band 3800 - 4000	VMRU-Gen1-3840-AE-AI

Table 4: Product identification format

¹ Device name “VMRU” will be changing depends on end customer.

3. What's in the Box?

The following list of primary items will be present in the box:

Medium Power RU	5G Outdoor Radio Unit	1
Installation & Bring-up Guide	Booklet/Soft copy for operational reference	1
Mounting Bracket & Mounting accessories	Mounting Bracket And Mounting Screw Kit	1

Table 5: List of Items in the box

3.1 Default Accessories List

The following accessories are included with RU:

Items	Description	Qty
Power connector	DC 48V power connector	1
Antenna⁽²⁾	External Clip on antenna	1

Table 6: Device Accessories

3.2 Add-on Accessories List

The following add-on accessories are based on the customer's requirement with RU:

Items	Description	Qty
10G SFP Transceiver	Manufacturer part no: SFP-10G-SR	2
10G SFP Optical Cable	Cable Length: 1.5m	1
Ethernet Cable	RJ45 Cat6 Network Ethernet Patch/LAN Cable, 3M/2M	1
USB Cable	USB Cable Console Cable – Type C USB Cable Part Number: DH-20M50052	1

Table 7: Add on Device Accessories

² Antenna will be included depends on the model series

4. Outlook

Learn about MPRU hardware, assembly procedures, and how to get started with it.

4.1 Dimensions of Product With Antenna

Dimension LxWxH: 342*253*157(mm).

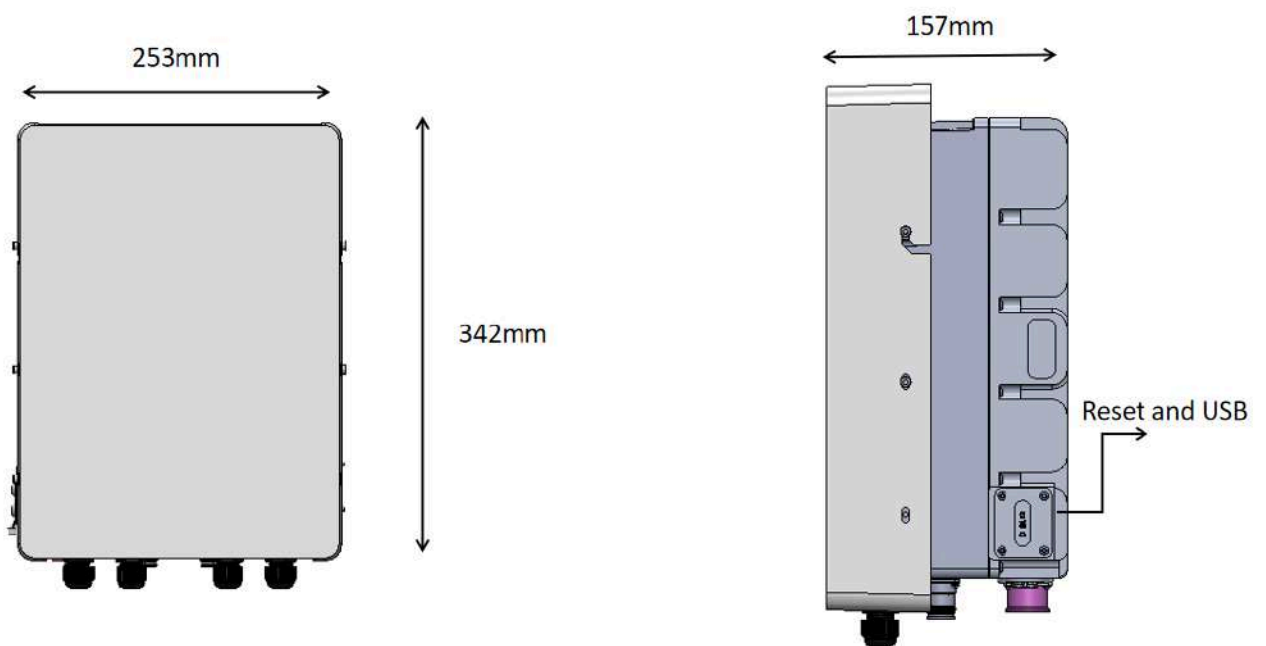


Fig 1: Product Dimension With Antenna

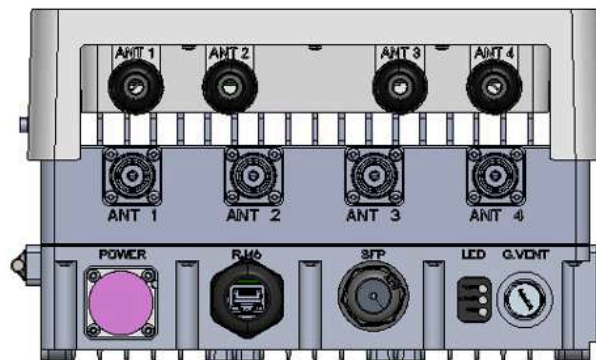


Fig 2: Antenna and FH details

4.2 Dimensions of Product Without Antenna

Dimension LxWxH: 303*245*111(mm).

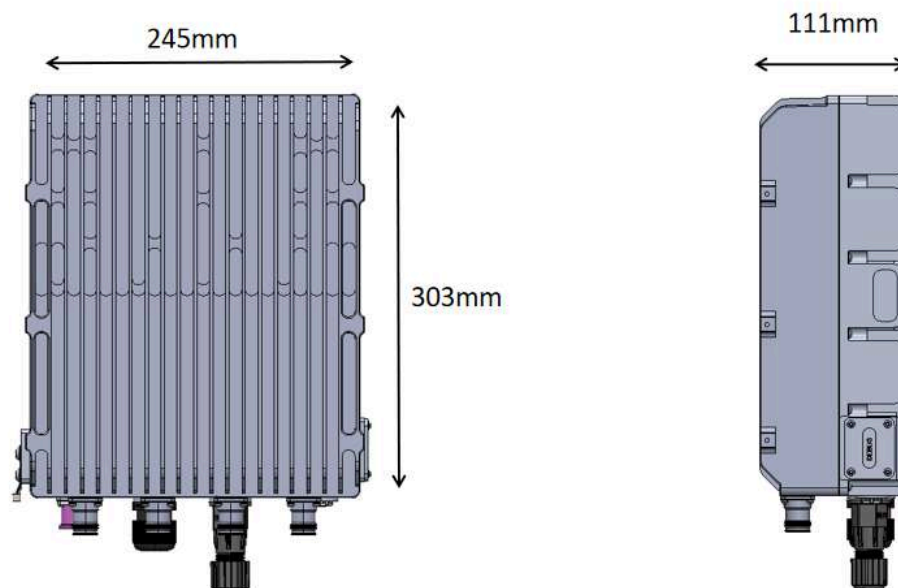


Fig 3: Product Dimension Without Antenna

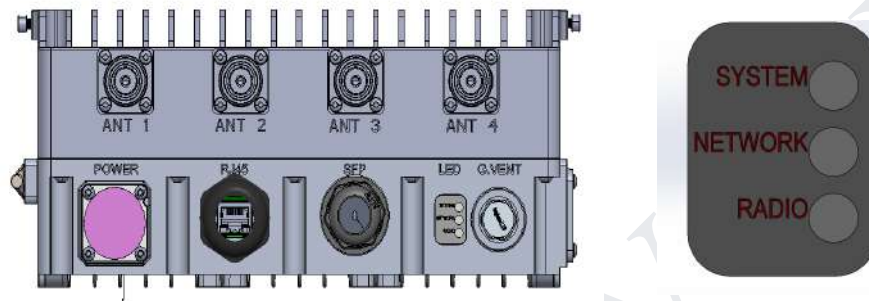


Fig 4: Antenna and FH details

4.3 Connectors Required for connecting the Antenna output port of MPRU

4.3/-10 Male to N Female connector



After connecting the 4.3 connector to the radio, the user can connect to antenna / attenuators by using any N-type RF cables based on their availability.

4.4 MPRU Basic Setup Diagram

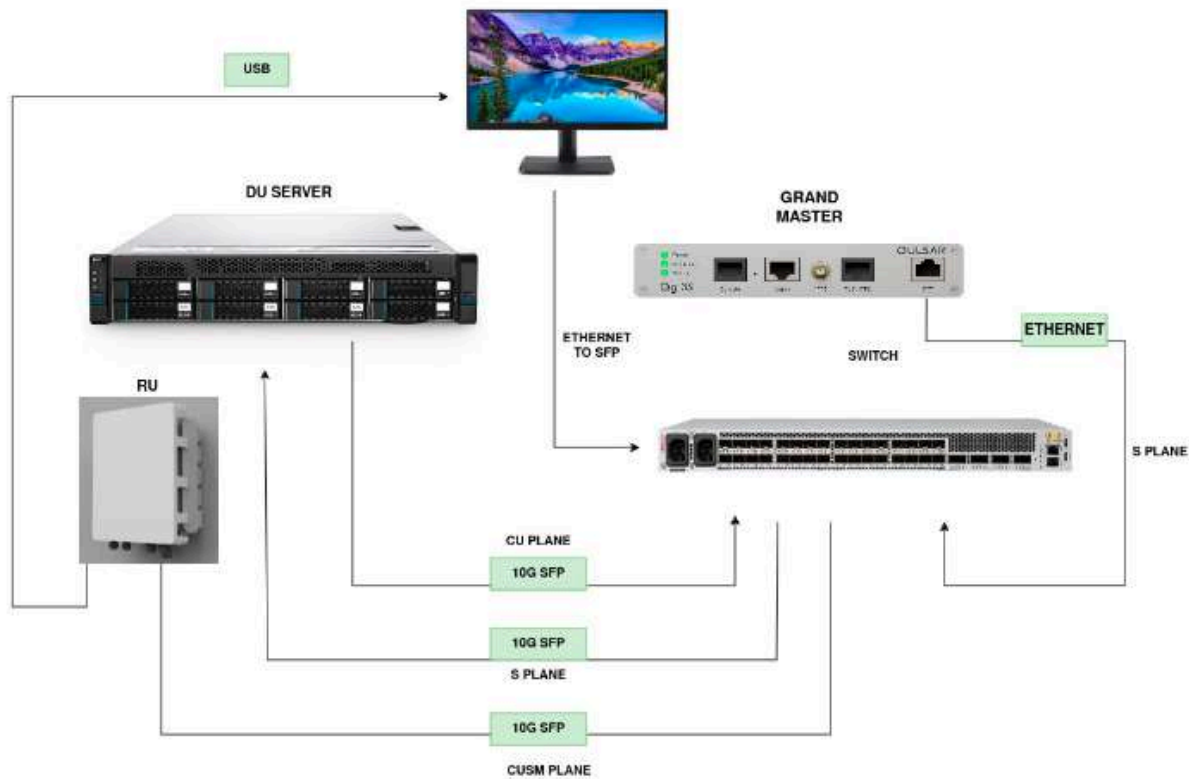


Fig 5: Setup Diagram

Netopeer-cli is installed in another test PC for M plane connection establishment, or it can be installed in the DU server.

This setup diagram is for the M-Plane connection/ E2E connection.

Note: Please make sure that all the radio antenna ports are either terminated(can be terminated with any 40 Watt terminators) or connected with any external antenna while in use.

4.5 MPRU LED Notification

For all good conditions, all the Green LED will be in a stable state.

LED Blinking Status	Power LED Indications	Colour
Slow	Temperature Warning	RED
Fast	Factory Reset	
Stable	Temperature Shut Down	

LED Blinking Status	Power LED Indications	Colour
Slow	Software Upgrade Process	Green
slow	RU Booted Successfully	
Fast	Initialization Fault	
Stable	Power On	

Table 8: Booting up led indication

Colour	Network LED		Status LED	
RED	Slow	DHCP Failure	Slow	Software Upgrade Fail
			Fast	PTP Sync Fail
	Fast	Factory Reset	Fast	Factory Reset
	Stable	Thermal Shut Down	Stable	Thermal Shut Down
	Stable	Link Down	Stable	Power Failure
Green	Slow	Software Upgrade process	Slow	Software Upgrade process
	Fast	Link UP, Trying DHCP	Fast	Unit has detected a transceiver fault
	Stable	Link UP + DHCP Ready	Stable	PTP UP

Table 9: Network and status led notification

5. Device Setup

5.1 Hardware Installation

The MPRU can be mounted on the Pole using a M10X100screw to fix the bracket as shown below. After fixing the mounting on the pole, fix the moment bracket with the help of M10X210 Nut & Bolt, then hang the device on the mounting. After installation, check for RF coverage and change the mounting location.

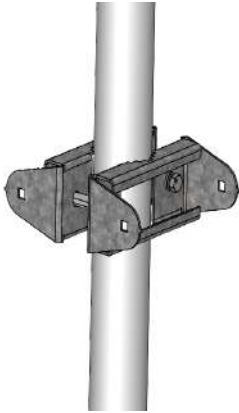


Fig 6: Pole Mounting

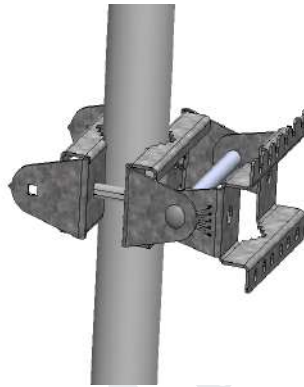


Fig 7: Moment Bracket

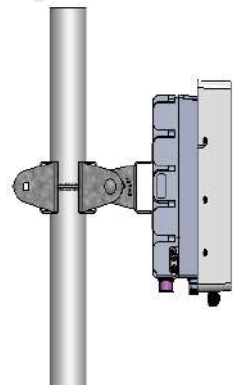


Fig 8: Device Mounting

5.1.1 Ideal mounting location

The MPRU can be installed, preferably either on the Straight Poll or Vertical wall. In Lab testing conditions, sufficient airflow shall be provided for thermal and RU performance.

5.1.2 Ideal Installation Height:

Above 2.13m/ 7ft from the ground for vertical wall or Pole mounting.

5.1.3 Mounting Screw Holes:

If mounting to a wooden surface, fix the screw directly to the surface. If mounting to a masonry surface (bricks, concrete), insert wall plugs before screwing the mounting bracket to the wall.

If mounting to a pole , fix the bracket on the pole with the help of M10X100 bolts .

5.1.4 Mounting the Device:

Hang the Device on the mounting bracket with the help of two upper screws and then tighten the lower screws.

5.2 WEB GUI

Commonly used browser for GUI login

1. Google Chrome
2. Firefox

Launch a web browser from a computer or wireless device that is connected to the network. In the address field of the web browser, enter the Fronthaul IP address.

Before powering ON the RU, ensure all the RF ports are terminated/Connected with Antenna.

Types of Logins

Separate types of logins have different purposes. It is important that the user understands the difference so that the user can choose the login type as per use case. Each user has its own specific access control as per the oRAN compliance.

Username	Password
oranuser	oranuser

Table 10: Login credentials

If RU is configured for Static IP, then use 192.168.4.50 otherwise go for the dynamic ip assigned to eth1 interface.

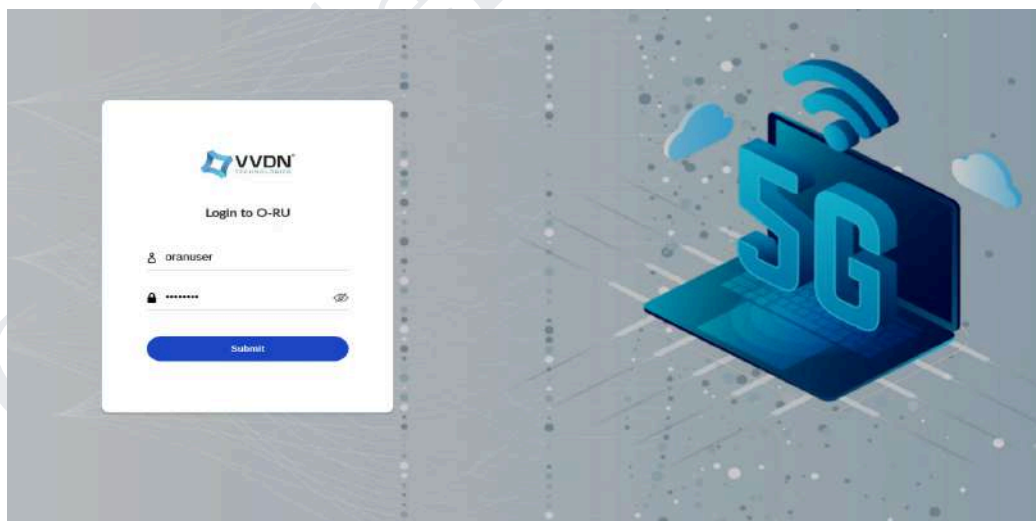


Fig 9 : GUI Login Page

5.2.1 Device Information

The device information dashboard will provide complete information about the radio unit. Once the radio unit is live, the dashboard extracts all the particulars in the Front end. Snippet attached.

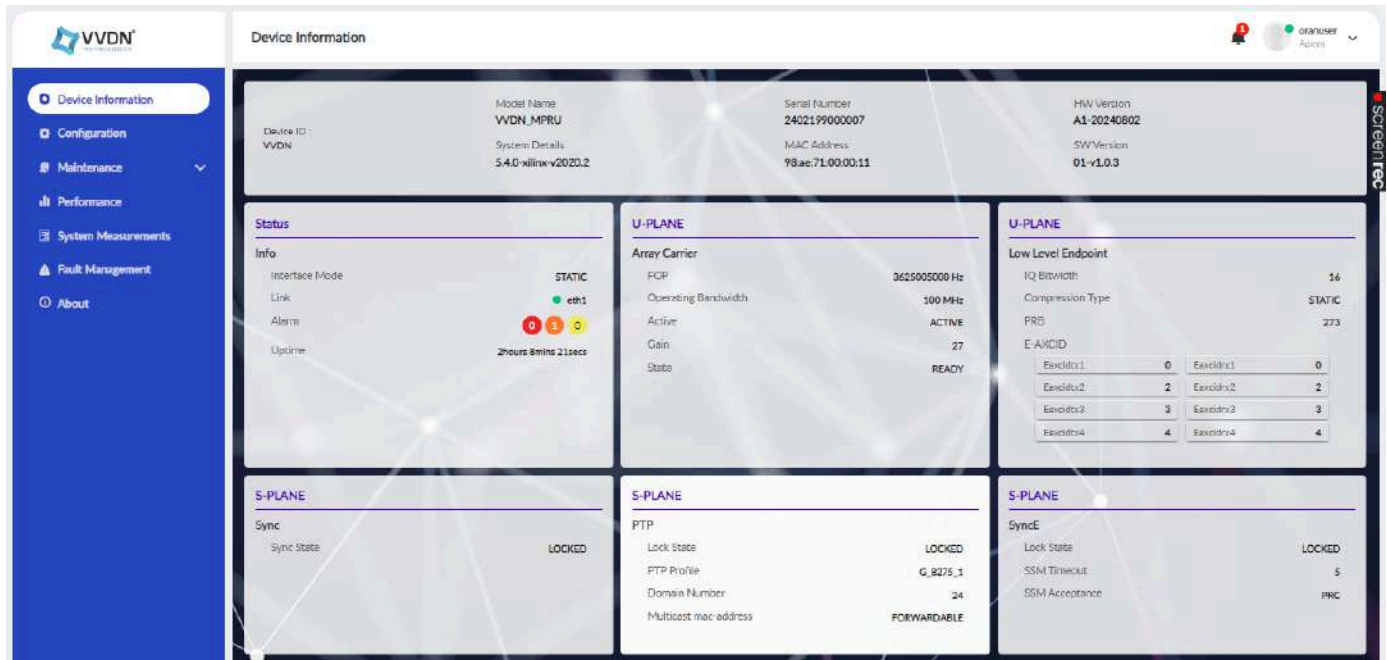


Fig 10: GUI Dashboard

- **Model Number:** Display the RU model number
- **Serial Number:** Display RU serial number
- **HW Version:** Display the HW version
- **System Details:** Display default System details incorporated with XILINX 2020.2
- **MAC address:** Display the RU's eth1 interface MAC address
- **SW version:** Display the installed SW version
- **Status:** Display the current status of RU
 - Interface Mode:** Display the RU IP mode whether in static or dynamic mode
 - Link:** Display the link status of eth1
 - Alarm:** Display the count of active alarms
 - Uptime:** Display the uptime of RU
- **Uplane:** Display the carrier related information
 - FOP:** Display the center frequency configured in RU
 - Operating Bandwidth:** Display the bandwidth configured in RU
 - Active:** Display the carrier state ie. ACTIVE/INACTIVE
 - Gain:** Display the gain value configured in RU
 - State:** Display the carrier state of RU ie. READY/BUSY
- **Low Level End Point:** Display the information related to endpoints configured in RU
 - IQ Bitwidth:** Display the IQ bitwidth configured in RU
 - Compression Type:** Display the Compression technique configured in RU
 - PRB:** Display the number of PRBs configured in RU for Downlink
 - E-AXCID:** Display the e-axcid configured in RU for both tx & rx
- **S-Plane:** Display other parameters like SYNCE and PTP synchronization states like LOCKED, FREERUN, and HOLDOVER, Domain number, etc

5.2.2 Configuration

a)Sync

LPRU needs to be PTP synchronized with Grandmaster for the proper data transmission. As per oRAN, MPRU is supporting LLS-C1/LLS-C3 Configuration.

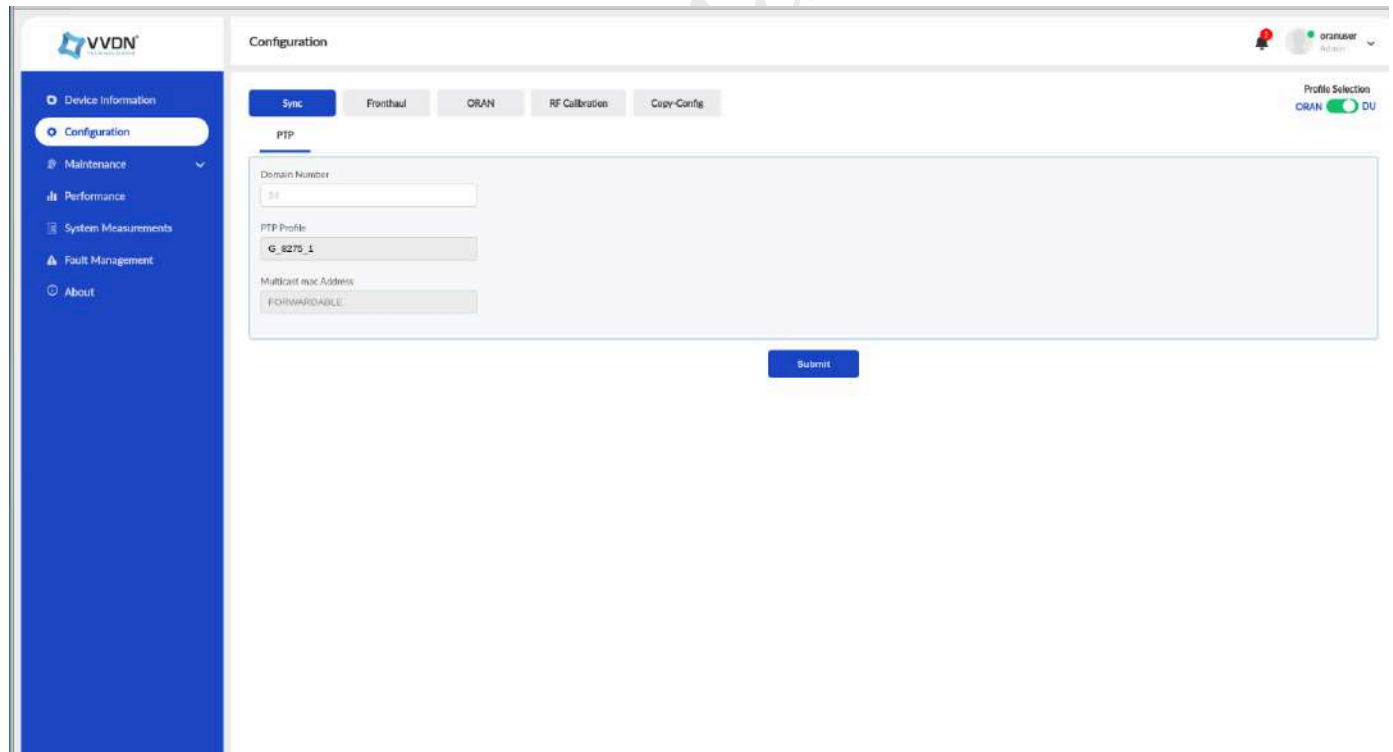
To select one or more synchronization input sources. The sync container allows the RU to list via an array of synchronization sources which it is capable of supporting **PTP and SyncE**.

User can trigger the Sync-related parameters using the below-mentioned attributes:

- **Domain number: Range (24-45)**
- **PTP Profile: Default(G_8275_1)**
- **Multicast mac Address: FORWARDABLE**

Note: MPRU is supporting only:

- *ITU-T standards G_8275_1 and G_8275_2 profile for the PTP synchronization.*
- LPRU supports only Multicast PTP profiles. Click the submit button to save the configuration*



The screenshot displays the VVDN Configuration web interface. On the left is a blue sidebar with navigation links: Device Information, Configuration (selected), Maintenance, Performance, System Measurements, Fault Management, and About. The main content area is titled 'Configuration' and features tabs for Sync, Fronthaul, ORAN, RF Calibration, and Copy-Config. The 'Sync' tab is active, showing a 'PTP' configuration section. This section includes three input fields: 'Domain Number' (containing '24'), 'PTP Profile' (containing 'G_8275_1'), and 'Multicast mac Address' (containing 'FORWARDABLE'). A 'Submit' button is located at the bottom right of the configuration area. In the top right corner, there is a 'Profile Selection' section with 'ORAN' and 'DU' options, where 'DU' is currently selected.

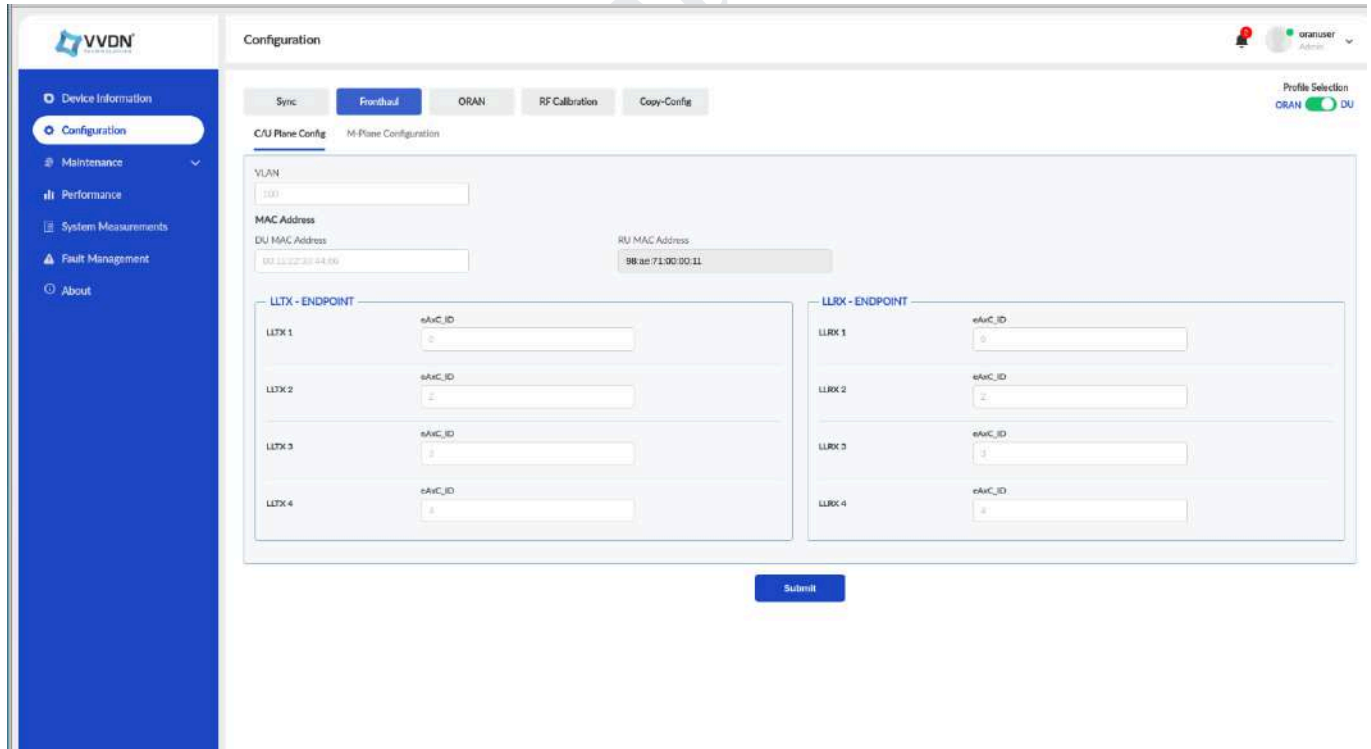
Fig 11: PTP configuration

b) Fronthaul

1. CU Plane Configurations in RU for Fronthaul

The MPRU supports ORAN-WG4.CUS.0-v07.00 for CU planes. This provides an option to configure the CU Plane as follows:

- VLAN Enable/Disable: VLAN Range between 0-4095
- No VLAN needed for CU plane transmission.
- No provision for S plane VLAN currently
- MAC address: MAC address shall be retrieved when connected with the RU. Enter the DU MAC address based on the deployment.
- C- PLANE & U-PLANE: enhances more feasibility to user plane configuration module is provided below based on the Yang model mentioned in the ORAN Management Plane Specification
 - **DU port ID Bitmask: 65024**
 - **Band Selector ID Bitmask: 448**
 - **Component carrier ID BitMask: 56**
 - **RU port ID from the mentioned ranges displayed: 7**
 - **eAxC_ID: 1 to 4 for Downlink or uplink or PRACH**
- Click the submit button and you get a pop up mentioning your settings are saved.



The screenshot shows the VVDN Configuration web interface. The left sidebar contains navigation links: Device Information, Configuration (selected), Maintenance, Performance, System Measurements, Fault Management, and About. The main content area is titled 'Configuration' and has tabs for Sync, Fronthaul (selected), ORAN, RF Calibration, and Copy-Config. Below the tabs, there are two sub-tabs: CU Plane Config (selected) and M-Plane Configuration. The CU Plane Config section includes fields for VLAN (set to 100), MAC Address (DU MAC Address: 00:11:22:33:44:55, RU MAC Address: 98:9e:71:00:00:11), and two columns of endpoints: LLTX-Endpoint and LLRX-Endpoint. Each column has four rows, each with an eAxC_ID dropdown menu. A Submit button is located at the bottom right of the configuration area.

Fig 12: Fronthaul Configuration

2) M Plane Configurations in RU for Fronthaul

The M-plane configuration section helps the user to configure the m-plane VLAN.

- **VLAN:** VLAN Range between **0-4095**
- Click the **submit** button, and you get a pop-up mentioning your settings are saved.

c) ORAN

O-RAN Sections help the user to validate the below fronthaul parameters.

- Standard Maximum PRB per Ethernet frame can be allocated.
- IQ Width can range 16-bit No compression and 9, 12 and 14 for BFP compression as per requirement
- Type of compression can be configured depending on the requirement ie. STATIC/DYNAMIC
- The PCID for PXSCH & PRACH can be configured based on the requirement.

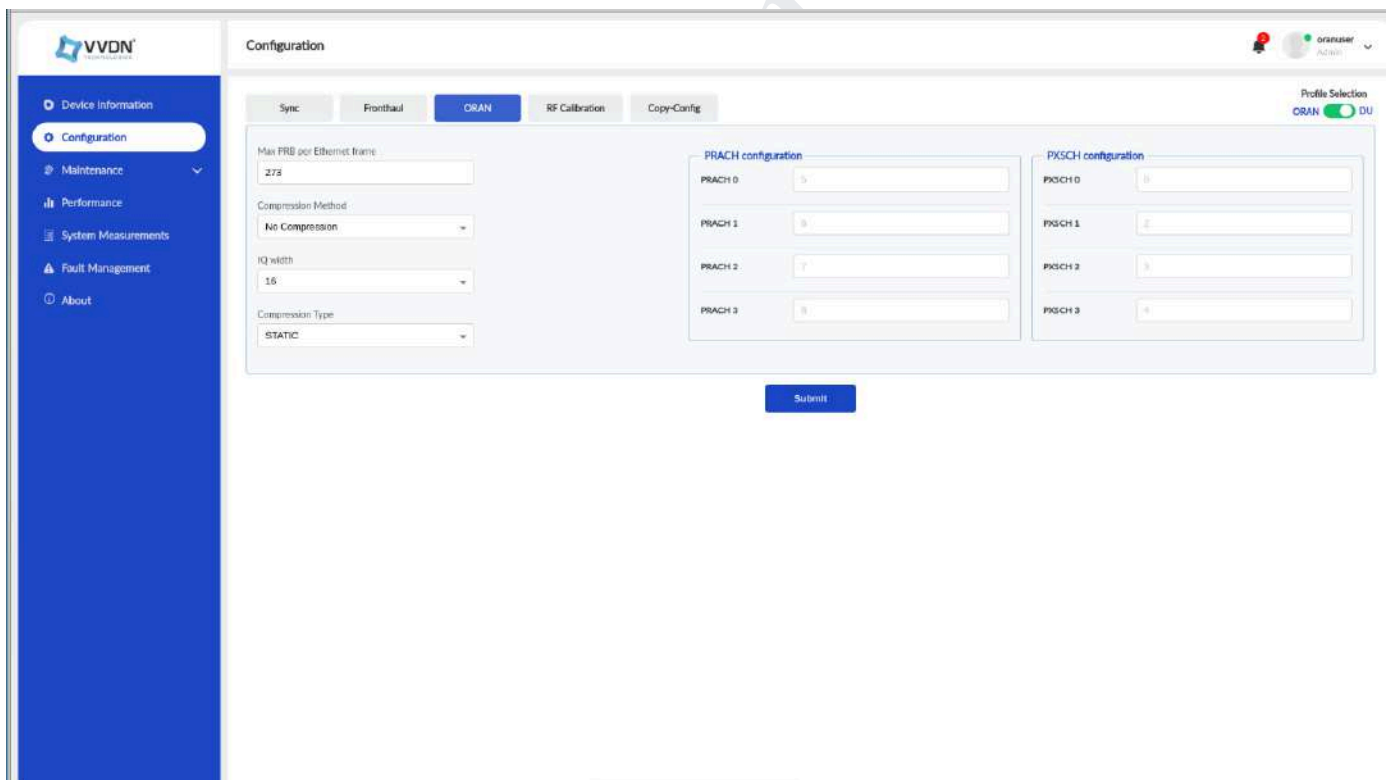


Fig 13 : ORAN Configuration

Note: Make sure that the compression method is configured properly before sending data to MPRU from DU or DU emulator. By default, the compression method is configured as 16 bit uncompressed.

d) RF Calibration

RF calibration section helps the user to change following parameters

- To change the operating bandwidth of the RU and ARFCN value within the operation frequency.
- The carrier state of RU ie. ACTIVE/INACTIVE can be configured from here based on the requirement
- The gain value can be changed based on the requirement in order to adjust the output power of RU.

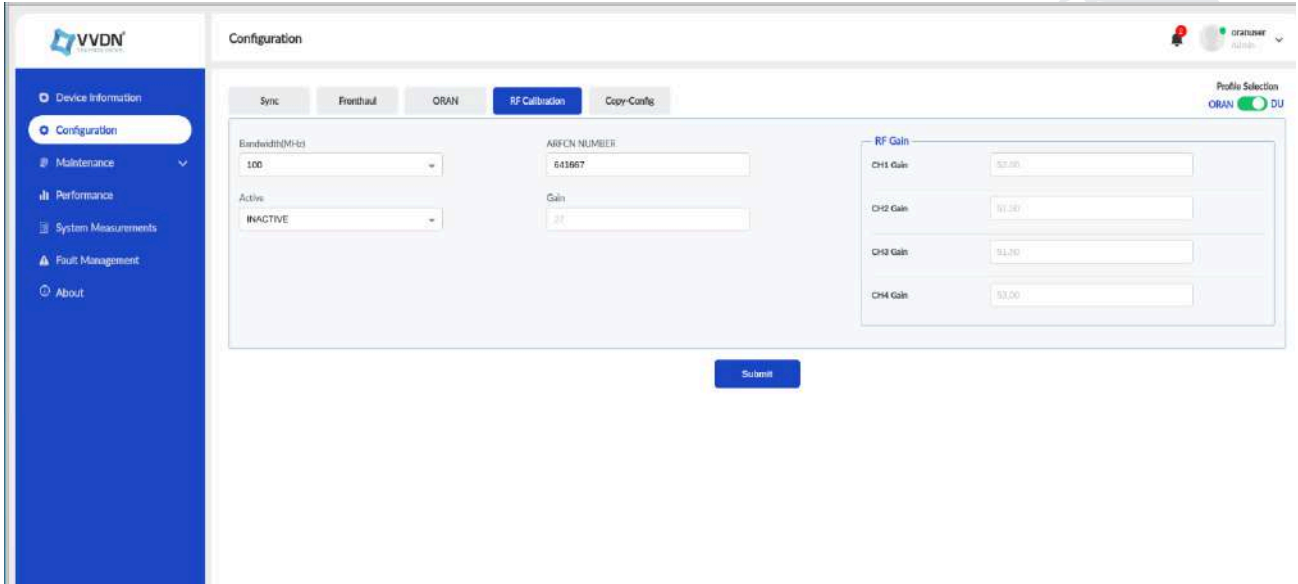


Fig 14: RF calibration

Once the changes are updated, copy the changes from running to startup and go for rebooting the RU to reflect the changes in RU.

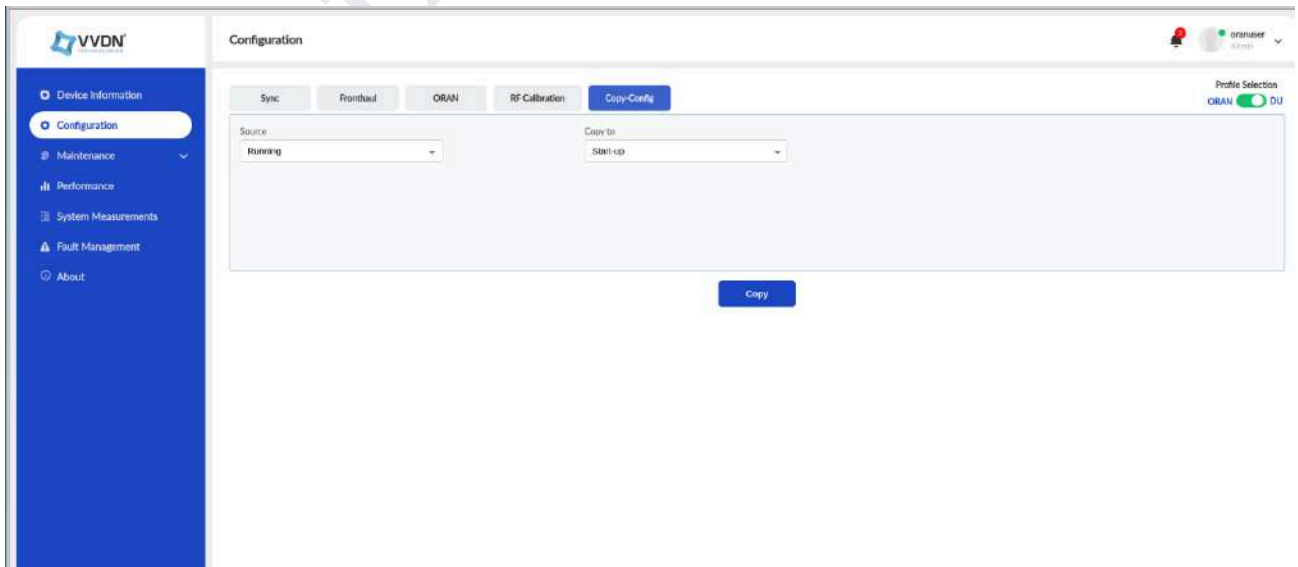


Fig 15: Copy-config

5.2.3 Maintenance

5.2.3.1 Management

The Management tab contains the below details, System

- IP Management
- Logs
- Interface Validation

System

System-level functions such as Reboot & Factory reset could be performed. Users can reboot or reset the radio unit from the system tab.

Follow the below instructions

- o Click Maintenance > Management > System >
- o Select Reboot for a soft reset of RU
- o Select Factory reset for the default setting

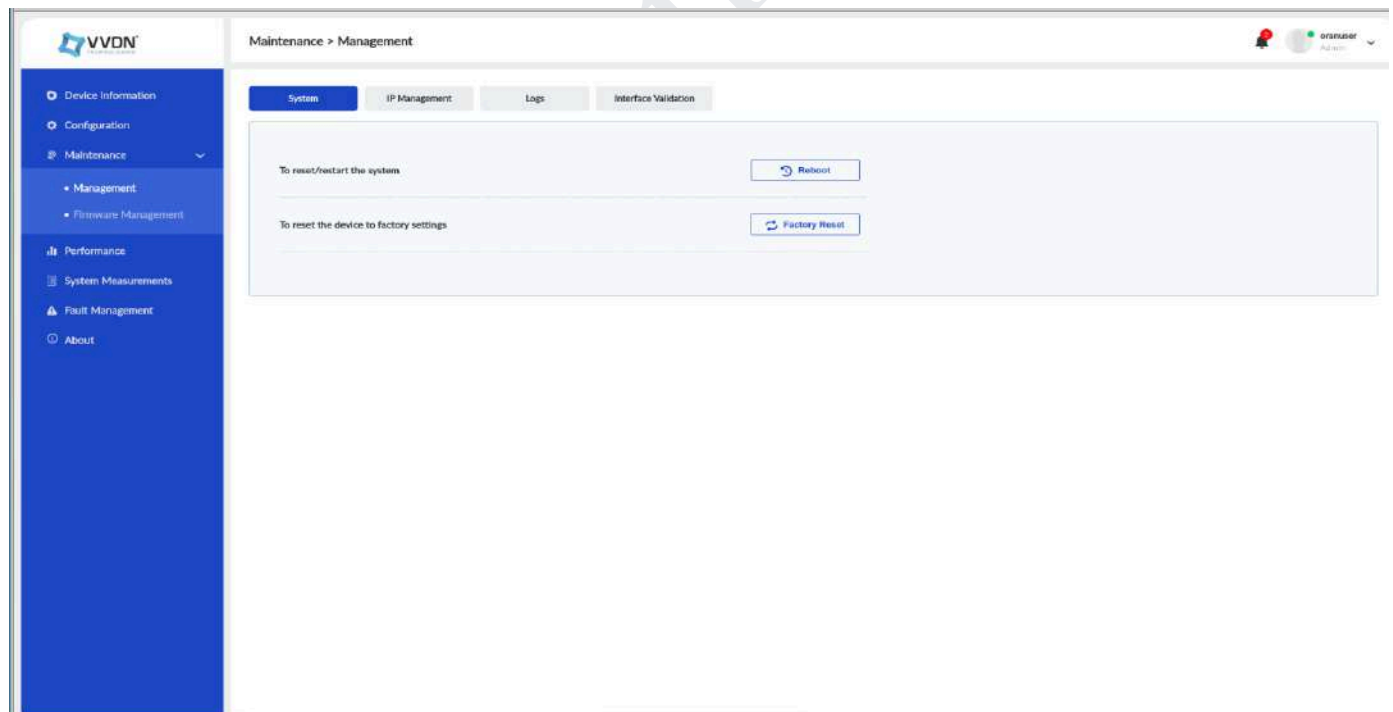
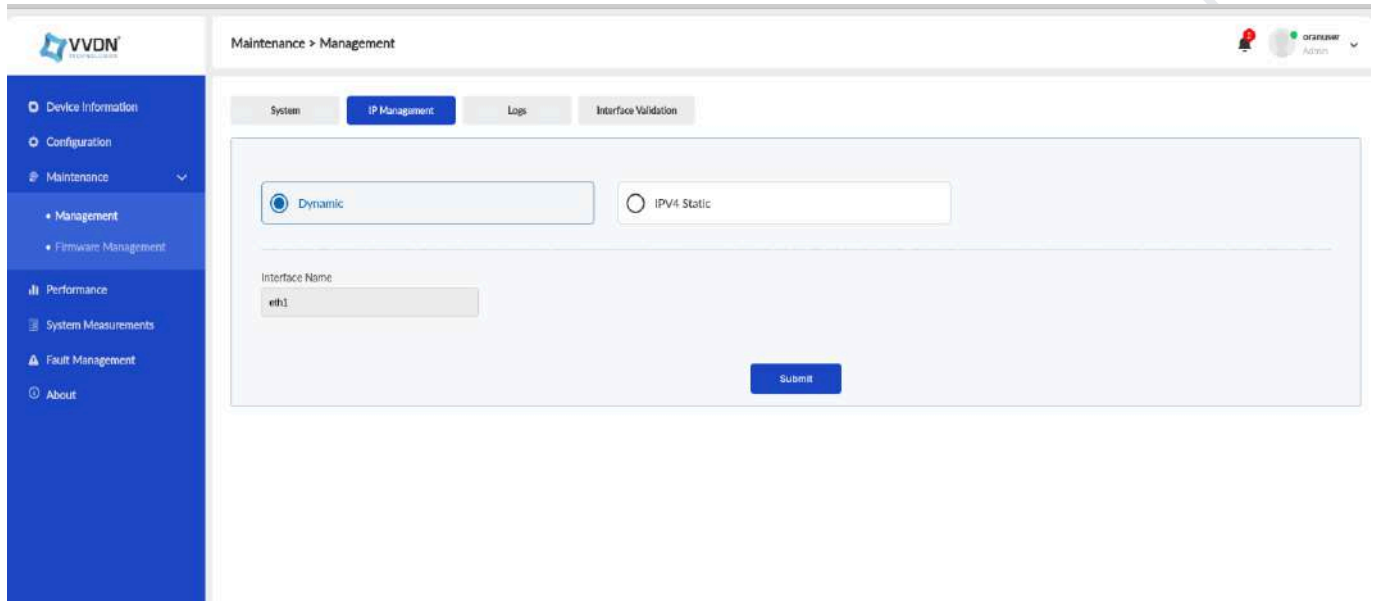


Fig 16: System Management

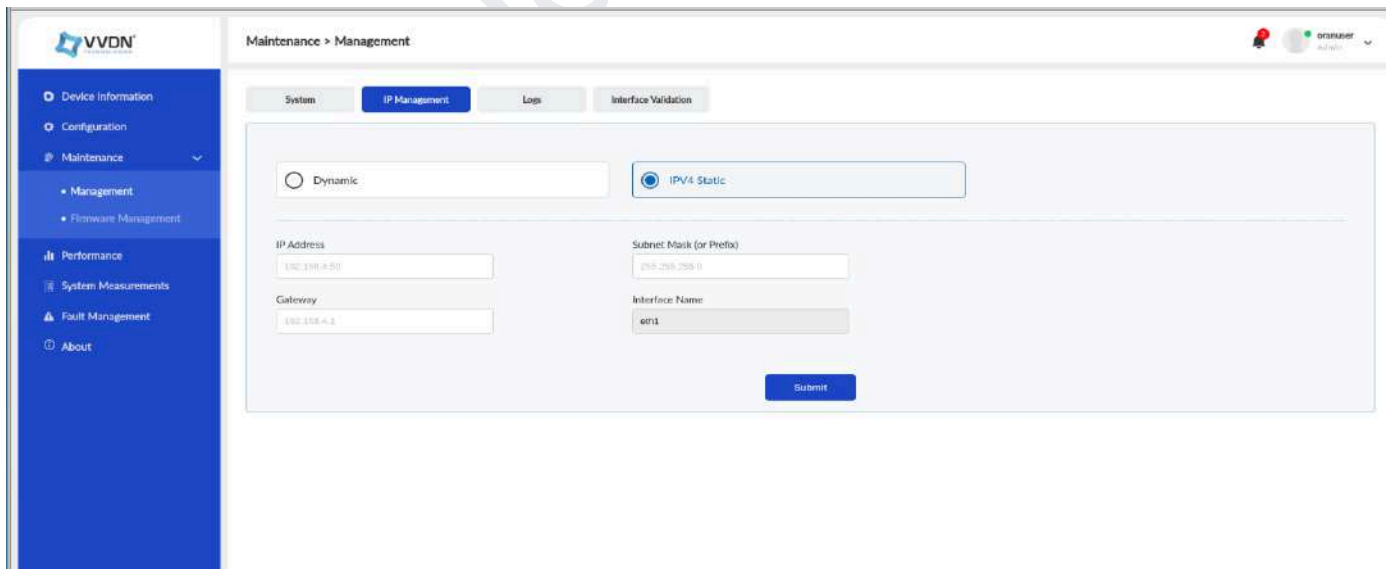
IP Management

IP management functions for configuring the IPv4 static & changing the interface in between dynamic/static IPs for the interface.



The screenshot shows the VVDN MPRU web interface. The sidebar on the left contains the following menu items: Device Information, Configuration, Maintenance (expanded), Management (selected), Firmware Management, Performance, System Measurements, Fault Management, and About. The main content area is titled 'Maintenance > Management' and has four tabs: System, IP Management (active), Logs, and Interface Validation. In the IP Management section, there are two radio buttons: 'Dynamic' (selected) and 'IPv4 Static'. Below these, there is a text field labeled 'Interface Name' containing the value 'eth1'. A 'Submit' button is located at the bottom right of the form.

Fig 17: IP management for Dynamic



This screenshot shows the same VVDN MPRU web interface, but with the 'IPv4 Static' radio button selected. The form fields are as follows: IP Address is '192.168.1.10', Subnet Mask (or Prefix) is '255.255.255.0', Gateway is '192.168.1.1', and Interface Name is 'eth1'. The 'Submit' button remains at the bottom right.

Fig 18: IP management for Static

Logs

The actual system log and temperature logs can be downloaded by the user for the system & temperature information. Click on the download icon for downloading the file. The file will be downloaded in the aforementioned format, Sample file name and format: **vvdn-gui-system-2024-11-22T06_33_35Z.log**

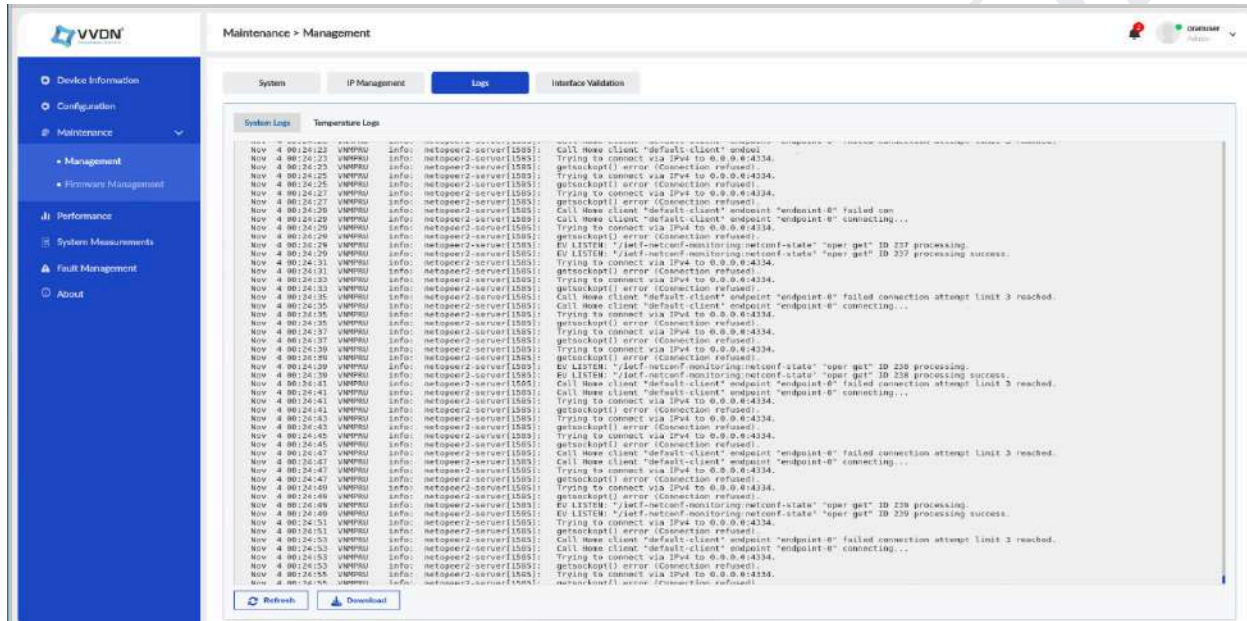


Fig 19: System Logs

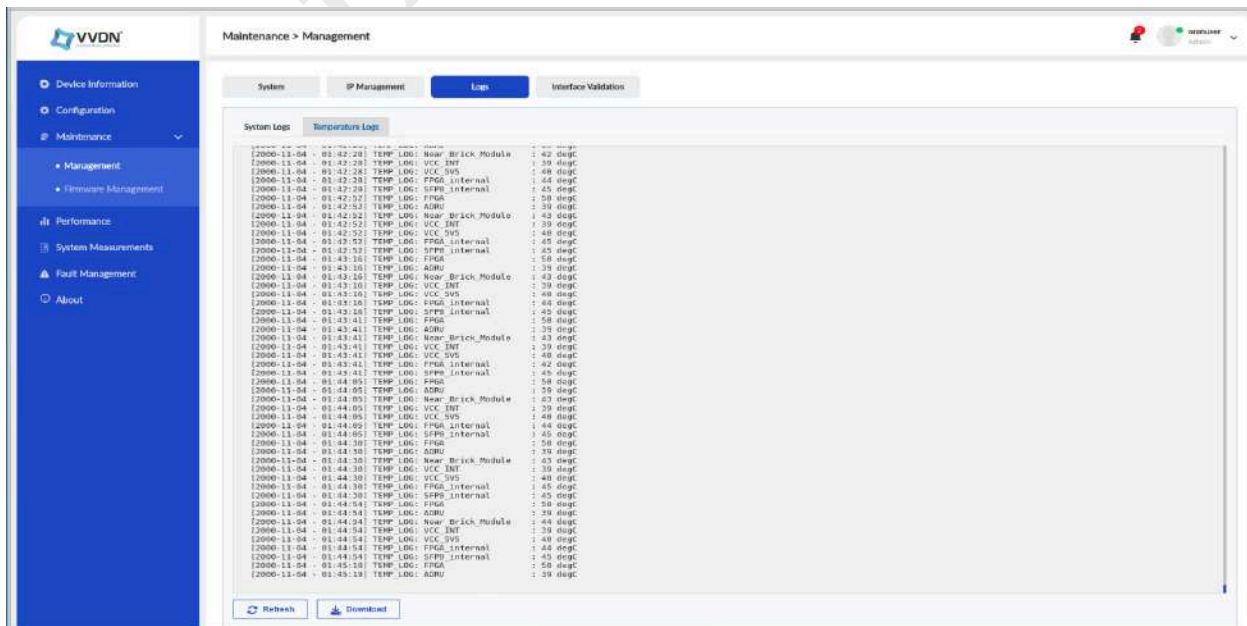


Fig 20: Temperature logs

Interface Validation

The various interface modules' status can be verified in this section of GUI.

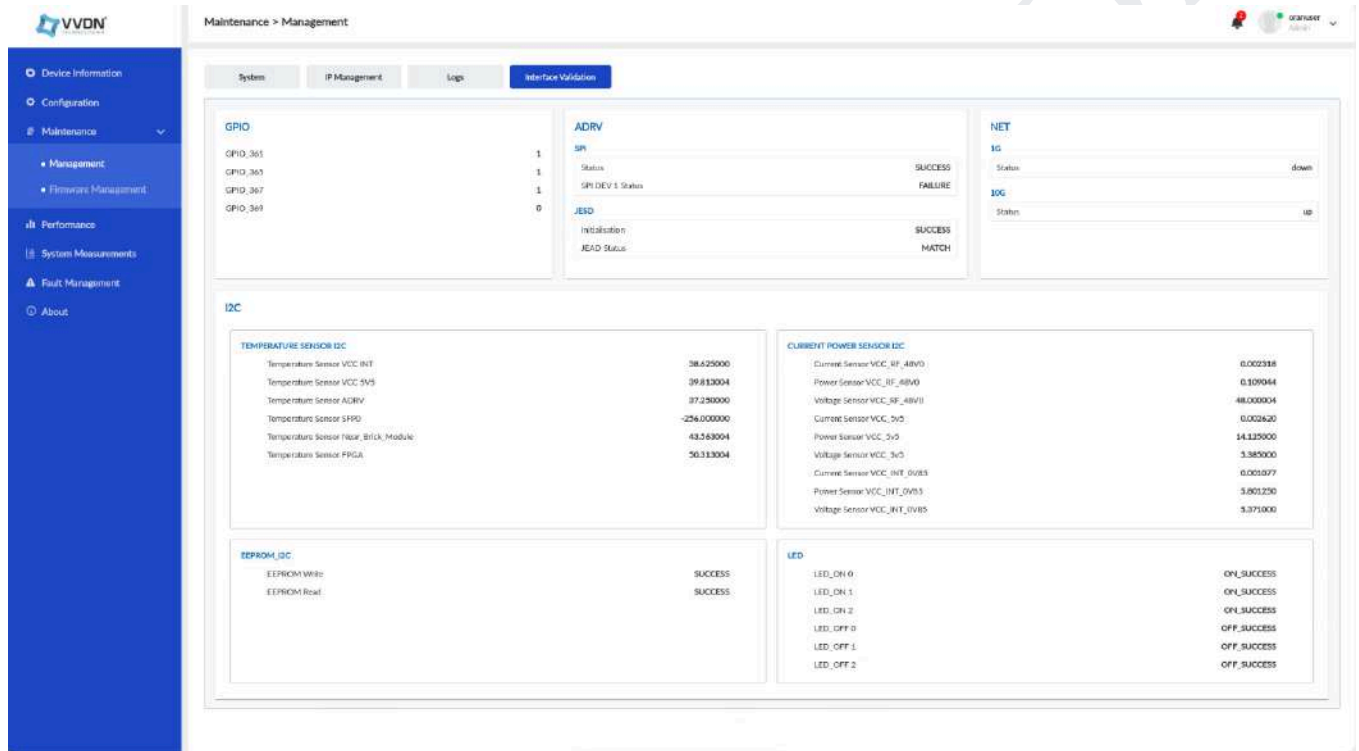


Fig 21: Interface logs

5.2.3.2 Firmware Upgrade

For the MPRU remotely, users can upgrade the firmware from any remote SFTP server. Users need to enter the valid details and credentials as follows:

- Username:** Valid username of the SFTP server.
- IP Address:** Remote server IP address.
- Password:** Remote server password.
- File:** Remote file location path where the software files are located. (.zip)
- Public Key:** Public Key for the remote server needs to be validated for the software changes in MPRU. (It is optional)

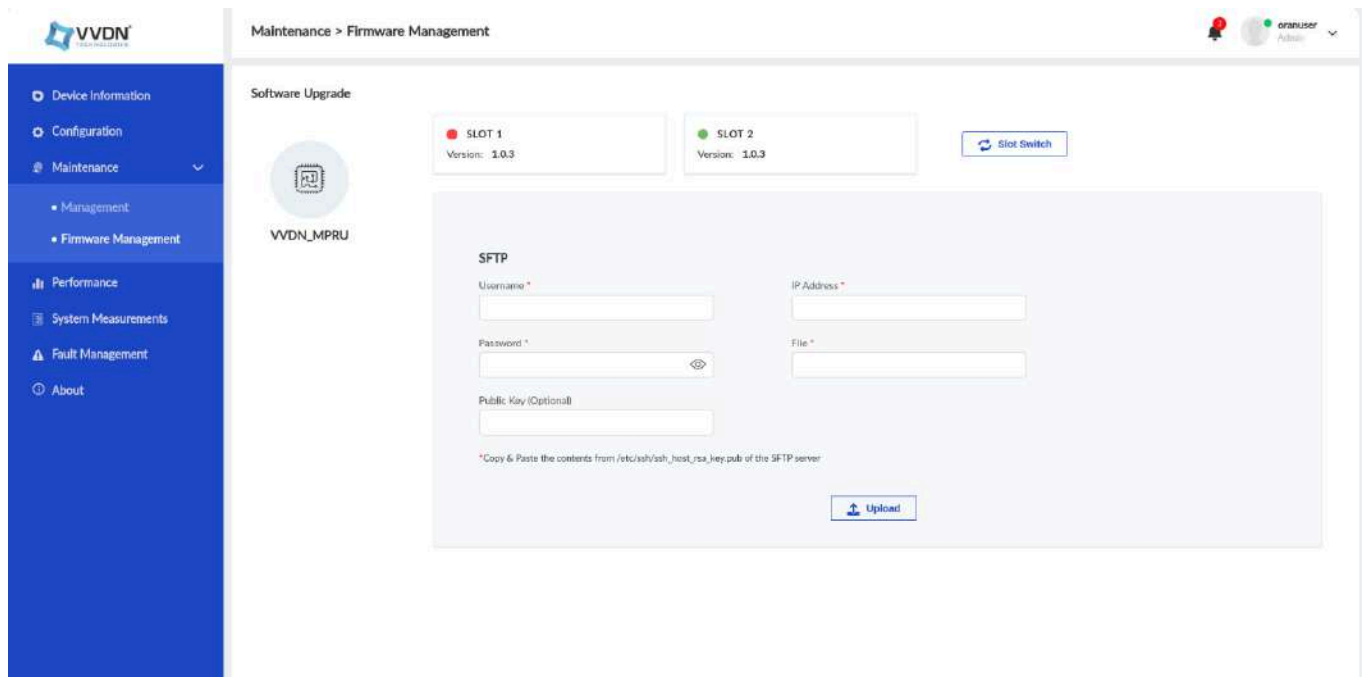


Fig 22: Firmware Management

5.2.4 Performance

The Performance tab displays the throughput for Downlink & Uplink in Mbps, MAC counters, RX window statistics, DL SIC

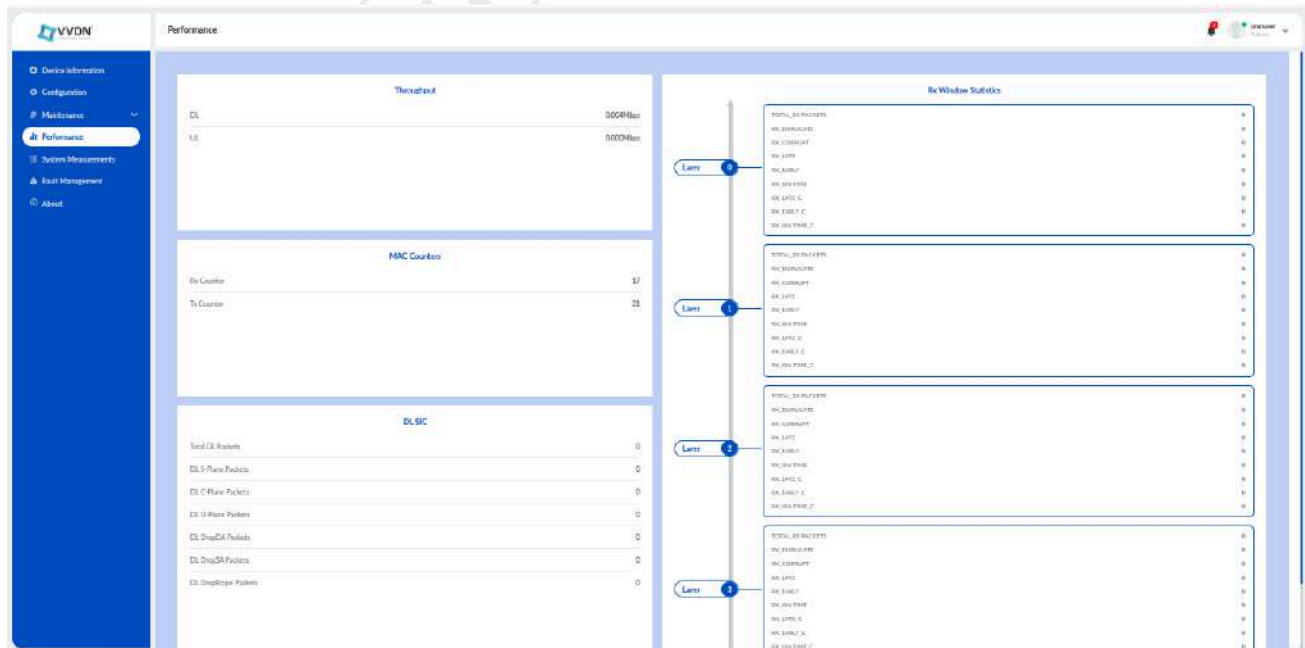


Fig 23: Performance Counters

5.2.5 System Measurements

The Performance tab displays the CPU usage, memory usage, disk usage, device status, Temperature, Sensor Info, and Antenna output power information.

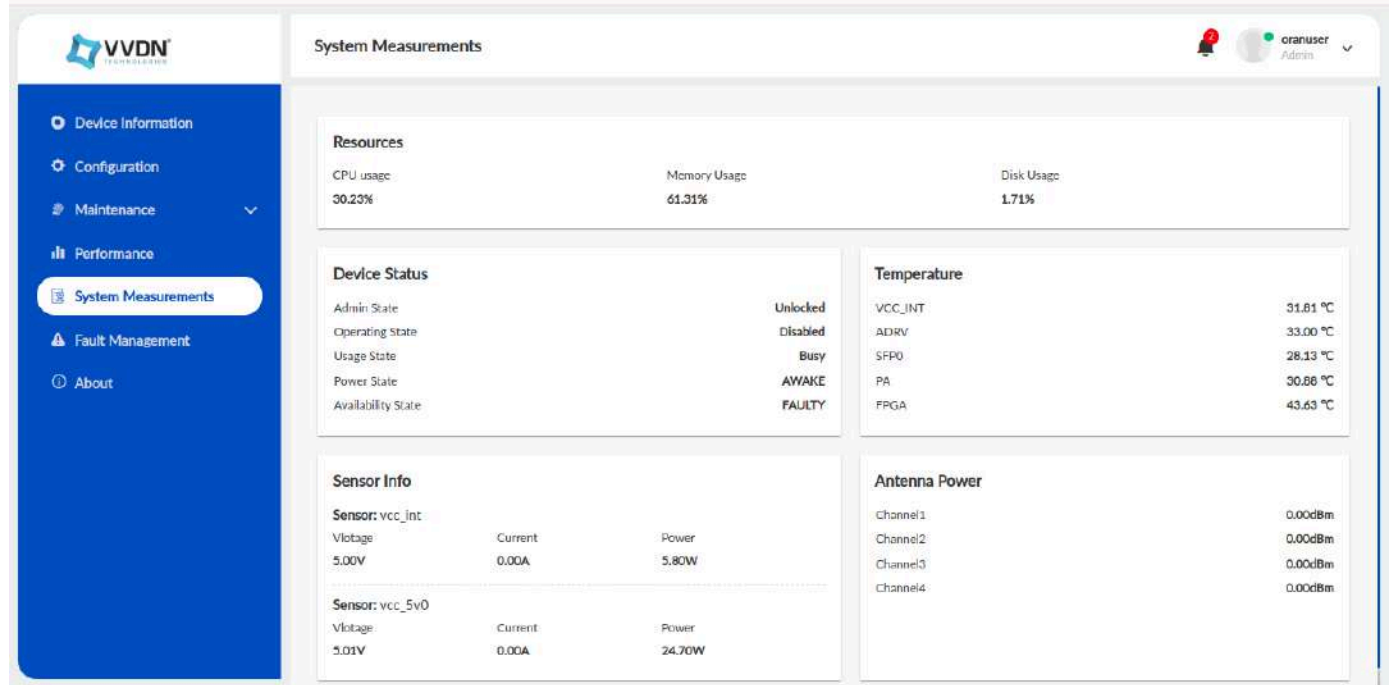


Fig 24: system Measurement

5.2.6 Fault Management

The fault management tab displays the active alarms in the MPRU.

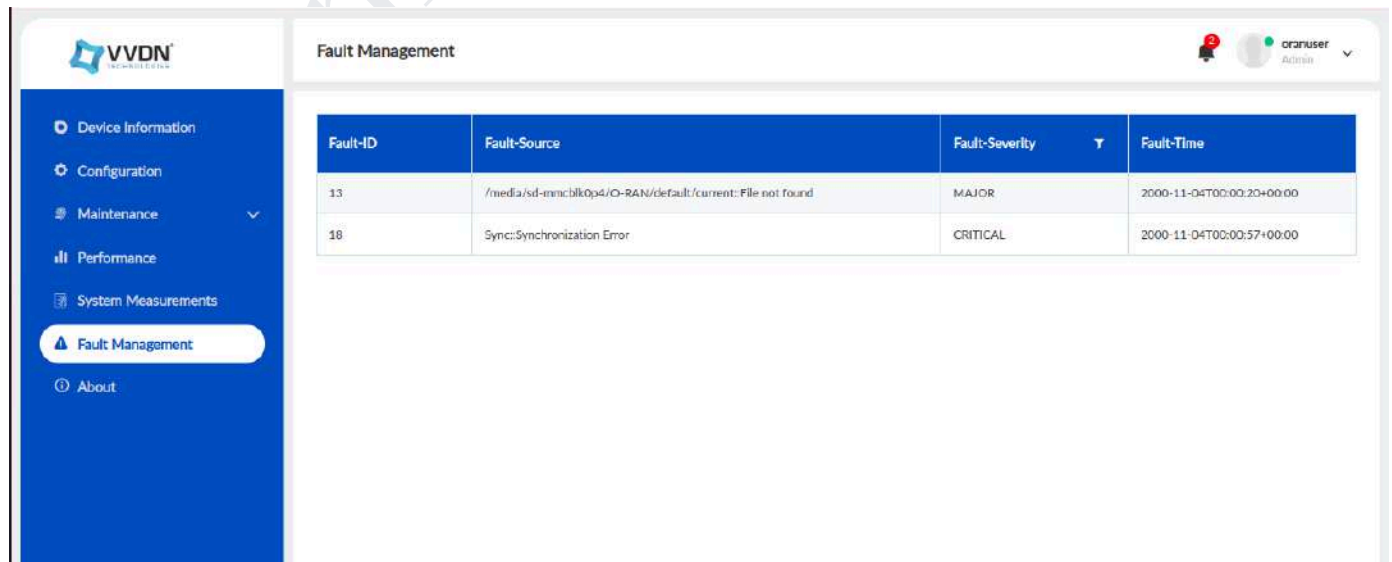


Fig 25: Fault Management

5.2.7 About

Details about the Manufacturer, Split version, Deployment Type, Radio Configuration, Band, Radio Configuration, Duplex Mode, SCS, RF output power, Supported Frequency range, Licence version and copyright is displayed on this “About page”

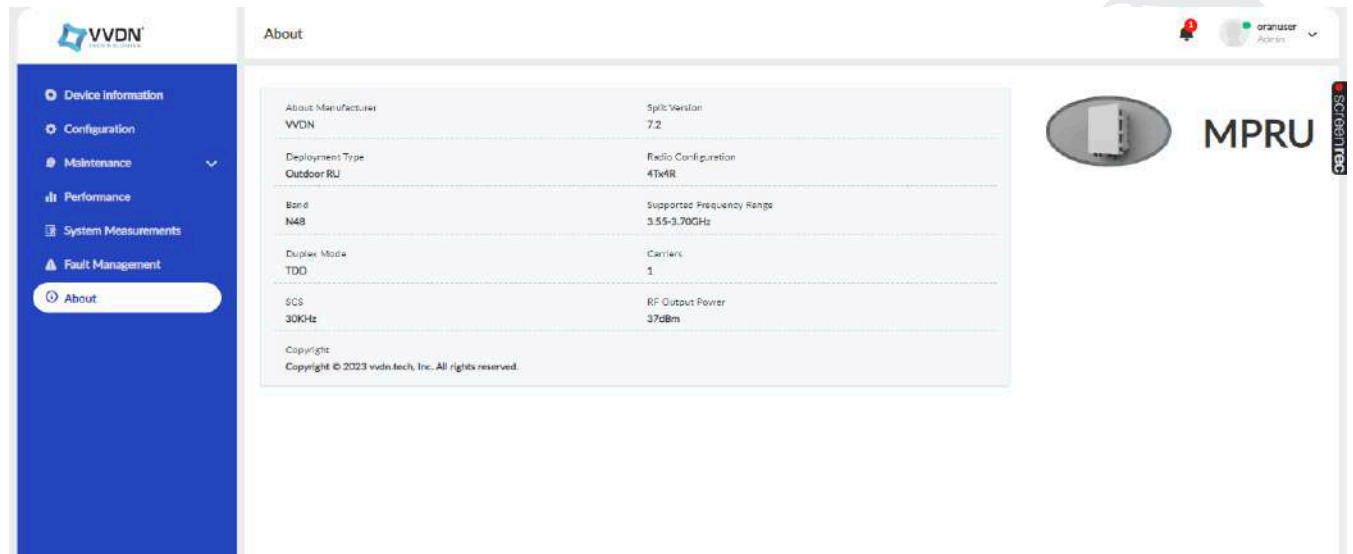


Fig 26: About Page

6. Startup Configurations

6.1. Booting up the device

- Connect the Power adapter, Voltage -48v Current 2.5 Amps
- Check for the LED indication.
- If the board is booted without error, it will indicate Power LED Status to Green.

6.2. Remote Configuration

Users can connect to MPRU using a M-Plane connection. Users need a network connection to the 10G interface.

O-RU will be in static mode with IPv4 address: 192.168.4.50 by default. The mode can be changed via CLI.

Steps for changing the mode via CLI are as follows:

1. To access CLI manager, use “telnet 192.168.4.50 8888”.
2. Enter login credentials as **username** : oranuser and **password** : oranuser.
3. get-IfaceStatus: It will show the status of the management interface.

4. Set-Ipv4 Static can be used to set a static IPv4 address along with arguments IPv4 address, net mask and broadcast address. [example usage : set-Ipv4Static 192.168.4.40 255.255.255.0 192.168.4.255]
5. Set-Ipv6 Static can be used to set a static IPv6 address along with arguments IPv6 address and prefix length. [example usage : set-Ipv6 Static 3ffe:501:CAFE::A001:1012 64]
6. set-IfaceDhcp will set the interface as dynamic for both IPv4 and IPv6.

6.3. Prerequisite

- Install Netopeer client in the host PC
- Network connection between MPRU and Host PC
- Host PC and MPRU should be in the same network domain.

6.5. Netconf Client Installation

Netopeer2 is a server for implementing network configuration management based on the NETCONF Protocol. This is the second generation, originally available as the [Netopeer project](#). Netopeer2 is based on the NETCONF and YANG libraries - [libyang](#) and [libnetconf2](#). The Netopeer2 server uses [sysrepo](#) as a NETCONF datastore implementation.

Requirements

- [libyang](#)
- [libnetconf2](#)
- [sysrepo](#)
- [netopeer2-cli](#)

6.5.1. Compilation and installation:

Install necessary packages for netopeer2

```
sudo apt-get update
sudo apt-get upgrade
sudo apt-get install git
sudo apt install snapd
sudo snap install sysrepo-netopeer-gen
sudo apt install openssl
sudo apt install libssh-4 libssh-dev
sudo apt install libgcrypt20-dev
sudo apt install libcrypto++-dev
sudo apt install libssl-dev
sudo apt-get install zlib1g-dev
sudo apt-get install build-essential
sudo apt-get install g++
sudo apt-get install cmake
```

To install netopeer-cli version 2 yang modules as follows.**1. libssh (checkout to 0.7.5 branch from git repo)**

```
$ git clone http://git.libssh.org/projects/libssh.git
$ cd libssh; mkdir build; cd build
$ cmake ..
$ rm -rf CMakeCache.txt
$ make install
$ make install -j8
$ make
```

2. libyang([v1.0.240](#))

Note : dependency on libpcrc (install libpcrc : `sudo apt-get install libpcrc3-dev libpcrc3`)

Install .tar file instead of cloning and extract

```
$ cd libyang-1.0.240; mkdir build; cd build
$ cmake ..
$ rm -rf CMakeCache.txt
$ make
$ make install
```

3. libnetconf2([v1.1.46](#))**Install .tar file instead of cloning and extract**

```
$ cd libnetconf2-1.1.46
$ mkdir build; cd build
$ cmake ..
$ rm -rf CMakeCache.txt
$ make
$ make install
```

4. sysrepo([v1.4.140](#))**Install .tar file instead of cloning and extract**

```
$ cd sysrepo-1.4.140
$ mkdir build; cd build
$ cmake ..
$ rm -rf CMakeCache.txt
$ make
$ make install
```

5. Netopeer server and client([Version 1.1.76](#))

Install .tar file instead of cloning and extract

```
--server installation;  
$ cd netopeer2-1.1.76  
$ mkdir build; cd build  
$ cmake ..  
$ rm -rf CMakeCache.txt  
$ sudo ldconfig  
$ make  
$ make install
```

Note : server make install may fail with the error (/usr/local/bin/sysrepoctl: error while loading shared libraries: libsysrepo.so.5: cannot open shared object file: No such file or directory

CMake Warning (dev) at cmake_install.cmake:61 (if):

given arguments: 127.....etc)

put ldconfig command and then proceed with make install

```
$ sudo ldconfig  
$ make  
$ make install
```

To install netopeer-cli version 7 yang modules as follows.

```
1.libssh (checkout to 0.7.5 branch from git repo)  
$ git clone http://git.libssh.org/projects/libssh.git  
$ cd libssh; mkdir build; cd build  
$ cmake ..  
$ rm -rf CMakeCache.txt  
$ make install  
$ make install -j8  
$ make
```

```
2. libyang(v2.1.4)
```

Note : dependency on libpcr (install libpcr : sudo apt-get install libpcr3-dev libpcr3)

Install .tar file instead of cloning and extract

```
$ cd libyang-2.1.4; mkdir build; cd build  
$ cmake ..  
$ rm -rf CMakeCache.txt  
$ make  
$ make install
```

```
3. libnetconf2(v2.1.25)
```

Install .tar file instead of cloning and extract

```
$ cd libnetconf2-2.1.25
$ mkdir build; cd build
$ cmake ..
$ rm -rf CMakeCache.txt
$ make
$ make install
4. sysrepo(v2.2.12)
```

Install .tar file instead of cloning and extract

```
$ cd sysrepo-1.4.140
$ mkdir build; cd build
$ cmake ..
$ rm -rf CMakeCache.txt
$ make
$ make install
5. Netopeer server and client(v2.1.49)
```

Install .tar file instead of cloning and extract

```
--server installation;
$ cd netopeer2-2.1.49
$ mkdir build; cd build
$ cmake ..
$ rm -rf CMakeCache.txt
$ sudo ldconfig
$ make
$ make install
```

Note : server make install may fail with the error (/usr/local/bin/sysrepoctl: error while loading shared libraries: libsysrepo.so.5: cannot open shared object file: No such file or directory

CMake Warning (dev) at cmake_install.cmake:61 (if)

given arguments: 127.....etc)

put ldconfig command and then proceed with make install

```
$ sudo ldconfig
$ make
$make install
```

6.6 Procedure

DHCP server will assign a dynamic ip to the 10G interface, then Follow below-mentioned commands for connecting via Netopeer

```
>netopeer2-cli
>listen --ssh --login <username>
```

- Insert any one of the credentials in [table 10](#)

6.7 Firmware upgrade via M Plane

Note:- For reference refer ORAN spec- O-RAN.WG4.MP.0-v07.00

6.7.1. Firmware upgrade using v7 yang modules

6.7.1.1. Software Download

```
subscribe --filter-xpath /o-ran-software-management:download-event
```

Download

```
>user-rpc
```

```
<software-download xmlns="urn:o-ran:software-management:1.0">
<remote-file-path>sftp://username@ip_address:22/file_path</remote-file-path>
  <password>
    <password>PASSWORD</password>
  </password>
</software-download>
```

Note:

Remote File path Location:

<username of Linux PC>@<IP address of Linux PC>:22/<Specify the software image location in linux PC>
Password:Linux PC's Password

6.7.1.2. Software Install

```
subscribe --filter-xpath /o-ran-software-management:install-event
```

Install

```
>user-rpc
```

```
<software-install xmlns="urn:o-ran:software-management:1.0">
  <slot-name>SLOT_NUMBER(ex:swSlot2)</slot-name>
</software-install>
```

6.7.1.3. Software Activate

```
subscribe --filter-xpath /o-ran-software-management:activation-event
```

Activate

```
>user-rpc
```

```
[OBJ]
```

```
<software-activate xmlns="urn:o-ran:software-management:1.0">
  <slot-name>SLOT_NUMBER(ex:swSlot2)</slot-name>
</software-activate>
```

6.7.1.4. Software Reset

Reset

```
>user-rpc
```

```
<reset xmlns="urn:o-ran:operations:1.0"></reset>
```

6.8. Performance management via M Plane

6.8.1.o-ran-performance-management.yang Module for V 7 Netopeercli yang.

```
edit-config --target running --config --defop replace
```

```
<performance-measurement-objects xmlns="urn:o-ran:performance-management:1.0">
  <enable-SFTP-upload>true</enable-SFTP-upload>
  <enable-random-file-upload>false</enable-random-file-upload>
  <remote-SFTP-uploads>
    <remote-SFTP-upload-path>sftp://username@ip_address:22/file_upload_path</remote-SFTP-upload-path>
    <password>
      <password>DU_PASSWORD</password>
    </password>
  </remote-SFTP-uploads>
```

```
</remote-SFTP-uploads>
    <rx-window-measurement-interval>20</rx-window-measurement-interval>
<transceiver-measurement-interval>20</transceiver-measurement-interval>
<notification-interval>20</notification-interval>
<file-upload-interval>20</file-upload-interval>
<rx-window-measurement-objects>
    <measurement-object>RX_ON_TIME</measurement-object>
    <active>true/false</active>
    <object-unit>EAXC_ID</object-unit>
    <report-info>MAXIMUM</report-info>
</rx-window-measurement-objects>
<rx-window-measurement-objects>
    <measurement-object>RX_EARLY</measurement-object>
    <active>true/false</active>
    <object-unit>EAXC_ID</object-unit>
    <report-info>MAXIMUM</report-info>
</rx-window-measurement-objects>
<rx-window-measurement-objects>
    <measurement-object>RX_LATE</measurement-object>
    <active>true</active>
    <object-unit>EAXC_ID</object-unit>
    <report-info>MAXIMUM</report-info>
</rx-window-measurement-objects>
<rx-window-measurement-objects>
    <measurement-object>RX_CORRUPT</measurement-object>
    <active>true/false</active>
    <object-unit>EAXC_ID</object-unit>
    <report-info>MAXIMUM</report-info>
</rx-window-measurement-objects>
<rx-window-measurement-objects>
    <measurement-object>RX_TOTAL</measurement-object>
    <active>true/false</active>
    <object-unit>EAXC_ID</object-unit>
    <report-info>MAXIMUM</report-info>
</rx-window-measurement-objects>
<transceiver-measurement-objects>
    <measurement-object>RX_DUPL</measurement-object>
    <active>true/false</active>
    <report-info>MAXIMUM</report-info>
    <object-unit>PORT_NUMBER</object-unit>
```

```

</transceiver-measurement-objects>
<transceiver-measurement-objects>
  <measurement-object>TX_POWER</measurement-object>
  <active>true/false</active>
  <report-info>MAXIMUM</report-info>
  <object-unit>PORT_NUMBER</object-unit>
</transceiver-measurement-objects>
<transceiver-measurement-objects>
  <measurement-object>TX_BIAS_COUNT</measurement-object>
  <active>true/false</active>
  <report-info>MAXIMUM</report-info>
  <object-unit>PORT_NUMBER</object-unit>
</transceiver-measurement-objects>
<transceiver-measurement-objects>
  <measurement-object>VOLTAGE</measurement-object>
  <active>true/false</active>
  <report-info>MAXIMUM</report-info>
  <object-unit>PORT_NUMBER</object-unit>
</transceiver-measurement-objects>
<transceiver-measurement-objects>
  <measurement-object>TEMPERATURE</measurement-object>
  <active>true/false</active>
  <report-info>MAXIMUM</report-info>
  <object-unit>PORT_NUMBER</object-unit>
</transceiver-measurement-objects>
</performance-measurement-objects>

```

Note:

Remote File Path Location:

<username of Linux PC>@<IP address of Linux PC>:22/<Specify the software image location in Linux PC>

Password: Linux PC's Password

- To access the Public key of the sftp server, follow the steps below
 - \$cat /etc/ssh/ssh_host_rsa_key.pub

```

vkdnl0055@0338:~$ cat /etc/ssh/ssh_host_rsa_key.pub
ssh-rsa AAAAB3NzaC1yc2EAAAADAQABAAQDPPFqGm35C4R0mv6bgnRfVY/g+uWfqXuZ8UcizajDg0+RpVzPeGqTibZOU/SsBl0FQr3VbEb40ASLPz5PUJFguKYZ7sRQ2D+LZs/Fe5rhGges5N0Btlw
v1WC0/NYGTqsNvpk0DMH48K/LqH4wF3PkIzypXwG0Sf40TSHMk3VhmSI7/9AWRQ06aQPIPIW02GjzDmLi00S/ekYVS13wQh4dc292drAltB2hCab4uUhgS5zy79iHLLr7T7X8sxJisTg7H/kCPX86gGwof5Ej2
UdBoQ31s43gWjt0ZPSPCEKwCnhsB+QfG1adR0N0agUkCKRsdPtm1NdVYhEwMwD0e9gmHyXhM3kqQqfKGCfzdxWzSefyN6Mfore82efG3BSKxg3ockUzroQhhdIPxxKA8aJ5v/ASPoSvwzF7gBLh00TujKKa0Z8
qPdHfDaCCzKk0dIO/UV+QfLpt12v5dfYYNL4ze80x20NE+92ZHN56bBi2BC8KR5JDMT40jazU6yCs= root@vvs-TravelMate-P214-53
vkdnl0055@0338:~$

```

Fig 27: ssh host key

Note: Below is the RSA public key of the sftp server; in which the key that comes within the bracket is only required here.

ssh-rsa

[\[AAAAB3NzaC1yc2EAAAADAQABAAQDKr9yVoc2uRPc4t2SeTjIJ3qO8ZfOvFIJJoPrR3FirgWK/zPFmQ4ugzhCThzEyTB39d/IJM5Ns8lgVsw53O6b72XMBST8StYfQKLWFCjQYvotyMPfolNu9JA2a8Hpun4cA7/LPDCOPOJVVW523x83XZMgKsiB4c7jlgmvCHLOVZmPLGhNcaVFXM8OvGM+m4XLnAXcyOfHh2K7IUB6Htt9igxyzigxXY9PDsnZTsTOlyARh2K2Sm/7vJZZY/fRM8TfZrCo6BsY+Ljl+Frd/p9Z+mOgacsgfGkbXUbP6bl+wprxGhZ4Nn10k7KvIHflanaD5wgQ2NNGLOGYLAve5V3KyF\]](#) root@CICDPC230120

To activate performance management :

Give *TRUE* in every <active> leaf in the xml

To deactivate performance management :

Give *FALSE* in every <active> leaf in the xml

6.9. U plane configuration via M Plane

6.9.1.o-ran-uplane-conf.yang Module

```
edit-config --target running --config --defop replace
```

```
<user-plane-configuration xmlns="urn:o-ran:uplane-conf:1.0">
  <low-level-tx-links>
    <name>lltxlink0</name>
    <processing-element>element1</processing-element>
    <tx-array-carrier>txarraycarrier0</tx-array-carrier>
    <low-level-tx-endpoint>slltx-endpoint0</low-level-tx-endpoint>
  </low-level-tx-links>
  <low-level-tx-links>
    <name>lltxlink1</name>
    <processing-element>element1</processing-element>
    <tx-array-carrier>txarraycarrier0</tx-array-carrier>
    <low-level-tx-endpoint>slltx-endpoint1</low-level-tx-endpoint>
  </low-level-tx-links>
  <low-level-tx-links>
    <name>lltxlink2</name>
    <processing-element>element1</processing-element>
    <tx-array-carrier>txarraycarrier0</tx-array-carrier>
    <low-level-tx-endpoint>slltx-endpoint2</low-level-tx-endpoint>
  </low-level-tx-links>
</low-level-tx-links>
```

```

<name>lltxlink3</name>
<processing-element>element1</processing-element>
<tx-array-carrier>txarraycarrier0</tx-array-carrier>
<low-level-tx-endpoint>slltx-endpoint3</low-level-tx-endpoint>
</low-level-tx-links>

<low-level-rx-links>
  <name>llrxlink0</name>
  <processing-element>element1</processing-element>
  <rx-array-carrier>rxarraycarrier0</rx-array-carrier>
  <low-level-rx-endpoint>sllrx-endpoint0</low-level-rx-endpoint>
</low-level-rx-links>
<low-level-rx-links>
  <name>llrxlink1</name>
  <processing-element>element1</processing-element>
  <rx-array-carrier>rxarraycarrier0</rx-array-carrier>
  <low-level-rx-endpoint>sllrx-endpoint1</low-level-rx-endpoint>
</low-level-rx-links>
<low-level-rx-links>
  <name>llrxlink2</name>
  <processing-element>element1</processing-element>
  <rx-array-carrier>rxarraycarrier0</rx-array-carrier>
  <low-level-rx-endpoint>sllrx-endpoint2</low-level-rx-endpoint>
</low-level-rx-links>
<low-level-rx-links>
  <name>llrxlink3</name>
  <processing-element>element1</processing-element>
  <rx-array-carrier>rxarraycarrier0</rx-array-carrier>
  <low-level-rx-endpoint>sllrx-endpoint3</low-level-rx-endpoint>
</low-level-rx-links>

<low-level-tx-endpoints>
  <name>slltx-endpoint0</name>
  <compression>
    <compression-type>STATIC</compression-type>
    <iq-bitwidth>16</iq-bitwidth>
  </compression>
  <cp-length>352</cp-length>
  <cp-length-other>288</cp-length-other>
  <offset-to-absolute-frequency-center>0</offset-to-absolute-frequency-center>
  <number-of-prb-per-scs>
    <scs>KHZ_30</scs>
    <number-of-prb>273</number-of-prb>
  </number-of-prb-per-scs>
  <e-axcid>

```

```

<o-du-port-bitmask>65024</o-du-port-bitmask>
<band-sector-bitmask>448</band-sector-bitmask>
<ccid-bitmask>56</ccid-bitmask>
<ru-port-bitmask>7</ru-port-bitmask>
<eexc-id>1</eexc-id>
</e-axcid>
</low-level-tx-endpoints>
<low-level-tx-endpoints>
  <name>slltx-endpoint1</name>
  <compression>
    <compression-type>STATIC</compression-type>
    <iq-bitwidth>16</iq-bitwidth>
  </compression>
  <cp-length>352</cp-length>
  <cp-length-other>288</cp-length-other>
  <offset-to-absolute-frequency-center>0</offset-to-absolute-frequency-center>
  <number-of-prb-per-scs>
    <scs>KHZ_30</scs>
    <number-of-prb>273</number-of-prb>
  </number-of-prb-per-scs>
  <e-axcid>
    <o-du-port-bitmask>65024</o-du-port-bitmask>
    <band-sector-bitmask>448</band-sector-bitmask>
    <ccid-bitmask>56</ccid-bitmask>
    <ru-port-bitmask>7</ru-port-bitmask>
    <eexc-id>2</eexc-id>
  </e-axcid>
</low-level-tx-endpoints>
<low-level-tx-endpoints>
  <name>slltx-endpoint2</name>
  <compression>
    <compression-type>STATIC</compression-type>
    <iq-bitwidth>16</iq-bitwidth>
  </compression>
  <cp-length>352</cp-length>
  <cp-length-other>288</cp-length-other>
  <offset-to-absolute-frequency-center>0</offset-to-absolute-frequency-center>
  <number-of-prb-per-scs>
    <scs>KHZ_30</scs>
    <number-of-prb>273</number-of-prb>
  </number-of-prb-per-scs>
  <e-axcid>
    <o-du-port-bitmask>65024</o-du-port-bitmask>
    <band-sector-bitmask>448</band-sector-bitmask>
    <ccid-bitmask>56</ccid-bitmask>

```

```

    <ru-port-bitmask>7</ru-port-bitmask>
    <eexc-id>3</eexc-id>
  </e-axcid>
</low-level-tx-endpoints>
<low-level-tx-endpoints>
  <name>slltx-endpoint3</name>
  <compression>
    <compression-type>STATIC</compression-type>
    <iq-bitwidth>16</iq-bitwidth>
  </compression>
  <cp-length>352</cp-length>
  <cp-length-other>288</cp-length-other>
  <offset-to-absolute-frequency-center>0</offset-to-absolute-frequency-center>
  <number-of-prb-per-scs>
    <scs>KHZ_30</scs>
    <number-of-prb>273</number-of-prb>
  </number-of-prb-per-scs>
  <e-axcid>
    <o-du-port-bitmask>65024</o-du-port-bitmask>
    <band-sector-bitmask>448</band-sector-bitmask>
    <ccid-bitmask>56</ccid-bitmask>
    <ru-port-bitmask>7</ru-port-bitmask>
    <eexc-id>4</eexc-id>
  </e-axcid>
</low-level-tx-endpoints>

<low-level-rx-endpoints>
  <name>sllrx-endpoint0</name>
  <compression>
    <compression-type>STATIC</compression-type>
    <iq-bitwidth>16</iq-bitwidth>
  </compression>
  <cp-length>352</cp-length>
  <cp-length-other>288</cp-length-other>
  <offset-to-absolute-frequency-center>0</offset-to-absolute-frequency-center>
  <number-of-prb-per-scs>
    <scs>KHZ_30</scs>
    <number-of-prb>273</number-of-prb>
  </number-of-prb-per-scs>
  <ul-fft-sampling-offsets>
    <scs>KHZ_30</scs>
  </ul-fft-sampling-offsets>
  <e-axcid>
    <o-du-port-bitmask>65024</o-du-port-bitmask>
    <band-sector-bitmask>448</band-sector-bitmask>

```

```

    <ccid-bitmask>56</ccid-bitmask>
    <ru-port-bitmask>7</ru-port-bitmask>
    <eexc-id>1</eexc-id>
  </e-axcid>
  <non-time-managed-delay-enabled>true</non-time-managed-delay-enabled>
</low-level-rx-endpoints>
<low-level-rx-endpoints>
  <name>sllrx-endpoint1</name>
  <compression>
    <compression-type>STATIC</compression-type>
    <iq-bitwidth>16</iq-bitwidth>
  </compression>
  <cp-length>352</cp-length>
  <cp-length-other>288</cp-length-other>
  <offset-to-absolute-frequency-center>0</offset-to-absolute-frequency-center>
  <number-of-prb-per-scs>
    <scs>KHZ_30</scs>
    <number-of-prb>273</number-of-prb>
  </number-of-prb-per-scs>
  <ul-fft-sampling-offsets>
    <scs>KHZ_30</scs>
  </ul-fft-sampling-offsets>
</e-axcid>
  <o-du-port-bitmask>65024</o-du-port-bitmask>
  <band-sector-bitmask>448</band-sector-bitmask>
  <ccid-bitmask>56</ccid-bitmask>
  <ru-port-bitmask>7</ru-port-bitmask>
  <eexc-id>2</eexc-id>
</e-axcid>
  <non-time-managed-delay-enabled>true</non-time-managed-delay-enabled>
</low-level-rx-endpoints>
<low-level-rx-endpoints>
  <name>sllrx-endpoint2</name>
  <compression>
    <compression-type>STATIC</compression-type>
    <iq-bitwidth>16</iq-bitwidth>
  </compression>
  <cp-length>352</cp-length>
  <cp-length-other>288</cp-length-other>
  <offset-to-absolute-frequency-center>0</offset-to-absolute-frequency-center>
  <number-of-prb-per-scs>
    <scs>KHZ_30</scs>
    <number-of-prb>273</number-of-prb>
  </number-of-prb-per-scs>
  <ul-fft-sampling-offsets>

```

```

    <scs>KHZ_30</scs>
  </ul-fft-sampling-offsets>
  <e-axcid>
    <o-du-port-bitmask>65024</o-du-port-bitmask>
    <band-sector-bitmask>448</band-sector-bitmask>
    <ccid-bitmask>56</ccid-bitmask>
    <ru-port-bitmask>7</ru-port-bitmask>
    <eaxc-id>3</eaxc-id>
  </e-axcid>
  <non-time-managed-delay-enabled>true</non-time-managed-delay-enabled>
</low-level-rx-endpoints>
<low-level-rx-endpoints>
  <name>sllrx-endpoint3</name>
  <compression>
    <compression-type>STATIC</compression-type>
    <iq-bitwidth>16</iq-bitwidth>
  </compression>
  <cp-length>352</cp-length>
  <cp-length-other>288</cp-length-other>
  <offset-to-absolute-frequency-center>0</offset-to-absolute-frequency-center>
  <number-of-prb-per-scs>
    <scs>KHZ_30</scs>
    <number-of-prb>273</number-of-prb>
  </number-of-prb-per-scs>
  <ul-fft-sampling-offsets>
    <scs>KHZ_30</scs>
  </ul-fft-sampling-offsets>
  <e-axcid>
    <o-du-port-bitmask>65024</o-du-port-bitmask>
    <band-sector-bitmask>448</band-sector-bitmask>
    <ccid-bitmask>56</ccid-bitmask>
    <ru-port-bitmask>7</ru-port-bitmask>
    <eaxc-id>4</eaxc-id>
  </e-axcid>
  <non-time-managed-delay-enabled>true</non-time-managed-delay-enabled>
</low-level-rx-endpoints>
<tx-array-carriers>
  <name>txarraycarrier0</name>
  <absolute-frequency-center>[ARFCN]</absolute-frequency-center>
  <center-of-channel-bandwidth>[CENTER FREQUENCY]</center-of-channel-bandwidth>
  <channel-bandwidth>[BANDWIDTH]</channel-bandwidth>
  <active>INACTIVE</active>
  <gain>27</gain>
  <downlink-radio-frame-offset>0</downlink-radio-frame-offset>
  <downlink-sfn-offset>0</downlink-sfn-offset>

```

```

<rw-duplex-scheme>TDD</rw-duplex-scheme>
<rw-type>NR</rw-type>
</tx-array-carriers>
<rx-array-carriers>
  <name>rxarraycarrier0</name>
  <absolute-frequency-center>[ARFCN]</absolute-frequency-center>
  <center-of-channel-bandwidth>[CENTER FREQUENCY]</center-of-channel-bandwidth>
  <channel-bandwidth>[BANDWIDTH]</channel-bandwidth>
  <active>INACTIVE</active>
  <downlink-radio-frame-offset>0</downlink-radio-frame-offset>
  <downlink-sfn-offset>0</downlink-sfn-offset>
  <gain-correction>0</gain-correction>
  <n-ta-offset>25600</n-ta-offset>
</rx-array-carriers>
</user-plane-configuration>

```

Note: For 4T4R the eAxC ID mapping is
PDSCH- 0,1,2,3
PUSCH-0,1,2,3
PRACH-4,5,6,7

ARFCN of center frequency chosen within the band eg : ARFCN : 641667, Freq : 3625.005 Mhz
Bandwidth within ibw/obw can be used.

Note: We need to push the ACTIVE leaf in the U-plane each time after the RU gets synchronized.

6.10. Interface configuration via M Plane

6.10.1.o-ran-interface.yang Module for V7 yang modules.

```
edit-config --target running --config --defop merge
```

```

<interfaces xmlns="urn:ietf:params:xml:ns:yang:ietf-interfaces">
  <interface>
    <name>eth1.100(interface_name.valn)</name>
    <type xmlns:ianaift="urn:ietf:params:xml:ns:yang:iana-if-type">ianaift:l2vlan</type>
    <enabled>true</enabled>
    <base-interface xmlns="urn:o-ran:interfaces:1.0">eth1</base-interface>
    <vlan-id xmlns="urn:o-ran:interfaces:1.0">100(valn)</vlan-id>
    <mac-address xmlns="urn:o-ran:interfaces:1.0">[MAC_ADDRESS]</mac-address>
  </interface>
</interfaces>

```

```

    <port-reference xmlns="urn:o-ran:interfaces:1.0">
      <port-name>ru-port0</port-name>
      <port-number>0</port-number>
    </port-reference>
  </interface>
</interfaces>

```

6.10.2.o-ran-interface.yang Module for V7 yang modules.

```

<interfaces xmlns="urn:ietf:params:xml:ns:yang:ietf-interfaces">
  <interface>
    <name>eth1(name_of_the_eth_interface)</name>
    <type xmlns:ianaift="urn:ietf:params:xml:ns:yang:iana-if-type">ianaift:ethernetCsmacd</type>
    <enabled>true</enabled>
    <ipv4 xmlns="urn:ietf:params:xml:ns:yang:ietf-ip">
      <enabled>true</enabled>
      <forwarding>false</forwarding>
      <m-plane-marking xmlns="urn:o-ran:interfaces:1.0">18</m-plane-marking>
    </ipv4>
    <l2-mtu xmlns="urn:o-ran:interfaces:1.0">1500</l2-mtu>
    <vlan-tagging xmlns="urn:o-ran:interfaces:1.0">true</vlan-tagging>
    <class-of-service xmlns="urn:o-ran:interfaces:1.0">
      <u-plane-marking>7</u-plane-marking>
      <c-plane-marking>7</c-plane-marking>
      <m-plane-marking>2</m-plane-marking>
      <s-plane-marking>7</s-plane-marking>
      <other-marking>1</other-marking>
      <enhanced-uplane-markings>
        <up-marking-name>uplane</up-marking-name>
        <enhanced-marking>7</enhanced-marking>
      </enhanced-uplane-markings>
    </class-of-service>
    <mac-address xmlns="urn:o-ran:interfaces:1.0">RU_MAC_ADDRESS</mac-address>
    <port-reference xmlns="urn:o-ran:interfaces:1.0">
      <port-name>ru-port1</port-name>
      <port-number>1</port-number>
    </port-reference>
  </interface>
</interface>
  <interface>
    <name>eth1.100(name_of_the_vlan_interface_to_be_created)</name>

```



```
<type xmlns:ianaift="urn:ietf:params:xml:ns:yang:iana-if-type">ianaift:l2vlan</type>
<enabled>true</enabled>
<ipv4 xmlns="urn:ietf:params:xml:ns:yang:ietf-ip">
  <enabled>true</enabled>
  <forwarding>>false</forwarding>
  <address>
    <ip>192.168.3.45(ip_of_the_vlan_interface)</ip>
    <netmask>255.255.255.0</netmask>
  </address>
  <m-plane-marking xmlns="urn:o-ran:interfaces:1.0">18</m-plane-marking>
</ipv4>
<base-interface xmlns="urn:o-ran:interfaces:1.0">eth0(FH_Interface_MPRU)</base-interface>
<vlan-id xmlns="urn:o-ran:interfaces:1.0">100(vlan_id)</vlan-id>
<mac-address xmlns="urn:o-ran:interfaces:1.0">RU_MAC_ADDRESS</mac-address>
<port-reference xmlns="urn:o-ran:interfaces:1.0">
  <port-name>ru-port1</port-name>
  <port-number>1</port-number>
</port-reference>
</interface>
</interfaces>
```

6.11. Processing element via M Plane

```
edit-config --target running --config --defop replace
```

```
<processing-elements xmlns="urn:o-ran:processing-element:1.0">
  <transport-session-type>ETH-INTERFACE</transport-session-type>
  <ru-elements>
    <name>element1</name>
    <transport-flow>
      <interface-name>eth1.100(name_of_the_vlan_interface)</interface-name>
      <eth-flow>
        <ru-mac-address>RU_MAC_ADDRESS</ru-mac-address>
        <vlan-id>100(vlan_id)</vlan-id>
        <o-du-mac-address>DU_MAC_ADDRESS</o-du-mac-address>
      </eth-flow>
    </transport-flow>
  </ru-elements>
</processing-elements>
```

```
</transport-flow>
</ru-elements>
</processing-elements>
```

6.12. Transceiver configuration via M Plane

```
edit-config --target running --config --defop replace
```

```
<port-transceivers xmlns="urn:o-ran:transceiver:1.0">
  <port-transceiver-data>
    <interface-name>eth1</interface-name>
    <port-number>1</port-number>
    <name>ru-port1</name>
    <present>true</present>
    <vendor-id>Syrotech</vendor-id>
    <vendor-part>GOXP-8596-02</vendor-part>
    <vendor-rev>V0</vendor-rev>
    <serial-no>SY2210-OLC0716</serial-no>
    <SFF8472-compliance-code>rev10.2-diagnostics</SFF8472-compliance-code>
    <connector-type>lucent-connector</connector-type>
    <identifier>sfp</identifier>
    <nominal-bitrate>103</nominal-bitrate>
    <low-bitrate-margin>0</low-bitrate-margin>
    <high-bitrate-margin>0</high-bitrate-margin>
    <rx-power-type>avp</rx-power-type>
    <rx-power>0.4287</rx-power>
    <tx-power>0.5889</tx-power>
    <tx-bias-current>7.93</tx-bias-current>
    <voltage>3.3348</voltage>
  </port-transceiver-data>
</port-transceivers>
</data>
```

6.13. mplane-int.yang configuration via M plane

6.13.1. Mplane-int.yang for v7 yang modules

```
edit-config --target running --config --defop replace
```

```

<mplane-info xmlns="urn:o-ran:mplane-interfaces:1.0">
  <searchable-mplane-access-vlans-info>
    <searchable-access-vlans>100</searchable-access-vlans>
    <vlan-range>
      <lowest-vlan-id>1</lowest-vlan-id>
      <highest-vlan-id>4094</highest-vlan-id>
    </vlan-range>
    <scan-interval>100</scan-interval>
  </searchable-mplane-access-vlans-info>
  <m-plane-interfaces>
    <m-plane-sub-interfaces>
      <interface-name>eth1.100</interface-name>
      <sub-interface>100</sub-interface>
    </m-plane-sub-interfaces>
    <m-plane-ssh-ports>
      <call-home-ssh-port>4334</call-home-ssh-port>
      <server-ssh-port>830</server-ssh-port>
    </m-plane-ssh-ports>
    <m-plane-tls-ports>
      <call-home-tls-port>4335</call-home-tls-port>
      <server-tls-port>6513</server-tls-port>
    </m-plane-tls-ports>
  </m-plane-interfaces>
  <configured-client-info>
    <mplane-ipv4-info>
      <mplane-ipv4>ex:192.168.4.15(ip_for_the_created_vlan_interface)</mplane-ipv4>
      <port>830</port>
    </mplane-ipv4-info>
    <mplane-ipv6-info>
      <mplane-ipv6>fe80::7a7d:f3ff:fe01:12e9</mplane-ipv6>
      <port>830</port>
    </mplane-ipv6-info>
    <mplane-fqdn>vvdntech</mplane-fqdn>
  </configured-client-info>
</mplane-info>

```

6.14. O-ran-troubleshooting configuration via M plane

6.14.1. Start Troubleshooting

user-rpc

```
<start-troubleshooting-logs xmlns="urn:o-ran:troubleshooting:1.0">  
</start-troubleshooting-logs>
```

6.14.2. Stop Troubleshooting

user-rpc

```
<stop-troubleshooting-logs xmlns="urn:o-ran:troubleshooting:1.0">  
</stop-troubleshooting-logs>
```

Logs: The troubleshooting logs will be stored inside radio's at location: /media/sd-mmcbk4/O-RAN/log/troubleshooting

6.15.o-ran-trace configuration via M plane

6.15.1. Start Trace

user-rpc

```
<start-trace-logs xmlns="urn:o-ran:trace:1.0">  
</start-trace-logs>
```

6.15.2. Stop Trace

user-rpc

```
<stop-trace-logs xmlns="urn:o-ran:trace:1.0">  
</stop-trace-logs>
```

Logs: The troubleshooting logs will be stored inside radio's at location: /media/sd-mmcbk4/O-RAN/log/trace

6.16. o-ran-supervision configuration via M Plane

```
<supervision-watchdog-reset xmlns="urn:o-ran:supervision:1.0">
  <supervision-notification-interval>60</supervision-notification-interval>
  <guard-timer-overhead>10</guard-timer-overhead>
</supervision-watchdog-reset>
```

6.17. o-ran-usermgmt configuration via M plane

```
edit-config --target running --config --defop replace
```

```
<data xmlns="urn:ietf:params:xml:ns:netconf:base:1.0">
  <users xmlns="urn:o-ran:user-mgmt:1.0">
    <user>
      <name>oranuser</name>
      <account-type>PASSWORD</account-type>
      <enabled>true</enabled>
    </user>
  </users>
</data>
```

```
get --filter-xpath /o-ran-usermgmt:users/user
```

6.18. o-ran-hardware configuration via M Plane

6.18.1. o-ran-hardware v7 yang modules.

```
get --filter-xpath /ietf-interfaces:interfaces
```

```
<data xmlns="urn:ietf:params:xml:ns:netconf:base:1.0">
  <interfaces xmlns="urn:ietf:params:xml:ns:yang:ietf-interfaces">
    <interface>
```

```
<name>lo</name>
<type xmlns:ianaift="urn:ietf:params:xml:ns:yang:iana-if-type">ianaift:ethernetCsmacd</type>
<enabled>true</enabled>
<oper-status>up</oper-status>
<phys-address>00:00:00:00:00:00</phys-address>
<statistics>
  <in-octets>200</in-octets>
  <in-discards>0</in-discards>
  <in-errors>0</in-errors>
  <out-octets>200</out-octets>
  <out-discards>0</out-discards>
  <out-errors>0</out-errors>
</statistics>
<ipv4 xmlns="urn:ietf:params:xml:ns:yang:ietf-ip">
  <enabled>true</enabled>
  <address>
    <ip>127.0.0.1</ip>
    <netmask>255.0.0.0</netmask>
  </address>
</ipv4>
<last-cleared xmlns="urn:o-ran:interfaces:1.0">2020-05-20T06:09:57+05:30</last-cleared>
<mac-address xmlns="urn:o-ran:interfaces:1.0">00:00:00:00:00:00</mac-address>
</interface>
<interface>
  <name>eth0</name>
  <type xmlns:ianaift="urn:ietf:params:xml:ns:yang:iana-if-type">ianaift:ethernetCsmacd</type>
  <enabled>true</enabled>
  <oper-status>up</oper-status>
  <phys-address>98:ae:71:00:00:22</phys-address>
  <statistics>
    <in-octets>0</in-octets>
    <in-discards>0</in-discards>
    <in-errors>0</in-errors>
    <out-octets>0</out-octets>
    <out-discards>0</out-discards>
    <out-errors>0</out-errors>
```

```
</statistics>
<ipv4 xmlns="urn:ietf:params:xml:ns:yang:ietf-ip">
  <enabled>true</enabled>
  <address>
    <ip>192.168.1.10</ip>
    <netmask>255.255.255.0</netmask>
  </address>
</ipv4>
<last-cleared xmlns="urn:o-ran:interfaces:1.0">2020-05-20T06:09:57+05:30</last-cleared>
<l2-mtu xmlns="urn:o-ran:interfaces:1.0">1500</l2-mtu>
<mac-address xmlns="urn:o-ran:interfaces:1.0">98:ae:71:00:00:22</mac-address>
<port-reference xmlns="urn:o-ran:interfaces:1.0">
  <port-name>ru-port0</port-name>
  <port-number>0</port-number>
</port-reference>
</interface>
<interface>
  <name>eth1</name>
  <type xmlns:ianaift="urn:ietf:params:xml:ns:yang:iana-if-type">ianaift:ethernetCsmacd</type>
  <enabled>true</enabled>
  <oper-status>up</oper-status>
  <phys-address>98:ae:71:00:00:11</phys-address>
  <statistics>
    <in-octets>81552</in-octets>
    <in-discards>0</in-discards>
    <in-errors>0</in-errors>
    <out-octets>877739</out-octets>
    <out-discards>0</out-discards>
    <out-errors>0</out-errors>
  </statistics>
  <ipv4 xmlns="urn:ietf:params:xml:ns:yang:ietf-ip">
    <enabled>true</enabled>
    <forwarding>false</forwarding>
    <address>
      <ip>192.168.4.50</ip>
      <netmask>255.255.255.0</netmask>
```

```

    </address>
    <m-plane-marking xmlns="urn:o-ran:interfaces:1.0">18</m-plane-marking>
  </ipv4>
  <last-cleared xmlns="urn:o-ran:interfaces:1.0">2020-05-20T06:09:57+05:30</last-cleared>
  <l2-mtu xmlns="urn:o-ran:interfaces:1.0">1500</l2-mtu>
  <vlan-tagging xmlns="urn:o-ran:interfaces:1.0">true</vlan-tagging>
  <class-of-service xmlns="urn:o-ran:interfaces:1.0">
    <u-plane-marking>7</u-plane-marking>
    <c-plane-marking>7</c-plane-marking>
    <m-plane-marking>2</m-plane-marking>
    <s-plane-marking>7</s-plane-marking>
    <other-marking>1</other-marking>
  </class-of-service>
  <mac-address xmlns="urn:o-ran:interfaces:1.0">98:ae:71:00:00:11</mac-address>
  <port-reference xmlns="urn:o-ran:interfaces:1.0">
    <port-name>ru-port1</port-name>
    <port-number>1</port-number>
  </port-reference>
</interface>
<interface>
  <name>eth1.100</name>
  <type xmlns:ianaift="urn:ietf:params:xml:ns:yang:iana-if-type">ianaift:l2vlan</type>
  <enabled>true</enabled>
  <oper-status>up</oper-status>
  <phys-address>98:ae:71:00:00:11</phys-address>
  <statistics>
    <in-octets>0</in-octets>
    <in-discards>0</in-discards>
    <in-errors>0</in-errors>
    <out-octets>5101</out-octets>
    <out-discards>0</out-discards>
    <out-errors>0</out-errors>
  </statistics>
  <ipv4 xmlns="urn:ietf:params:xml:ns:yang:ietf-ip">
    <enabled>true</enabled>
    <forwarding>false</forwarding>
  </ipv4>

```



```

<address>
  <ip>10.10.0.1</ip>
  <netmask>255.255.255.0</netmask>
</address>
<m-plane-marking xmlns="urn:o-ran:interfaces:1.0">18</m-plane-marking>
</ipv4>
<last-cleared xmlns="urn:o-ran:interfaces:1.0">2020-05-20T06:09:57+05:30</last-cleared>
<base-interface xmlns="urn:o-ran:interfaces:1.0">eth1</base-interface>
<vlan-id xmlns="urn:o-ran:interfaces:1.0">100</vlan-id>
<mac-address xmlns="urn:o-ran:interfaces:1.0">98:ae:71:00:00:11</mac-address>
<port-reference xmlns="urn:o-ran:interfaces:1.0">
  <port-name>ru-port1</port-name>
  <port-number>1</port-number>
</port-reference>
</interface>
</interfaces>
</data>

```

6.18.2. o-ran-hardware v7 yang modules.

```

<hardware xmlns="urn:ietf:params:xml:ns:yang:ietf-hardware">
  <component>
    <energy-saving-enabled>true</energy-saving-enabled>
    <last-service-date>11-08-2023</last-service-date>
    <o-ran-name>ru_hw_component_name</o-ran-name>
  </component>
</hardware>

```

```
get --filter-xpath /ietf-hardware:hardware
```

6.19. o-ran-operations configuration via M plane

```
edit-config --target running --config --defop replace
```

```
<operational-info xmlns="urn:o-ran:operations:1.0">
  <clock>
    <timezone-name>Asia/Kolkata</timezone-name>
    <timezone-utc-offset>+0530</timezone-utc-offset>
  </clock>
  <re-call-home-no-ssh-timer>60</re-call-home-no-ssh-timer>
</operational-info>
```

```
get --filter-xpath /o-ran-operations:operational-info
```

6.20. O-ran-file-management configuration via M plane

6.20.1 o-ran-file-management configurationFor V7 based yang modules

6.20.1.1 O-ran-file-management: file-download

```
subscribe --filter-xpath /o-ran-file-management:file-download-event
```

```
user-rpc
```

```
<file-download xmlns="urn:o-ran:file-management:1.0">
  <local-logical-file-path>/home/root/</local-logical-file-path>
  <remote-file-path>sftp://username@ip_address:22/file_path</remote-file-path>
  <password>
    <password>DU_PASSWORD</password>
  </password>
</file-download>
```

Note:

Remote File path Location:

<username of Linux PC>@<IP address of Linux PC>:22/<Specify the software image location in linux PC>

Password:Linux PC's Password

6.20.1.2 O-ran-file-management: file-upload

```
subscribe --filter-xpath /o-ran-file-management:file-upload-event
```

```
user-rpc
```

```
<file-upload xmlns="urn:o-ran:file-management:1.0">
  <local-logical-file-path>/home/root/name_of_the_file</local-logical-file-path>
  <remote-file-path>sftp://username@ip_address:22/file_upload_path</remote-file-path>
  <password>
    <password>DU_PASSWORD</password>
  </password>

</file-upload>
```

Note:

Remote File path Location:

**<username of Linux PC>@<IP address of Linux PC>:22/<Specify the software image location in linux PC>
Password:Linux PC's Password**

6.20.1.3 O-ran-file-management: retrieve-file-list

```
user-rpc
```

```
<retrieve-file-list xmlns="urn:o-ran:file-management:1.0">
  <logical-path>/home/root/</logical-path>
  <file-name-filter>*</file-name-filter>
</retrieve-file-list>
```

7.CLI MANAGER

```
root@vvdn_mpru:~$telnet localhost 8888
Connected to localhost

Enter Login Credentials

Username : oranuser
Password : oranuser

CLI Manager Client Connected Successfully
```

Fig 28: CLI manager log in

CLI Manager Client Connected Successfully

Command	Description
set-Ipv4Static	- Set ipv4 interface as static
set-Ipv6Static	- Set ipv6 interface as static
set-IfaceDhcp	- Set interface as dynamic
get-IfaceStatus	- Get Management Interface is static/Dynamic
get-IfaceIpType	- Get Management Interface IP type
set-IfaceIpType	- Set IP type of Management Interface
get-SwInv	- Get Software inventory details
get-HwInv	- Get Hardware inventory details
get-SysMac	- MAC address of the box
get-SysUptime	- System Uptime Information
get-1GStatus	- Get status of 1G Mac interface
get_fh_status	- Get status of 10G Mac interface
get_counter_stats	- Gets the updated rx layer stats
get-BandWidth	- Get Bandwidth details
set-BandWidth	- Set Bandwidth for the RU in MHZ
set_dl_compression	- Set Downlink Compression(9/12/14/16 bit)
get_dl_compression	- Get Downlink Compression
set_du_mac_address	- Set the DU MAC Address
get_du_mac_address	- Get the DU MAC Address
get-FpgaRegisterVersion	- Read Fpga Register details
set_pxsch_pcid	- Set PxSCH PCID L0 L1 L2 L3 (range 0 - 15)
get_pxsch_pcid	- Get PxSCH PCID
get_ru_ecpri_mac_address	- Get the RU ECPRI MAC Address
get_ru_xBAR_mac_address	- Get the RU xBAR MAC Address
get-PrachFormat	- Get PrachFormat Detail
get_DL_FPGA_DBFS_Power	- Get Downlink FPGA DBFS Power
get_UL_FPGA_DBFS_Power	- Get Uplink FPGA DBFS Power
set-CUPlaneVlan	- Set Vlan for the CU Plane in RU
get-CUPlaneVlan	- Get Vlan for the CU Plane in RU
get-dl_power_scaling	- Get dl_power scaling
set-dl_power_scaling	- Set dl_power scaling
get-ul_power_scaling	- Get ul_power scaling
set-ul_power_scaling	- Set ul_power scaling
set_ul_compression	- Set Uplink Compression(9/12/14/16 bit)
get_ul_compression	- Get Uplink Compression
get_prach_pcid	- Get the PRACH PCID
set_prach_pcid	- Set the PRACH PCID (2 2 2 2)
set-Templevels	- Set the Ambient and Fault Temperature levels
get_traceNotif_interval	- Get Trace Notification time interval
set_traceNotif_interval	- Set Trace Notification time interval
ruReset	- RU Diagnostic Triggered Restart
changePasswd	- Password change for logged in user
clear	- Clear the screen
help	- Get detailed help
exit	- Quit/Disconnect with the client

Fig 29: CLI Manager Functions

```

CLI:/> set-IPv4Static

Usage:-
Arg's:  ? : show command usage
        -h : same as '?'(Applicable for all commands)
        IP  : IPv4 IP Address
        MASK : Subnet mask
        BCST : Broadcast Ip Address
        <eg : set-IPv4Static 192.168.4.10 255.255.255.0 192.168.4.1>

CLI:/> set-IPv4Static 192.168.4.50 255.255.255.0 192.168.4.1

-----
Parameters                                     - Response
-----
Status                                         - Configured Successfully
-----

```

Fig 30: To set RU IP static

Eg:

1. set-IPv4Static 192.168.4.50 255.255.255.0 192.168.4.1
2. set-IPv4Static 192.168.2.20 255.255.255.0 192.168.2.1

```

CLI:/> get-IfaceStatus

-----
Parameters                                     - Response
-----
management_interface                         - static
-----

CLI:/> set-IfaceDhcp

-----
Parameters                                     - Response
-----
Status                                         - Configured Successfully
-----

CLI:/> get-IfaceStatus

-----
Parameters                                     - Response
-----
management_interface                         - dhcp
-----

```

Fig 31: To get and set RU interface status

```
CLI:/> get-SwInv
```

Parameters	Response
slot_name	swRecoverySlot
slot_status	VALID
slot_activation	false
slot_running	false
product_code	MPRU
vendor_code	VN
build_id	factory_img
build_name	Beta Release
build_version	1.0.0
boot_name	BOOT0003.BIN
boot_version	1.0.0

Confidential

slot_name	- swSlot1
slot_status	- VALID
slot_activation	- false
slot_running	- false
product_code	- MPRU
vendor_code	- VN
build_id	- fd30bbb
build_name	- Beta Release
build_version	- 1.0.3
boot_name	- BOOT0001.BIN
boot_version	- 1.0.0
boot_integrity	- OK
kernel_name	- image0001.ub
kernel_version	- 1.0.0
kernel_integrity	- OK
rootFs_name	- rootfs.tar.gz
rootFs_version	- 1.0.0
rootFs_integrity	- OK
md5sum	-

Parameters	- Response

slot_name	- swSlot2
slot_status	- VALID
slot_activation	- true
slot_running	- true
product_code	- MPRU
vendor_code	- VN
build_id	- fd30bbb
build_name	- Beta Release
build_version	- 1.0.3
boot_name	- BOOT0002.BIN
boot_version	- 1.0.0
boot_integrity	- OK
kernel_name	- image0002.ub
kernel_version	- 1.0.0
kernel_integrity	- OK
rootFs_name	- rootfs.tar.gz
rootFs_version	- 1.0.0
rootFs_integrity	- OK

Fig 32: To get RU sw version


```
CLI:/> get-HwInv

-----
Paramaters                - Response
-----
mfg-name                  - VVDN
description                - VVDN-RU
model-name                - VVDN_MPRU
serial-num                - 2404199000025
hardware-rev              - A1-20240802
software-rev              - 01-v1.0.3
uuid                      - f81d4fae-7dec-11d0-a765-00a0c91e6bf6
oper-state                - disabled
usage-state               - busy
availability-state         - FAULTY
```

Fig 33: To get HW information

```
CLI:/> get-SysMac

-----
Paramaters                - Response
-----
eth0 mac_address          - 98:ae:71:00:00:22
eth1 mac_address          - 98:ae:71:00:00:11
-----
```

Fig 34: FH MAC address

```
CLI:/> get-SysUptime

-----
Paramaters                - Response
-----
Days                      - 0
Hours                     - 13
Minutes                   - 5
Seconds                   - 23
-----
```

Fig 35: RU up time

```
CLI:/> get-1GStatus

-----
Paramaters                - Response
-----
1G_mac                    - down
```

Fig 36: 1G Status

```
CLI:/> get_fh_status
```

Parameters	- Response
10G_status	- up

Fig 37: 10G Status

```
CLI:/> get_counter_stats
```

Parameters	- Response
------------	------------

RX_COUNTER_LAYER0

total_rx_packets	- 0
rx_duplicate	- 0
rx_corrupt	- 0
rx_late	- 0
rx_early	- 0
rx_on_time	- 0

RX_COUNTER_LAYER1

total_rx_packets	- 0
rx_duplicate	- 0
rx_corrupt	- 0
rx_late	- 0
rx_early	- 0
rx_on_time	- 0

RX_COUNTER_LAYER2

total_rx_packets	- 0
rx_duplicate	- 0
rx_corrupt	- 0
rx_late	- 0
rx_early	- 0
rx_on_time	- 0

RX_COUNTER_LAYER3

total_rx_packets	- 0
rx_duplicate	- 0
rx_corrupt	- 0
rx_late	- 0
rx_early	- 0
rx_on_time	- 0

Fig 38: RU counters

```

CLI:/>
CLI:/> get-BandWidth

-----
Paramaters                - Response
-----
Bandwidth                 - 100MHz
-----

CLI:/> set-BandWidth
Correct usage is:set-BandWidth <5/10/15/20/30/40/50/60/70/80/90/100>

CLI:/> set-BandWidth 90
DONE

CLI:/> get-BandWidth

-----
Paramaters                - Response
-----
Bandwidth                 - 90MHz
-----

```

Fig 39: Get and Set Bandwidth

```

CLI:/> get_dl_compression

-----
Paramaters                - Response
-----
DL Compression           - 16 bit
-----

CLI:/> set_dl_compression
Correct usage is: set_dl_compression <9/12/14/16>

CLI:/> set_dl_compression 9
DONE

CLI:/> get_dl_compression

-----
Paramaters                - Response
-----
DL Compression           - 9 bit
-----

```

Fig 40: Get and set DL compression

```

CLI:/> get_du_mac_address

-----
Paramaters                               - Response
-----
DU MAC Address                           - 00:11:22:33:44:66

CLI:/> set_du_mac_address
Invaild Argument: set_du_mac_address <MAC>

CLI:/> set_du_mac_address 11:22:44:55:88:89
DONE

CLI:/> get_du_mac_address

-----
Paramaters                               - Response
-----
DU MAC Address                           - 11:22:44:55:88:89

```

Fig 41: Get and Set DU MAC address

```

CLI:/> get_pxsch_pcid

-----
Paramaters                               - Response
-----
LAYER 0                                  - 0
LAYER 1                                  - 2
LAYER 2                                  - 3
LAYER 3                                  - 4

CLI:/> set_pxsch_pcid
Correct usage is: set_pxsch_pcid L0 L1 L2 L3 (range 0 - 15)

CLI:/> set_pxsch_pcid 0 1 2 3
DONE

CLI:/> get_pxsch_pcid

-----
Paramaters                               - Response
-----
LAYER 0                                  - 0
LAYER 1                                  - 1
LAYER 2                                  - 2
LAYER 3                                  - 3

```

Fig 42: Get and Set PXSCH PCID

```

CLI:/> get-CUPlaneVlan

-----
Parameters                               - Response
-----
CU_Plane-Vlan                           - 100

CLI:/> set-CUPlaneVlan
Invalid Arguments: Correct usage is set-CUPlaneVlan vlanid[Range:1-4094]

CLI:/> set-CUPlaneVlan 101
DONE

CLI:/> get-CUPlaneVlan

-----
Parameters                               - Response
-----
CU_Plane-Vlan                           - 101

CLI:/>

```

Fig 43: Get and Set CU Plane VLAN

```

CLI:/> get_ul_compression

-----
Parameters                               - Response
-----
UL Compression                           - 16

CLI:/> set_ul_compression 9
DONE

CLI:/> get_ul_compression

-----
Parameters                               - Response
-----
UL Compression                           - 9

```

Fig 44: Set and Get UL compression

```
CLI:/> get_prach_pcid

-----
Paramaters                - Response
-----
LAYER 0                   - 5
LAYER 1                   - 6
LAYER 2                   - 7
LAYER 3                   - 8

CLI:/> set_prach_pcid 4 5 6 7
DONE

CLI:/> get_prach_pcid

-----
Paramaters                - Response
-----
LAYER 0                   - 4
LAYER 1                   - 5
LAYER 2                   - 6
LAYER 3                   - 7
```

Fig 45: Get and Set PRACH PCID

```
CLI:/> help

Usage:  help { ? | -h | -d | -a }
Arg's:  ? : show command usage
        -h : same as '?'(Applicable for all commands)
        -d : list debug commands only
        -a : list all commands
```

Fig 46: Help

8.FAQ

8.1 How to check if RU is properly booted or not?

Check the power LED, it should be glowed with a stable green.

8.2 How to check if RU is getting C,U,M & S plane packets properly or not?

By hitting the below-mentioned command in the RU console & check for the M & S Plane counts

root@vvdn_mpru: bash /etc/scripts/stat_ru.sh

```

root@vvdn_mpru:~$ /etc/scripts/stat_ru.sh
*****DOWNLINK PATH*****
-----
----- MAC COUNTERS DL -----
----- TOTAL_RX Packets (LSB) : 60323
----- TOTAL_RX Packets (MSB) : 0
=====
----- DL SMART INTERCONNECT COUNTERS -----
----- DL-PATH
----- Total DL Count : 60156
----- DL S-Plane Count : 137
----- DL C-Plane Count : 9264
----- DL U-Plane Count : 50693
----- DL M0-Plane Count : 62
----- DL M1-Plane Count : 0
----- DL M2-Plane Count : 0
----- DL M3-Plane Count : 0
----- DL M4-Plane Count : 0
----- DL Incorrect Pkt Count : 0
----- DL DropDA_Pkt Count : 0
----- DL DropSA_Pkt Count : 0
----- DL Dropetype_Pkt Count : 0
=====
----- RECIEVE COUNTERS DL -----
----- LAYER-0
----- TOTAL_RX Packets : 50465
----- RX_DUPLICATE : 0
----- RX_CORRUPT : 0
----- RX_LATE : 0
----- RX_EARLY : 0
----- RX_ON-TIME : 51442
----- LAYER-1
----- TOTAL_RX Packets : 0
----- RX_DUPLICATE : 0
----- RX_CORRUPT : 0
----- RX_LATE : 0

```

Fig 47: CUSM plane counts

8.3 How to check if the SFP port is Link Up or not?

Hit the below-mentioned command in the RU's console & check whether Link is detected or not.

root@vvdn_mpru: ethtool eth1


```

root@vvdn_mpru:~$ethtool eth1
Settings for eth1:
Cannot get device settings: No such device
Link detected: yes
root@vvdn_mpru:~$

```

Fig 48: ethtool command

8.4 Can I add Switch between O-RU and GM?

Yes. But, please make sure Switch supports IEEE 1588 PTP.

8.5 Can I add a Switch to connect O-RU and O-DU?

Yes. Please make sure following items:

- The L2 switch should support VLAN with tag.
- Those ports (connected to RU & DU) should be in trunk mode and make sure both are connected to the same VLAN tag.
- Should keep VLAN tag in those ports (DO NOT set untag)
- Enable jumbo frames. Set frame size more than 9600 Bytes.

8.6 How to check if RU is PTP sync or not?

1. The SYNC status can be verified from WEB GUI Dashboard System Monitor Section /CLI SYNC - Locked (Successfully Synchronised)

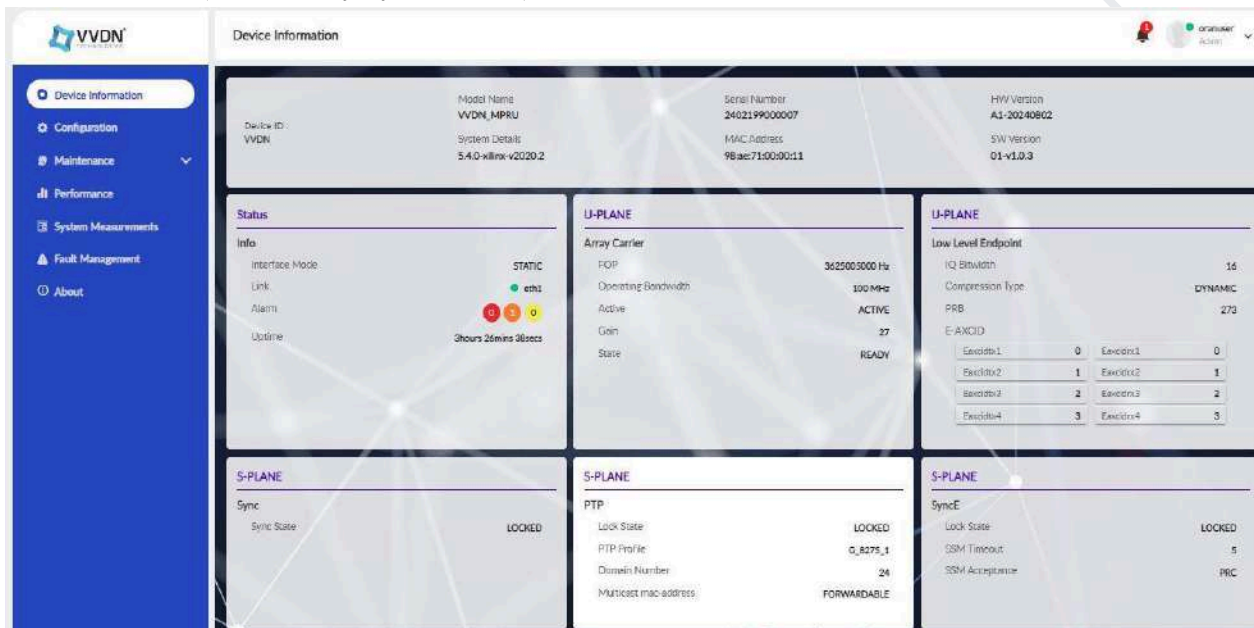


Fig 49: GUI Device Information tab

2. By checking the Network & status LED of RU, it should be stable Green

8.7 Which PRACH format does RU support?

RU only supports short PRACH format A3,B4,C2.

8.8 How can we configure the DU MAC address ?

[Refer section:6.11](#)

```
<processing-elements xmlns="urn:o-ran:processing-element:1.0">
  <transport-session-type>ETH-INTERFACE</transport-session-type>
  <ru-elements>
    <name>element0</name>
    <transport-flow>
      <interface-name>eth0.100</interface-name>
      <eth-flow>
        <ru-mac-address>98:ae:71:00:8a:55</ru-mac-address>
        <vlan-id>100</vlan-id>
        <o-du-mac-address>[DU_MAC_ADD]</o-du-mac-address>
      </eth-flow>
    </transport-flow>
  </ru-elements>
</processing-elements>
```

Fig 50: DU MAC address

8.9 How to add a VLAN ID ?

Change VLAN id

```
<processing-elements xmlns="urn:o-ran:processing-element:1.0">
  <transport-session-type>ETH-INTERFACE</transport-session-type>
  <ru-elements>
    <name>element0</name>
    <transport-flow>
      <interface-name>eth0.100</interface-name>
      <eth-flow>
        <ru-mac-address>98:ae:71:00:8a:55</ru-mac-address>
        <vlan-id>100</vlan-id>
        <o-du-mac-address>[DU_MAC_ADD]</o-du-mac-address>
      </eth-flow>
    </transport-flow>
  </ru-elements>
</processing-elements>
```

Fig 51: Vlan ID

8.10 How to change PCID for DL & UL carrier ?

In U Plane yang module

```
<ul-fft-sampling-offsets>
  <scs>KH2_30</scs>
</ul-fft-sampling-offsets>
<e-axcid>
  <o-du-port-bitmask>65024</o-du-port-bitmask>
  <band-sector-bitmask>448</band-sector-bitmask>
  <ccid-bitmask>56</ccid-bitmask>
  <ru-port-bitmask>15</ru-port-bitmask>
  <eaxc-id>1</eaxc-id>
</e-axcid>
<non-time-managed-delay-enabled>false</non-time-managed-delay-enabled>
</low-level-rx-endpoints>
<low-level-rx-endpoints>
  <name>s11rx-endpoint1</name>
  <compression>
    <compression-type>STATIC</compression-type>
    <bitwidth>16</bitwidth>
  </compression>
  <cp-length>352</cp-length>
  <cp-length-other>288</cp-length-other>
  <offset-to-absolute-frequency-center>0</offset-to-absolute-frequency-center>
  <number-of-prb-per-scs>
    <scs>KH2_30</scs>
    <number-of-prb>273</number-of-prb>
  </number-of-prb-per-scs>
  <ul-fft-sampling-offsets>
    <scs>KH2_30</scs>
  </ul-fft-sampling-offsets>
  <e-axcid>
    <o-du-port-bitmask>65024</o-du-port-bitmask>
    <band-sector-bitmask>448</band-sector-bitmask>
    <ccid-bitmask>56</ccid-bitmask>
    <ru-port-bitmask>15</ru-port-bitmask>
    <eaxc-id>2</eaxc-id>
  </e-axcid>
  <non-time-managed-delay-enabled>false</non-time-managed-delay-enabled>
```

Fig 52: eAxCID or PC ID

8.11 How to Check & Select the MAC Address for fronthaul Interface ?

Choose the eth1 MAC address for fronthaul communication, go to the board console do the ifconfig to check the eth1 MAC address

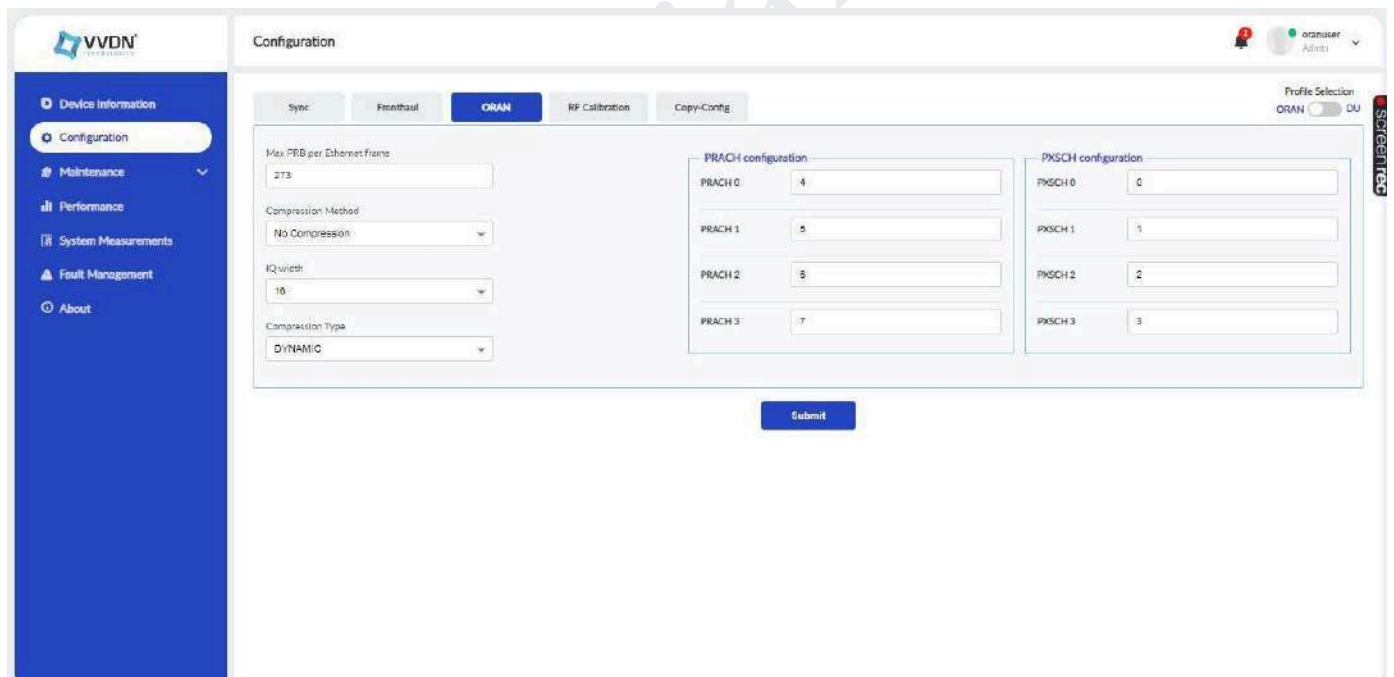
8.12 If you are using an INTEL E810 card, the below configuration needs to be installed.

The E810 NIC driver should be updated to 1.12.7 in order to create 2 VF's with the same MAC address.

Link:<https://www.intel.com/content/www/us/en/download/19630/789309/intel-network-adapter-driver-for-e810-series-devices-under-linux.html>

8.13 How to change PCID for PRACH carrier ?

The PCID for the PRACH carrier can be changed by using GUI. Go to the configuration tab, in the ORAN section and configure PRACH & PXSCH pcid as per your requirement and click on submit.



The screenshot shows the VVDN GUI Configuration page for the ORAN section. The left sidebar contains navigation links: Device Information, Configuration (selected), Maintenance, Performance, System Measurements, Fault Management, and About. The main content area has tabs for Sync, Fronthaul, ORAN (selected), RF Calibration, and Copy-Config. The ORAN tab displays the following configuration fields:

- Max PEB per Ethernet Frame: 273
- Compression Method: No Compression
- IQwidth: 10
- Compression Type: DYNAMIC
- PRACH configuration:
 - PRACH 0: 4
 - PRACH 1: 5
 - PRACH 2: 6
 - PRACH 3: 7
- PXSCH configuration:
 - PXSCH 0: 0
 - PXSCH 1: 1
 - PXSCH 2: 2
 - PXSCH 3: 3

A Submit button is located at the bottom center of the configuration area.

Fig 53: PRACH PCID configuration via GUI

8.14 What is the O-RAN M-Plane specification version with which VVDN MPRU is compliant?

VVDN MPRU is compliant with the ORAN WG-4 M-Plane v7.

9. Troubleshooting

9.1 Why can DU not receive any data from RU?

Please check following items:

- a. Check PTP is synced and GM's quality. You may need to check GM's status with satellites, O-RU's log and O-DU's log.
- b. Check the 10GbE interface in the DU server is linked up. Also check if DU MAC address is configured correctly in RU
- c. Check the 10GbE interface in the DU server is running at 10Gb speed
- d. Check connectivity, make sure SFP+ module is actually inserted into the cage of the connector in the DU server.
- e. Check O-RU's log for CU Plane packet
 - e.1. Please ensure there should be not any C/U drop DL counts

```

root@vvdn_mpru:~$ /etc/scripts/stat_ru.sh
*****DOWNLINK PATH*****
----- MAC COUNTERS DL -----
----- TOTAL_RX Packets (LSB) : 60323
----- TOTAL_RX Packets (MSB) : 0
=====
----- DL SMART INTERCONNECT COUNTERS -----
----- DL-PATH -----
----- Total DL Count : 60156
----- DL S-Plane Count : 137
----- DL C-Plane Count : 9264
----- DL U-Plane Count : 50693
----- DL M0-Plane Count : 62
----- DL M1-Plane Count : 0
----- DL M2-Plane Count : 0
----- DL M3-Plane Count : 0
----- DL M4-Plane Count : 0
----- DL Incorrect Pkt Count : 0
----- DL DropDA_Pkt Count : 0
----- DL DropSA_Pkt Count : 0
----- DL Dropetype_Pkt Count : 0
=====
----- RECIEVE COUNTERS DL -----
----- LAYER-0 -----
----- TOTAL_RX Packets : 50465
----- RX_DUPLICATE : 0
----- RX_CORRUPT : 0
----- RX_LATE : 0
----- RX_EARLY : 0
----- RX_ON-TIME : 51442
----- LAYER-1 -----
----- TOTAL_RX Packets : 0
----- RX_DUPLICATE : 0
----- RX_CORRUPT : 0
----- RX_LATE : 0

```

Fig 54: SMIC counters

- e.2. Make sure that there should be count for both PUSCH & PRACH on L1 side.
- e.3. If you are configuring 4T4R configuration at DU end, make sure that pcid configured at RU end should be in sequence of 0,1,2,3 for PXSCH and 4,5,6,7 for PRACH.
- e.4. If you are configuring for 1T1R configuration at DU end, make sure that pcid configured at RU end should be in like 0 for PXSCH and 1 for PRACH for any antenna on which you want to radiate.
- f. Check if there are any late or early packets in the RU counters.

All U plane packets should be on time for the UE to connect.

If there is any late packets, check the PTP status of RU,DU and the timing and delay parameters

9.2 If you have further queries about RU, where to reach ?

If you have any further questions/queries, please reach to us on ru.support@vvdntech.in

FCC Compliance This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) This device must accept any interference received, including interference that may cause undesired operation.

2.1 OPERATING REQUIREMENTS AND CONDITIONS The design of AMPU-LPRU-Gen3-3537-AE-AI complies with U.S. Federal Communications Commission (FCC) guidelines respecting safety levels of radio frequency (RF) exposure for Mobile devices.

2.2 RF Radiation Exposure Statement This equipment complies with FCC RF radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with a minimum distance of 20 centimeters between the radiator and your body.

2.3 FCC PART 15 STATEMENT § 15.105 (Class B digital device) This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

REGULATORY INFORMATION

Model Name: AMPU-MPRU-Gen 2-3537-AI-BI

Contains FCC ID: 2BNMP-AMPU-MPRU