SOFTWARE USER GUIDE FOR RAN*X*50-02 CAT-B O-RUs

June 2022

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This guide outlines the steps necessary to run either the Benetel RAN550 or RAN650 CAT-B O-RUs with Phluido Upper-L1 (UL1).

Qualified Personnel

This guide is for use only by suitably qualified personnel with experience in radio unit deployment and operation. The document provides guidance for such trained personnel but the execution of these two supported modes remains the responsibility of the User with the support of their UL1 and L2/L3 partners

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Personal and Product Safety

Electrical

The product is designed to operate from a -48 V DC supply and is therefore classified as Safe Extra Low Voltage (SELV) equipment. All structural parts are grounded and all input and outputs have built-in isolation from the network. All input and output ports that connect to external power sources are designed to meet relevant national safety requirements. The product contains hazardous energy levels as defined by EN 60950. Care must be taken when maintaining this equipment as injury to personnel or damage to the equipment could result from mistakes. Maintenance should only be carried out by trained and competent engineers who are familiar with the relevant procedures and instructions.

Lasers

The product is fitted with optical modules rated as Class 1 radiation-emitting devices under EN 60825-1. During installation, operation, and maintenance, never look into the end of an optical fibre directly or by reflection either with the naked eye or through an optical instrument. Do not operate equipment with exposed fibre connectors-cover these with fibre cables or blanking caps. Do not remove equipment covers during operation unless requested to do so in the documentation. Carry out normal safety precautions when trimming fibres during installation.

Manual Handling

Care should be taken when handling equipment. Give due consideration to the weight of the equipment, the physical capability of the individual(s) handling the equipment, and movements such as twisting, bending and stooping, which could lead to skeletal and muscular injuries.

Installation

Installation must be carried out by trained and competent engineers only. All relevant safety measures should be taken to ensure equipment is not connected to live power and transmission sources during installation. Equipment must be correctly installed in order to meet the relevant safety standards and approval conditions. Each power feed to the unit requires a separate fused feed from the provided power supply.

Maintenance

Maintenance must only be carried out by a suitably trained and competent technician. All safety instructions must be carefully observed at all times. Equipment covers should not be removed while live power and transmission is connected unless in a controlled environment by trained technicians.

Fire

The RAN650 product is powered from a -48 V DC supply. To protect against fire, the equipment is fused.

Environment

The product must be operated in an environment with the specified relative humidity and ambient temperature ranges. Keep all liquids away from the equipment as accidental spillage can cause severe damage.

Cooling

The product is natural convection cooling type.

Anti-Static Precautions

The circuit boards and other modules in the product are sensitive to and easily damaged by static electricity. If any card or sub-assembly is removed from the unit, the following anti-static precautions must be observed at all times:

- Service personnel must wear anti-static wrist straps.
- Circuit boards and sub-assemblies must be placed on ground conductive mats or in conductive bags.
- All tools must be discharged to ground before use.
- The anti-static wrist strap and cord must be checked at regular intervals for their suitability for use.

Grounding

To comply with EN 60950, the equipment must be connected to a safety grounding point via a permanent link. Grounding points are located on the product for this purpose. Always connect the ground cable before fitting other cables. The product must remain grounded continuously unless all connections to the power supply and data network are all removed. If equipment is grounded through a cabinet or rack, make sure it is done so properly according to the installation instructions.

Power Supply Connection

The RAN650 equipment is designed to be powered from a -48 V DC supply.

The RAN550 equipment is designed to be powered from a +12 V DC supply.

1. Introduction

This document will guide the user through the bring up of the RAN550 or RAN650 CAT-B O-RU and the execution of the TestMAC Execution & Verification.

NOTES:

1. For full End to End integration, the User should contact Phluido support and/or the relevant L2/L3 vendors
2. TestMAC Execution requires previous installation of Phluido and Effnet binaries, Benetel does not share these binaries

2. Reference Documentation

- [1] RAN650 Install and Bring up Guide Rev 2.0.pdf
- [2] RAN550 Install and Bring up Guide Rev 2.1.pdf

3. Handling Information

Handling Guidelines and ESD Warning

ESD (Electrostatic Discharge) Sensitive Device.

Charged devices and circuit boards can discharge without detection. Although this product features proprietary protection circuitry, damage may occur on devices subjected to higher energy ESD. Therefore, proper ESD precautions should be taken to avoid performance degradation or loss of functionality.

4. Waste Electrical and Electronic Equipment (WEEE)

Business users in the European Union

For proper treatment, recovery and recycling, this product must be disposed of only in designated collection points. If you wish to discard this product, please contact your supplier for further information.

Other Countries outside of the EU

If you wish to discard of this product, please contact your local authorities for the correct method of disposal. Penalties may be applicable for incorrect disposal of this waste, in accordance with your national legislation.

5. Initial Power-up and O-DU connection

Before starting this process it is assumed that the user has read, understood and configured the O-RU according to the relevant Installation and Bring Up Guide; RAN650[1] or RAN550[2].

The O-RU automatically starts once power is applied.

The next section details how the user can connect to the O-RU ahead of connecting to the UL1 and L2/L3 layers.

5.1 Initial O-DU to O-RU connections

5.1.1 Configuring DU NIC Card and initial SSH connection from O-DU

- The O-RU is configured by default with 10.10.0.100 as a static IP address
- To initiate SSH connection via fronthaul fibre to the O-RU, Benetel recommends setting the IP address of the fronthaul NIC on the DU to 10.10.0.1

```
root@epc:/home/labuser/RAN650-2_SystemTest# ifconfig eno4
eno4: f[illegible]ST,MULTICAST>  mtu 9000
        inet 10.10.0.1  netmask 255.255.255.0  broadcast 10.10.0.255
        [illegible]f:fefd:f551  prefixlen 64  scopeid 0x20<link>
        ether 00:1e:67:fd:f5:51  txqueuelen 1000  (Ethernet)
        RX packets 3930457399  bytes 10250567817689 (10.2 TB)
        RX errors 2  dropped 0  overruns 0  frame 2
        TX packets 110196831  bytes 426289788008 (426.2 GB)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0
```

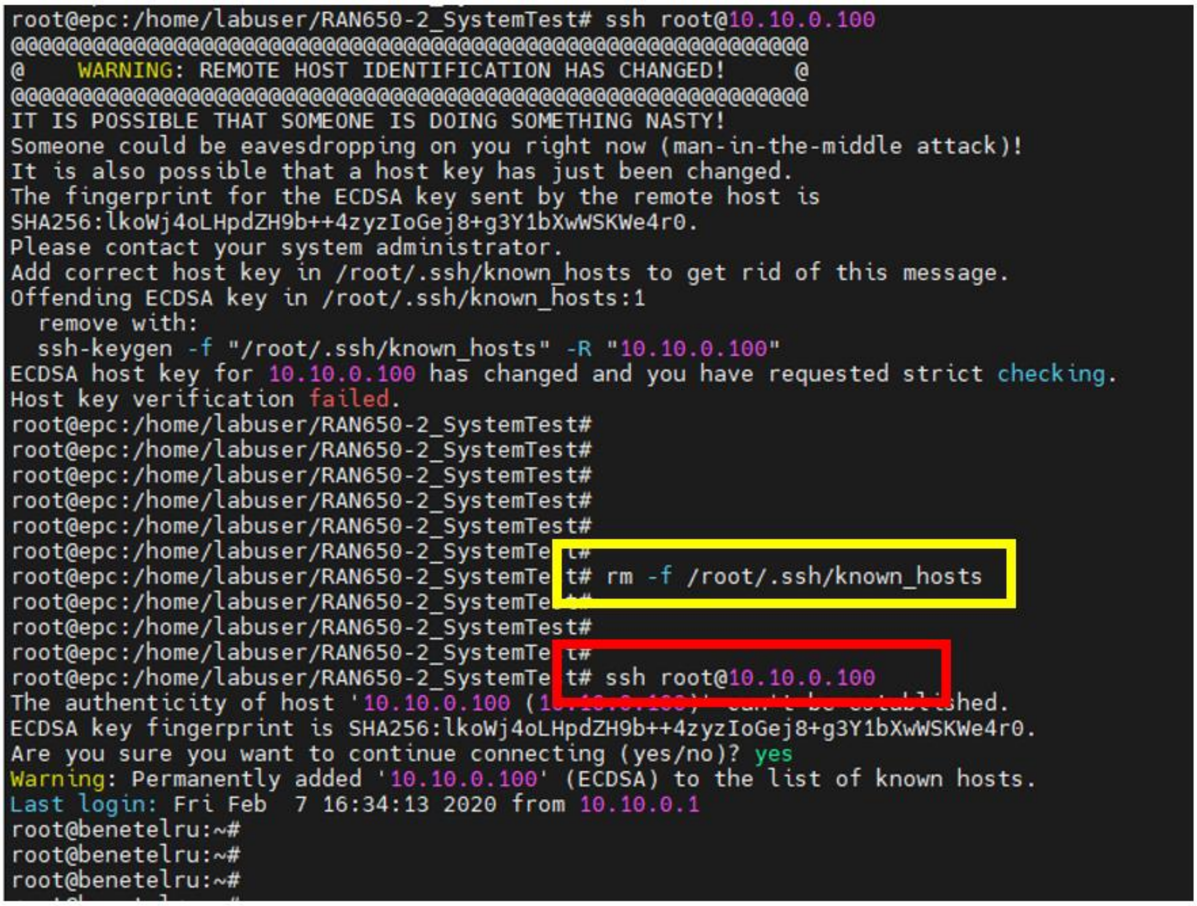
- Confirm the 10G link status by executing the command *ethtool* on server. Check the highlighted parameters below for the Ethernet NIC the RAN650 is connected to.

```
Settings for p3p2:
        Supported ports: [ FIBRE ]
        Supported link modes:   1000baseX/Full
                                10000baseSR/Full
        Supported pause frame use: Symmetric
        Supports auto-negotiation: Yes
        Supported FEC modes: Not reported
        Advertised link modes:  1000baseX/Full
                                10000baseSR/Full
        Advertised pause frame use: No
        Advertised auto-negotiation: Yes
        Advertised FEC modes: Not reported
        Speed: 10000Mb/s
        Duplex: Full
        Port: FIBRE
        PHYAD: 0
        Transceiver: internal
        Auto-negotiation: off
        Supports Wake-on: d
        Wake-on: d
        Current message level: 0x0000000f (15)
                               drv probe link timer
        Link detected: yes
```

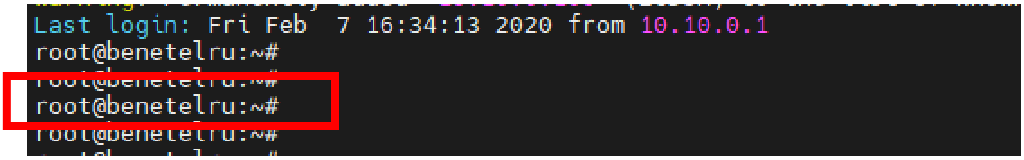
Figure 1: Confirmed fronthaul conection between O-RU and O-DU

Tip: If unable to establish a fronthaul link as above, then you may need to clear the SSH known hosts on the O-DU. Commands to resolve this are highlighted in yellow below.

This can be required if for example the O-DU was previously connected to O-RU's with the same IP address configured.



The user will then be at the Linux prompt of the Benetel O-RU



The fibre transport link between O-DU and O-RU is now configured.

5.2 Sync & Radio Configuration

The O-RU is set to auto configuration mode and will automatically configure the radio to the settings summarised in below on each hard or soft boot up cycle.

Radio Configuration: 2 x 2

Centre Frequency: 3751.68MHz

RAN550 Deployed Power: 24dBm

RAN650 Deployed Power: 35dBm

RAN550 Frequency Support: 3300MHz to 3800MHz

RAN650 Frequency Support: 3700MHz to 4200MHz

This boot up process takes approximately 5 minutes to complete.

WARNING: The User should not start any U-Plane traffic during this time

WARNING: The User should not execute any additional radiocontrol commands during this initialisation period

5.2.1 Time Sync Configuration & Verification

The RAN650 O-RU can only be configured for GPS at this time (PTP feature will following in a V0.6.0 release)

The RAN550 O-RU currently supports Ext 1PPS and PTP synchronisation

IMPORTANT: The O-RU will not proceed with Radio Initialisation if there is no valid Time Sync connected on boot up.

This can be confirmed by reading the *radio_status* file in the */tmp/logs* directory:

cat /tmp/logs/radio_status

The following two screenshots show a passing and failing screenshot of Sync Status, it will attempt the sync three times before exiting to this error:

```
root@benetelru:~# cat /tmp/radio_status
[INFO] Platform: RAN650_B
[INFO] Frequency:
[INFO] Radio bringup begin
[INFO] Waiting for Sync
[ERROR] RU did not synchronize within 3 mins. Exiting radio initialization.
[ERROR] Radio bringup failed with: 0
[INFO] Restting
[INFO] Radio bringup begin
[INFO] Waiting for Sync
[ERROR] RU did not synchronize within 3 mins. Exiting radio initialization.
[ERROR] Radio bringup failed with: 0
[INFO] Restting
[INFO] Radio bringup begin
[INFO] Waiting for Sync
[ERROR] RU did not synchronize within 3 mins. Exiting radio initialization.
[ERROR] Radio bringup failed with: 0
[INFO] Restting
[INFO] Radio bringup begin
[INFO] Waiting for Sync
[ERROR] RU did not synchronize within 3 mins. Exiting radio initialization.
[ERROR] Radio bringup failed with: 0
[ERROR] Un-recoverable system failure detected, reboot required.
root@benetelru:~#
```

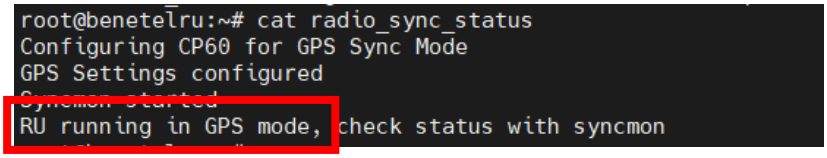
```
Every 1.0s: cat /tmp/radio_status

[INFO] Platform: RAN650_B
[INFO] Radio bringup begin
[INFO] Load EEPROM Data
[INFO] Tx1 Attenuation set to 15000 mdB
[INFO] Tx3 Attenuation set to 15410 mdB
[INFO] Operating Frequency set to 3751.680 MHz
[INFO] Waiting for Sync
[INFO] Sync completed
[INFO] Start Radio Configuration
[INFO] Initialize RF IC
[INFO] Disabled CFR for Antenna 1
[INFO] Disabled CFR for Antenna 3
[INFO] Move platform to TDD mode
[INFO] Set CP60 as TDD control master
[INFO] Enable TX on FEM
[INFO] FEM to full MIMO1_3 mode
[INFO] DPD Tx1 configuration
[INFO] DPD Tx3 configuration
[INFO] Set attn at 3751.680 MHz
[INFO] Reg 0xC0366 to 0x3FF
[INFO] Tuning the UE TA to reduce timing_offset
[INFO] The O-RU is ready for System Integration
[INFO] Radio bringup complete
 15:54:32 up 3 min,  load average: 0.07, 0.17, 0.08
^C
root@benetelru:~#
```

The O-RU sync setting can be checked following boot up by reading the radio_sync_status as follows:

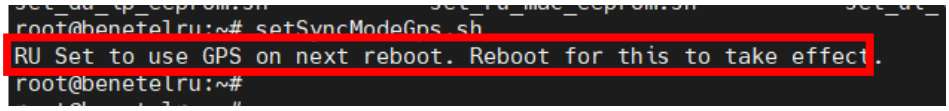
cat /tmp/logs/radio_sync_status

It should outline “RU running in GPS mode” as shown below:



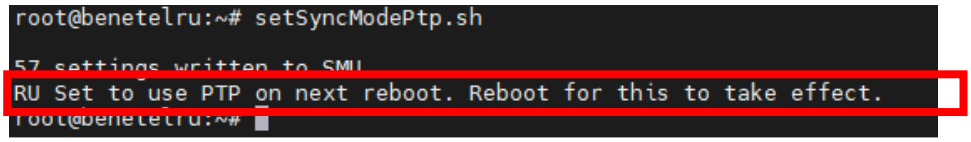
If this is not seen and it displays PTP Mode selected or some other response, the user should issue the following command and following reboot the O-RU will be configured for GPS Mode as shown in the screenshot

setSyncModeGps.sh



Should the user which to move from GPS/Ext 1PPs Mode to PTP Mode, they should send the following command:

setSyncModePtp.sh

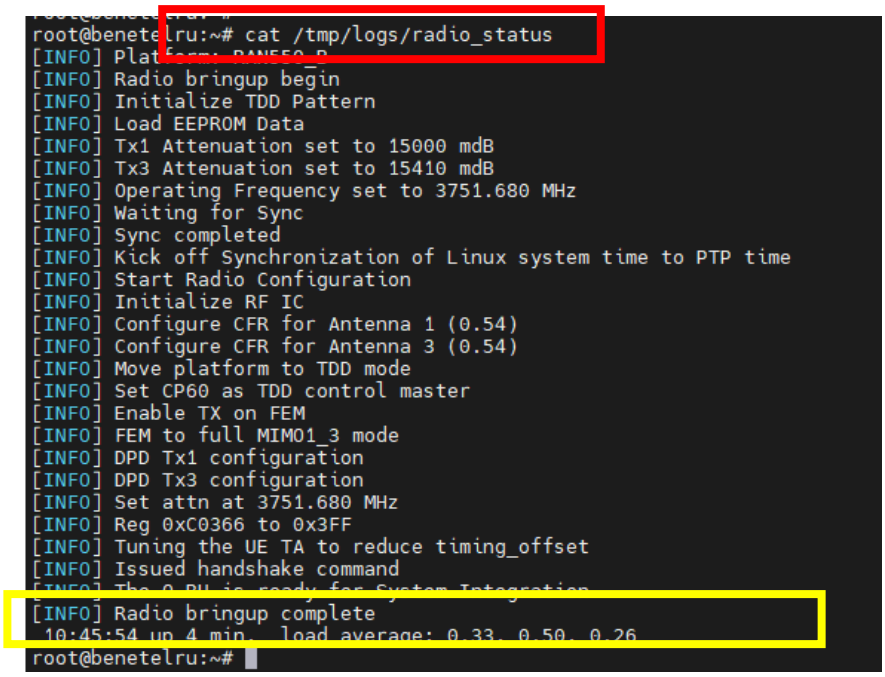


5.2.2 Radio Configuration

The User can monitor the progress of the boot up sequence by "watching" a *radio status* file created on each boot up in *"/tmp/logs"* directory.

The command is shown below and the user must wait until the highlighted text in Yellow is achieved before moving to End to End or TestMAC Testing

watch -n 1 'cat /tmp/logs/radio_status'



At this point the radio is configured and the user can move to TestMAC Integration testing as outlined in **Section 6** of this document.

5.3 System Configuration Verification

On the either the RAN550 or RAN650 CAT-B, following radio configuration, there are three commands to verify that the radio is configured as required with correct TX power, antenna configuration and frequency and this must be checked by the user ahead of UL1 and Stack execution.

- *radiocontrol -o G a*

  This command responds with the status of the radio following initialisation

  The key parameters, Frequency and ANT1 and ANT3 attenuation settings are highlighted below

  NOTE: If the response from this command are not in this format, the user should hard power cycle the O-RU. Should this continue to fail, please contact Benetel at support@benetel.com

```
root@benetelru:~# radiocontrol -o G a

Benetel radiocontrol Version          : 0.9.4
Madura API Version                    : 5.1.0.21
Madura ARM FW version                 : 5.1.0.9
Madura ARM DPD FW version             : 5.1.0.9
Madura Stream version                 : 8.1.0.1
Madura Product ID                     : 0x84
Madura Device Revision                : 0xb0
Tx1 Attenuation (mdB)                 : 15000
Tx2 Attenuation (mdB)                 : 40000
Tx3 Attenuation (mdB)                 : 15400
Tx4 Attenuation (mdB)                 : 40000
PLL1 Frequency (Hz)                   : 0
PLL2 Frequency (Hz)                   : 3751680000
Front-end Control                     : 0x2aa491
Madura Deframer 0                     : 0x87
Madura Framer 0                       : 0xa
Internal Temperature (degC)           : 57
External Temperature (degC)           : 44.740234
RX1 Power Level (dBFS)                : -60.500000
RX2 Power Level (dBFS)                : -60.750000
RX3 Power Level (dBFS)                : -60.750000
RX4 Power Level (dBFS)                : -60.750000
ORX1 Peak/Mean Power Level (dBFS)     : -20.866970/-31.124148
ORX2 Peak/Mean Power Level (dBFS)     : -inf/-inf
ORX3 Peak/Mean Power Level (dBFS)     : -22.232338/-32.404635
ORX4 Peak/Mean Power Level (dBFS)     : -inf/-inf
```

*Figure 2: Expected response to "*radiocontrol -o G a*"*

- *radiocontrol -o D s*

This command responds with the status of each of the active transmitters of the O-RU. As this deployment is only ANT1 and ANT3, we only reference the responses for these antenna's.

Again the key parameters are highlighted below in the screenshot

ExtPath Delay reading should be either 154, 155, 156 or 157 for the active ANT1 and ANT3 antenna's

```
--------------------
root@benetelru:~# radiocontrol -o D s
Report DPD status

TX1
ExtPathDelay.fifoDelay : 157
ExtPathDelay.interpolationIndex : 0

dpdErrorCode: 13324
dpdPercentComplete: 0
dpdPerformanceMetric: 0
dpdIterCount: 231
dpdUpdateCount: 0
dpdSyncStatus: 1
dpdModelTable: 0
dpdDirectEvm: 0.000000
dpdIndirectEvm: 0.000000
dpdSelectError: 0.000000
dpdIndirectError: 0.000000
dpdErrorStatus0 (metrics:actions): 0:0
dpdErrorStatus1 (metrics:actions): 0:0
dpdPersistentErrorStatus0 (metrics:actions): 0:0
dpdPersistentErrorStatus1 (metrics:actions): 0:0
reservedPM: 0
reservedTP: 0
reservedPR: 0
--------------------
```

```
--------------------

----------
TX3
ExtPathDelay.fifoDelay : 156
ExtPathDelay.interpolationIndex : 10

dpdErrorCode: 13324
dpdPercentComplete: 0
dpdPerformanceMetric: 0
dpdIterCount: 195
dpdUpdateCount: 0
dpdSyncStatus: 1
dpdModelTable: 0
dpdDirectEvm: 0.000000
dpdIndirectEvm: 0.000000
dpdSelectError: 0.000000
dpdIndirectError: 0.000000
dpdErrorStatus0 (metrics:actions): 0:0
dpdErrorStatus1 (metrics:actions): 0:0
dpdPersistentErrorStatus0 (metrics:actions): 0:0
dpdPersistentErrorStatus1 (metrics:actions): 0:0
reservedPM: 0
reservedTP: 0
reservedPR: 0
--------------------
```

*Figure 3: Expected response to "*radiocontrol -o D s*"*

- *reportRuStatus*

This command queries the system and provides feedback which should be shared with your Benetel support engineer. The register description in the response provides an indication of the status.

```
root@benetelru:~# reportRuStatus

[INFO] Sync status is:
Register 0xc0367, Value : 0x1
------------------------------

[INFO] RU Status information is:
Register 0xc0306, Value : 0xf71802
------------------------------

[INFO] Fill level of Reception Window is:
Register 0xc0308, Value : 0x8e17
------------------------------

[INFO] Packet Count is:
Register 0xc0311, Value : 0x56f49
------------------------------


============================================================
RU Status Register description:
============================================================
[31:24] Payload Format field value when an invalid detection is made

[23:20] Symbol Index 0 counter to delay fronthaul processing (increments every 10.24 secs)

[19] same as bit [9]
[18] set to 1 if handshake is successful
[17] set to 1 when settling time (fronthaul) has completed
[16] set to 1 when first Symbol Index 0 is captured

[15] Sticky Alarm: set to 1 if payload format is invalid
[14] Sticky Alarm: set to 1 if Symbol Index Sequence Error has been detected (out-of-order packets)
[13] Sticky Alarm: set to 1 if a truncated symbol arrives from DU
[12] reserved

[11] set to 1 if DU MAC address is correct
[10] reserved
[9] toggles HIGH if Symbol Index Sequence Error (live, toggling)
[8] reserved

[7:4] reserved

[3:2] reserved
[1] Sticky Alarm: set to 1 if Reception Window Buffer is empty
[0] Sticky Alarm: set to 1 i Reception Window Buffer is full
```

*Figure 4: Expected response to "*reportRuStatus"

5.4 O-RU Sync Status – GPS or Ext 1PPS Query

If the user is running in either RAN650 GPS mode or in RAN550 Ext 1PP mode, they query the sync status of the O-RU by sending the following command:

syncmon

This will respond with a script that will update every second with a sync status.

To exit you much send Ctrl-C

For RAN650 GPS deployment, the key parameter is CLK5 and for the RAN550 Ext 1PPS Deployment, the key parameter is CLK6 Ext 1PPS Live:

- **CLK5 GPS LIVE or CLK6 EXT 1PPS LIVE:**
  - **LOS + No Actvity**
    The system cannot detect the Input GPS/1PPS signal to the O-RU
  - **OK**
    The system successfully detects the Input GPS/1PPS Signal to the O-RU

    Note: This must be the case to allow for DPLL3 to move off FREERUM Mode

- **DPLL3:**
  - **FREERUN**:
    There is no lock state detected

- **ACQUIRING LOCK**:
  The system is in the process of moving from Freerun to Locked
- **LOCKED**:
  The system has achieved GPS/1PPS lock
- **HOLDOVER**:
  The system has lost GPS/1PPS sync and has moved to holdover mode

```
root@benetelru:~# syncmon

DPLL0 State (SyncE/Ethernet clock): LOCKED

DPLL1 State (FPGA clocks): FREERUN

DPLL2 State (FPGA clocks): FREERUN

DPLL3 State (RF/PTP clock): LOCKED


CLK0 SyncE LIVE: OK

CLK0 SyncE STICKY: LOS + No Activity


CLK2 10MHz LIVE: LOS + No Activity

CLK2 10MHz STICKY: LOS + No Activity


CLK5 GPS LIVE: OK

CLK5 GPS STICKY: LOS and Frequency Offset


CLK6 EXT 1PPS LIVE: LOS and Frequency Offset

CLK6 EXT 1PPS STICKY: LOS and Frequency Offset
```

5.5 O-RU Sync Status – PTP

If supported, the User can query the PTP sync status of the O-RU by sending the following command:

cat /var/log/pcm4l

Successful PTP lock can be seen by validating the Freq and Time locker status as highlighted below:

```
root@benetelru:~# tail -f /var/log/pcm4l
RE::SyncAnalysis: 2020-02-07 15:52:22 094138500 ns [2, Supervisor] (3066) LO state: 'Frequency Locked' to 'Time Locked'    Event: 'LO time locked'.
RE::Debug: 2020-02-07 15:52:22 095260800 ns [2, Supervisor] Enter time locked state
RE::Debug: 2020-02-07 15:52:22 095759320 ns [2, Supervisor] Tracker#0:
RE::Debug: 2020-02-07 15:52:22 096483600 ns [2, Supervisor]                                                    :80:ff:fe:07:e3:b1.2
RE::Debug: 2020-02-07 15:52:22 096939040 ns [2, Supervisor]     Current reference master: Yes
RE::Debug: 2020-02-07 15:52:22 097620460 ns [2, Supervisor]     Freq locked: Yes
RE::Debug: 2020-02-07 15:52:22 098091440 ns [2, Supervisor]     Time locked: Yes
RE::SyncAnalysis: 2020-02-07 15:52:23 710058420 ns [3, Tracker#0] (3044) DL packet rate (3.61) is different from the nominal rate (16.00).
RE::SyncAnalysis: 2020-02-07 15:52:28 650094280 ns [3, Tracker#0] (3240) offset: 0.5 ns    delay: 131.5 ns
```

5.6 RF Power Adjustment

The user can adjust the output power of each of the transmitters using the following steps.

RAN650 Configuration:

The Tx Attn settings are stored in EEPROM and loaded from there. These can be read manually by the user by issuing the following commands for the Transmitters in use, i.e. Tx1 and Tx3:

read_tx1_attn

read_tx3_attn

Both will return the attenuation stored in EEPROM for the O-RU you are working with, e.g. 15000mdB

The user can also read the existing Transmitter attenuation settings using the "*radiocontrol -o G a*" and this will report Tx1/2/3/4 settings.

For Example: *Tx1 Attn (mdB) 13000*

To adjust this power for the transmitter the user must edit the attenuation setting.

- For increasing the power the attenuation must be reduced
- For decreasing the power, the attenuation must be increased

For Example:

- RAN650 is autoconfigured to operate at 35dBm as an outdoor O-RU
- When you read the Tx1 attenuation, this is reported as 11500mdB
- If you wish to decrease the output power by 5dB to 30dBm, you must increase the Tx1 attenuation by 5000mdB using the following command:

  radiocontrol -o A 16500 1
- This will adjust the power for Tx1 only
- For other transmitters please use the following command format:

  Tx1: *radiocontrol -o A 16500 1*

  Tx2: *radiocontrol -o A 16500 2*

  Tx3: *radiocontrol -o A 16500 4*

  Tx4: *radiocontrol -o A 16500 8*

5.7 RF Frequency Adjustment

The Tx and Rx Frequencies are stored in EEPROM and loaded from there. This can be read manually by the user by issuing the following command and the response will be in MHz:

read_default_tx_frequency

The user should reference Section 7.16 and 7.15 to modify the operating frequency of the O-RU.

6. O-RU Bring Up – Phluido & Effnet Binary Execution Check

This section outlines the step procedure to successfully bring up the O-RU system and initiate execution of the Phulido UL1 and the Effnet TestMAC.

Please note for detailed information on Phluido and Effnet execution please contact the companies directly. Benetel cannot debug Phluido and Effnet integration.

For the purposes of this execution the following are assumed:

- The Benetel O-RU is powered on and the User has verified the Radio Configuration steps outlined in this document
- The DU server hosting the UL1/TestMAC software is powered on and available for SSH connection
- There is a 10GbE fibre connection between the Benetel O-RU and the a 10GbE NIC card on the DU server

6.1 DU MAC Address configuration

- The O-RU needs to know the MAC Address of the 10GbE NIC card in the DU Server and this needs to be set.
- This is stored in the EEPROM of the unit and this can be queried as summarised in Section 7.9 later in this document

6.2 Phluido UL1 Execution

The user should have the following files available from Phluido for this integration:

PhluidoL1_NR; this is the UL1 binary file

PhluidoL1_NR.cfg; this is the configuration file which you should refer to Phluido documents

From experience, Benetel recommends the creation of a script on the DU server to assist with the execution of this application every time we wish to start the Phluido UL1,

e.g. *run.sh* script

```
sudo ifconfig eno4 10.10.0.1 netmask 255.255.255.0 mtu 9000
./PhluidoL1_NR PhluidoL1_NR.cfg
```

This ensures:

- Configuration of the NIC is correct and as expected by the Phluido UL1
- The MTU size is set correctly for the deployment
- Successful Execution of the UL1 application against the Phluido configuration file (*PhluidoL1_NR.cfg)*

When the user executes the “run.sh” script on the O-DU the response should be as outlined below:

```
root@oai-epc:/home/labuser/phlui                              apult_du# ./run.sh
Reading configuration from config file "PhluidoL1_NR.cfg"...
*****************************************************************************************************
*                                                                                                   *
*  Phluido 5G-NR virtualized L1 implementation                                                      *
*                                                                                                   *
*  Copyright (c) 2014-2020 Phluido Inc.                                                             *
*  All rights reserved.                                                                             *
*                                                                                                   *
*  The User shall not, and shall not permit others to:                                              *
*    - integrate Phluido Software within its own products;                                          *
*    - mass produce products that are designed, developed or derived from Phluido Software;         *
*    - sell products which use Phluido Software;                                                    *
*    - modify, correct, adapt, translate, enhance or otherwise prepare derivative works or          *
*      improvements to Phluido Software;                                                            *
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*  IN NO EVENT SHALL THE AUTHOR BE LIABLE FOR ANY DIRECT, INDIRECT, INCIDENTAL, SPECIAL,            *
*  EXEMPLARY, OR CONSEQUENTIAL DAMAGES (INCLUDING, BUT NOT LIMITED TO, PROCUREMENT OF               *
*  SUBSTITUTE GOODS OR SERVICES; LOSS OF USE, DATA, OR PROFITS; OR BUSINESS INTERRUPTION)           *
*  HOWEVER CAUSED AND ON ANY THEORY OF LIABILITY, WHETHER IN CONTRACT, STRICT LIABILITY, OR         *
*  TORT (INCLUDING NEGLIGENCE OR OTHERWISE) ARISING IN ANY WAY OUT OF THE USE OF THIS               *
*  SOFTWARE, EVEN IF ADVISED OF THE POSSIBILITY OF SUCH DAMAGE.                                     *
*                                                                                                   *
*****************************************************************************************************

Copyright information already accepted on 2021-03-11, 20:47:40.
Starting Phluido 5G-NR L1 software...
       PHAPI version       = 0.5 (12/10/2020)
       L1 SW version       = 0.8.1
       L1 SW internal rev  = r3852
Parsed configuration parameters:
    logLevel_verbose = INFORMATIVE
    LicenseKey = FE23-D713-0586-1D80-8C0F-D500-F292-4017
    bbuFronthaulServerMode = 1
    targetRecvSymbolDelay = 70
    prachDecodeMode = 2
    maxNumPdschLayers = 1
    maxNumPuschLayers = 1
```

This confirms a successful connection between the O-RU and the UL1 and allows for the TestMAC to be execute in the next section

6.3 TestMAC Execution

The user should have the following files available for this integration:

testMAC_5msTDD_3751680khz_2tx; this is the testMAC binary file

This is executed and responds as shown below:

```
root@oai-epc:/home/labuser/phluido_binaries_2021/digital_catapult_du# ./testMAC_5msTDD_3751680khz_2tx

Starting Phluido 5G-NR TestMAC
Creating output file "TestMAC_NR.output.txt"
Initializing message passing interface "Phluido5GL1_0"
Sending CONFIG message to Layer 1
Received CONFIG-ACK from Layer 1
       API version         = 0.5
       L1 SW version       = 0.3852
       numUlHarqBuffers    = 1024
Sending START-REQUEST to Layer 1
Received START-RESPONSE from Layer 1
```

6.4 Benetel O-RU Handshake

There are now two methods of handshaking depending on the release you are working with.

This can be checked as follows:

cat /etc/benetel-rootfs-version

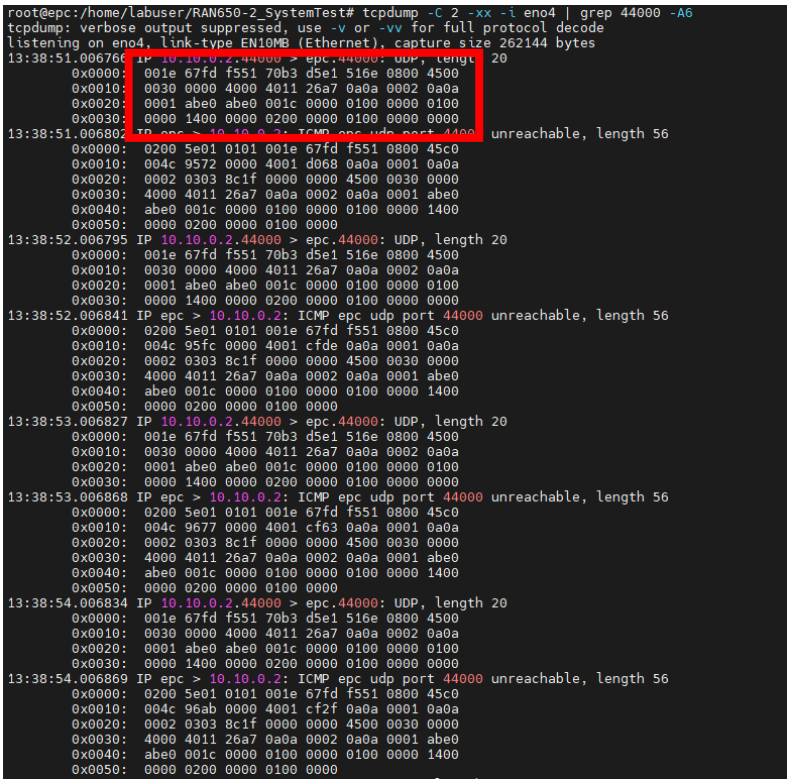
If the response is V0.5.1 or greater, you should follow the steps outlined in 6.4.1 and if it is less than that, you should following steps in 6.4.2

6.4.1 Benetel O-RU Handshake

This is the new handshake procedure between the O-RU and UL1.

Instead of the user executing a handshake command from the O-RU, the O-RU will now be transmitting Handshake Msg#1 packets every sec and waiting for the O-DU to respond.

This can be seen in the screenshot below, ahead of any UL1/TestMAC execution.



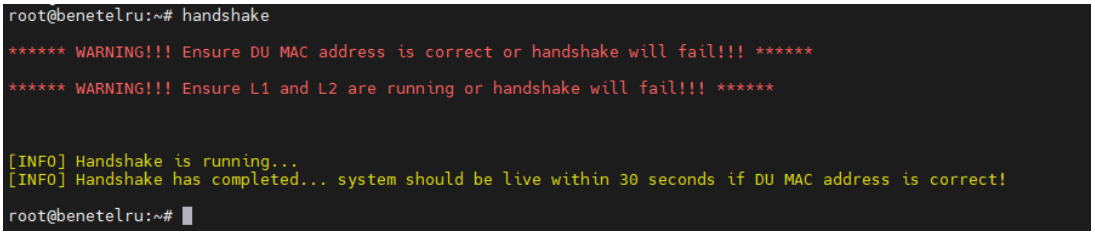
Once the UL1 and TestMAC are run, the "*System is Live*" will appear immediately.

6.4.2 Benetel O-RU Handshake

This is the original process where the user manually issues the handshaking commands once the UL1/TestMAC are started.

Having configured the DU MAC address and starting the UL1/TestMAC applications, the -Benetel O-RU needs a reset command sent to the FPGA to create the link to the system.

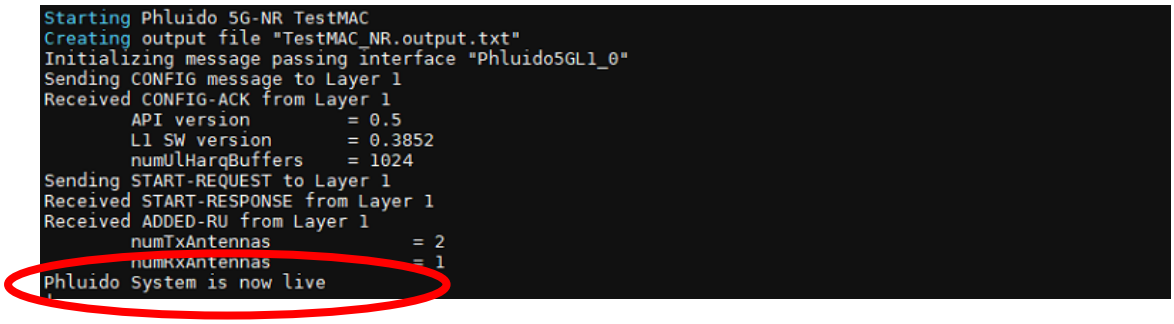
This is achieved by executing the "*handshake*" script installed on the Benetel O-RU as shown below.



6.5 Benetel O-RU Bring Up Complete

The Effnet TestMAC console will show the system as live after approximately 20-30 secs in the case of the RAN650-2V0.5 or earlier but immediately in the case of RAN650-2V0.5.1 and beyond.

At this point the system is successfully brought up.



THIS COMPLETES THE SYSTEM BRING-UP & UE CAN BE CONNECTED

Contact your integration partner for next steps

6.6 User Network Configuration

As the user integrates the O-RU with their O-DU, the following steps must be completed.

1. O-DU IP address set in EEPROM (see section 7 of this guide for instructions).
2. O-RU Control IP address set in EEPROM (section 7). This address must be on the same subnet as the O-DU IP address.
3. O-RU and O-DU UDP ports set in EEPROM (section 7).
4. O-RU ADV, RSP and UPLINK checksums calculated according to the new IP addresses (see section 7.16).
5. O-RU ADV, RSP and UPLINK checksums set in EEPROM (section 7).
6. Reboot O-RU.
7. Edit the *run.sh* script to use updated O-DU IP address (see section 6.2)
8. Edit Phluido configuration file (*PhluidoL1_NR.cfg*) so that the *bbuFronthaulServerAddr* aligns to the updated O-DU IP address. If UDP ports have been modified, *bbuFronthaulServerPort* in the Phluido configuration file must also be modified.
9. Complete the O-RU bring-up according to section 6.

7. Appendix 1: EEPROM Configuration

The RAN550 and RAN650 utilises the addition of the EEPROM as a storage device for the parameters summarised below.

- O-RU MAC Address
- O-RU IP Address
- O-RU UDP Port Number
- O-RU ADV Checksum
- O-RU RSP Checksum
- O-RU UPLINK Checksum

- O-DU MAC Address
- O-DU IP Address
- O-DU UDP Port Number
- O-DU IP Checksum

This section of the document will explain the settings for these parameters and how the user needs to configure them.

7.1 EEPROM Parameter Query

The O-RU has an application in */usr/bin* which allows the user to read/write from the EEPROM, this is call *eeprog_cp60*

The parameter/variable will be stored in either ASCII or HEX format and there is a slight difference in the query command for each:

ASCII Format

eeprog_cp60 -q -f -16 /dev/i2c-0 0x57 -r 0:6

- This will return the EEPROM entry in ASCII from address 0 for a total of 6 bytes

HEX Format

eeprog_cp60 -q -f -16 /dev/i2c-0 0x57 -x -r 0:6

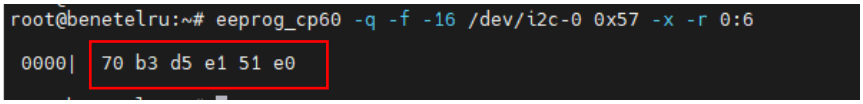
- This will return the EEPROM entry in HEX from address 0 for a total of 6 bytes

The only parameters outside the additional "-x" for the HEX format that the User should be changing is the address and length at the end, currently set to 0:6

- 0: Represents the start address in decimal
- 6: Represents the number of bytes to read in decimal

Example: Reading O-RU MAC Address, which is in HEX format as outlined in Section 8.3 below

- This O-RU Mac address is 70:B3:D5:E1:51:E0



7.2 EEPROM Parameter Write

The O-RU has an application in */usr/bin* which allows the user to read/write from the EEPROM, this is call *eeprog_cp60*

While the parameter/variable will be stored in either ASCII or HEX format, there is no difference in how the User should writes the settings to the EEPROM:

EEPROM Write Format

- *eeprog_cp60 -f -x -16 /dev/i2c-0 0x57 -w 0x00:0x01:0x72*

  0x00: Represents the address where the byte should be written to

  0x01: Represents the number of bytes to write, this is always 0x01

  0x72: Represents the new value of the EEPROM location

Example: Writing the O-RU MAC Address, which is in HEX format as outlined in Section 8.3 below

- This new O-RU Mac address is 72:B3:D3:E1:52:E0

- The following six commands would then be sent to the O-RU to configure this:

  echo -n "0-0057" > /sys/bus/i2c/devices/0-0057/driver/unbind

  registercontrol -w 0xC036B -x 0x88000088

  eeprog_cp60 -f -x -16 /dev/i2c-0 0x57 -w 0x00:0x01:0x72

  eeprog_cp60 -f -x -16 /dev/i2c-0 0x57 -w 0x01:0x01:0xB3

  eeprog_cp60 -f -x -16 /dev/i2c-0 0x57 -w 0x02:0x01:0xD3

  eeprog_cp60 -f -x -16 /dev/i2c-0 0x57 -w 0x03:0x01:0xE1

  eeprog_cp60 -f -x -16 /dev/i2c-0 0x57 -w 0x04:0x01:0x52

  eeprog_cp60 -f -x -16 /dev/i2c-0 0x57 -w 0x05:0x01:0xE0

registercontrol -w 0xC036B -x 0x88000488

- The writing is verified by querying the settings:
  eeprog_cp60 -q -f -x -16 /dev/i2c-0 0x57 -x -r 0:6

```
root@benetelru:~# echo -n "0-0057" > /sys/bus/i2c/devices/0-0057/driver/unbind
root@benetelru:~# registercontrol -w 0xC036B -x 0x88000088
root@benetelru:~# eeprog_cp60 -f -x -16 /dev/i2c-0 0x57 -w 0x00:0x01:0x72
eeprog 0.7.6, a 24Cxx EEPROM reader/writer
Benetel T3K EEPROM Application 1.0.1
Copyright (c) 2003-2004 by Stefano Barbato - All rights reserved.
  Bus: /dev/i2c-0, Address: 0x57, Mode: 16bit
  Writing value 0x72 at address 0x0 for size 0x1
.

root@benetelru:~# eeprog_cp60 -f -x -16 /dev/i2c-0 0x57 -w 0x01:0x01:0xB3
eeprog 0.7.6, a 24Cxx EEPROM reader/writer
Benetel T3K EEPROM Application 1.0.1
Copyright (c) 2003-2004 by Stefano Barbato - All rights reserved.
  Bus: /dev/i2c-0, Address: 0x57, Mode: 16bit
  Writing value 0xb3 at address 0x1 for size 0x1
.

root@benetelru:~# eeprog_cp60 -f -x -16 /dev/i2c-0 0x57 -w 0x02:0x01:0xD3
eeprog 0.7.6, a 24Cxx EEPROM reader/writer
Benetel T3K EEPROM Application 1.0.1
Copyright (c) 2003-2004 by Stefano Barbato - All rights reserved.
  Bus: /dev/i2c-0, Address: 0x57, Mode: 16bit
  Writing value 0xd3 at address 0x2 for size 0x1
.

root@benetelru:~# eeprog_cp60 -f -x -16 /dev/i2c-0 0x57 -w 0x03:0x01:0xE1
eeprog 0.7.6, a 24Cxx EEPROM reader/writer
Benetel T3K EEPROM Application 1.0.1
Copyright (c) 2003-2004 by Stefano Barbato - All rights reserved.
  Bus: /dev/i2c-0, Address: 0x57, Mode: 16bit
  Writing value 0xe1 at address 0x3 for size 0x1
.

root@benetelru:~# eeprog_cp60 -f -x -16 /dev/i2c-0 0x57 -w 0x04:0x01:0x52
eeprog 0.7.6, a 24Cxx EEPROM reader/writer
Benetel T3K EEPROM Application 1.0.1
Copyright (c) 2003-2004 by Stefano Barbato - All rights reserved.
  Bus: /dev/i2c-0, Address: 0x57, Mode: 16bit
  Writing value 0x52 at address 0x4 for size 0x1
.

root@benetelru:~# eeprog_cp60 -f -x -16 /dev/i2c-0 0x57 -w 0x05:0x01:0xE0
eeprog 0.7.6, a 24Cxx EEPROM reader/writer
Benetel T3K EEPROM Application 1.0.1
Copyright (c) 2003-2004 by Stefano Barbato - All rights reserved.
  Bus: /dev/i2c-0, Address: 0x57, Mode: 16bit
  Writing value 0xe0 at address 0x5 for size 0x1
.

root@benetelru:~# registercontrol -w 0xC036B -x 0x88000488
root@benetelru:~# eeprog_cp60 -q -f -x -16 /dev/i2c-0 0x57 -x -r 0:6

 0000|  72 00 d3 e1 52 e0
```

7.3 O-RU MAC Address

EEPROM Start Address: 0x00 [0 decimal]

EEPROM Storage Size: 6 bytes

EEPROM Format: HEX

Example: 72:B3:D3:E1:52:E0

Query Command: *eeprog_cp60 -q -f -x -16 /dev/i2c-0 0x57 -x -r 0:6*

7.4 O-RU IP Address

EEPROM Start Address: 0x12 [18 decimal]

EEPROM Storage Size: 4 bytes

EEPROM Format: HEX

Example: 0A:0A:00:64, which equates to 10.10.0.100

Query Command: *eeprog_cp60 -q -f -16 /dev/i2c-0 0x57 -x -r 18:4*

7.5 O-RU UDP Port Number

EEPROM Start Address: 0x16 [22 decimal]

EEPROM Storage Size: 2 bytes

EEPROM Format: HEX

Example: 0xABE0

Query Command: *eeprog_cp60 -q -f -16 /dev/i2c-0 0x57 -x -r 22:2*

7.6 O-RU ADV IP Checksum

EEPROM Start Address: 0x18 [24 decimal]

EEPROM Storage Size: 2 bytes

EEPROM Format: HEX

Example: 0x2645

Query Command: *eeprog_cp60 -q -f -16 /dev/i2c-0 0x57 -x -r 24:2*

7.7 O-RU RSP IP Checksum

EEPROM Start Address: 0x50E [1294 decimal]

EEPROM Storage Size: 2 bytes

EEPROM Format: HEX

Example: 0x264D

Query Command: *eeprog_cp60 -q -f -16 /dev/i2c-0 0x57 -x -r 1294:2*

7.8 O-RU UPLINK IP Checksum

EEPROM Start Address: 0x510 [1296 decimal]

EEPROM Storage Size: 2 bytes

EEPROM Format: HEX

Example: 0x1C59

Query Command: *eeprog_cp60 -q -f -16 /dev/i2c-0 0x57 -x -r 1296:2*

7.9 O-DU MAC Address

EEPROM Start Address: 0x1A [26 decimal]

EEPROM Storage Size: 6 bytes

EEPROM Format: HEX

Example: 00:7D:93:02:BB:FE

Query Command: *eeprog_cp60 -q -f -x -16 /dev/i2c-0 0x57 -x -r 26:6*

7.10 O-DU IP Address

EEPROM Start Address: 0x20 [32 decimal]

EEPROM Storage Size: 4 bytes

EEPROM Format: HEX

Example: 0A:0A:00:01, which equates to 10.10.0.1

Query Command: *eeprog_cp60 -q -f -16 /dev/i2c-0 0x57 -x -r 32:4*

7.11 O-DU UDP Port Number

EEPROM Start Address: 0x24 [36 decimal]

EEPROM Storage Size: 2 bytes

EEPROM Format: HEX

Example: 0xABE0

Query Command: *eeprog_cp60 -q -f -16 /dev/i2c-0 0x57 -x -r 36:2*

7.12 O-DU IP Checksum

EEPROM Start Address: 0x26 [38 decimal]

EEPROM Storage Size: 2 bytes

EEPROM Format: HEX

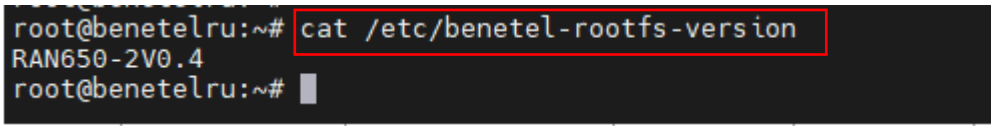
Example: 0x264D

Query Command: *eeprog_cp60 -q -f -16 /dev/i2c-0 0x57 -x -r 38:2*

7.13 O-RU Software Load Query

The User can query the software installed on the O-RU by sending the command:

cat /etc/benetel-rootfs-version



7.14 O-RU Sync Status

The User can query the sync status of the O-RU by sending the command:

syncmon

This will respond with a script that will update every second with a sync status.

To exit you much send Ctrl-C

For RAN650 GPS deployment, the key parameter is CLK5 and for the RAN550 Ext 1PPS Deployment, the key parameter is CLK6 Ext 1PPS Live:

- **CLK5 GPS LIVE or CLK6 EXT 1PPS LIVE:**
  - **LOS + No Actvity**
    The system cannot detect the Input GPS/1PPS signal to the O-RU
  - **OK**
    The system successfully detects the Input GPS/1PPS Signal to the O-RU

    Note: This must be the case to allow for DPLL3 to move off FREERUM Mode

- **DPLL3:**
  - **FREERUN**:
    There is no lock state detected
  - **ACQUIRING LOCK**:
    The system is in the process of moving from Freerun to Locked
  - **LOCKED**:
    The system has achieved GPS/1PPS lock
  - **HOLDOVER**:
    The system has lost GPS/1PPS sync and has moved to holdover mode

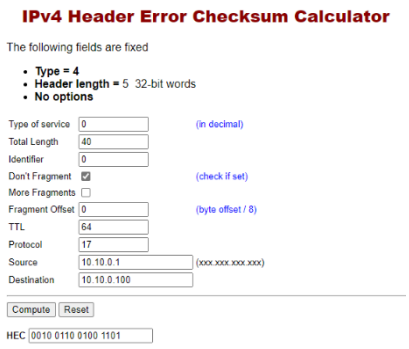
```
root@benetelru:~# syncmon

DPLL0 State (SyncE/Ethernet clock): LOCKED

DPLL1 State (FPGA clocks): FREERUN

DPLL2 State (FPGA clocks): FREERUN

DPLL3 State (RF/PTP clock): LOCKED


CLK0 SyncE LIVE: OK

CLK0 SyncE STICKY: LOS + No Activity


CLK2 10MHz LIVE: LOS + No Activity

CLK2 10MHz STICKY: LOS + No Activity


CLK5 GPS LIVE: OK

CLK5 GPS STICKY: LOS and Frequency Offset


CLK6 EXT 1PPS LIVE: LOS and Frequency Offset

CLK6 EXT 1PPS STICKY: LOS and Frequency Offset
```

7.15 IP Address CheckSum Reference

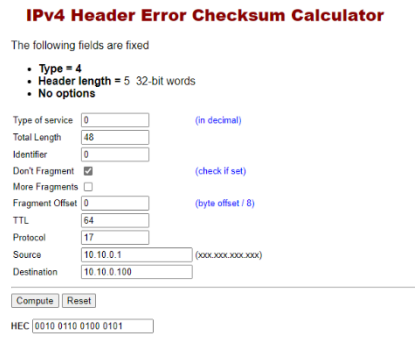
As outlined in the sections on Checksum above, with the assign IP addresses for the O-DU and O-RU, the correct checksum needs to be set.

Checksums can be calculated using the following website: http://www.n-cg.net/hec.htm

O-RU RSP IP CHECKSUM --> 0010 0110 0100 1101 --> **0x264D**

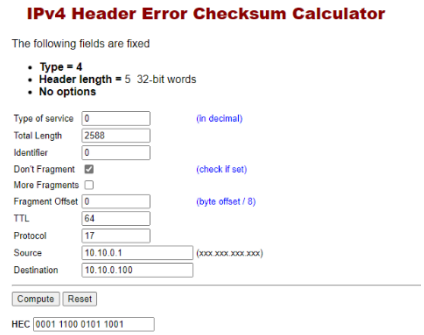


O-RU ADV IP CHECKSUM --> 0010 0110 0100 0101 --> **0x2645**

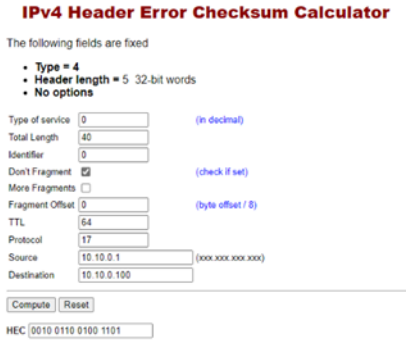


support@benetel.com

O-RU UPLINK IP CHECKSUM --> 0001 1100 0101 1001 --> **0x1C59**



O-DU IP CHECKSUM --> 0010 0110 0100 1101 --> **0x264D**



7.16 Read & Adjust Tx Frequency Settings

EEPROM Start Address: 0x174 [372 decimal]

EEPROM Storage Size: 8 bytes

EEPROM Format: ASCII

Default: 3751.680

Query Command: *eeprog_cp60 -q -f -16 /dev/i2c-0 0x57 -r 372:8*

```
root@benetelru:/# eeprog_cp60 -q -f -16 /dev/i2c-0 0x57 -r 372:8
3751.680root@benetelru:/#
```

Write Commands:

registercontrol -w 0xC036B -x 0x88000088

eeprog_cp60 -f -x -16 /dev/i2c-0 0x57 -w 0x174:0x01:0x33

eeprog_cp60 -f -x -16 /dev/i2c-0 0x57 -w 0x175:0x01:0x37

eeprog_cp60 -f -x -16 /dev/i2c-0 0x57 -w 0x176:0x01:0x35

eeprog_cp60 -f -x -16 /dev/i2c-0 0x57 -w 0x177:0x01:0x31

eeprog_cp60 -f -x -16 /dev/i2c-0 0x57 -w 0x178:0x01:0x2E

eeprog_cp60 -f -x -16 /dev/i2c-0 0x57 -w 0x179:0x01:0x36

eeprog_cp60 -f -x -16 /dev/i2c-0 0x57 -w 0x17A:0x01:0x38

eeprog_cp60 -f -x -16 /dev/i2c-0 0x57 -w 0x17B:0x01:0x30

registercontrol -w 0xC036B -x 0x88000488

7.17 Read & Adjust Rx Frequency Settings

EEPROM Start Address: 0x17C [380 decimal]

EEPROM Storage Size: 8 bytes

EEPROM Format: ASCII

Default: 3751.680

Query Command: *eeprog_cp60 -q -f -16 /dev/i2c-0 0x57 -r 380:8*

```
root@benetelru:~# eeprog_cp60 -q -f -16 /dev/i2c-0 0x57 -r 380:8
3751.680root@benetelru:~#
```

Write Commands:

registercontrol -w 0xC036B -x 0x88000088

eeprog_cp60 -f -x -16 /dev/i2c-0 0x57 -w 0x17C:0x01:0x33

eeprog_cp60 -f -x -16 /dev/i2c-0 0x57 -w 0x17D:0x01:0x37

eeprog_cp60 -f -x -16 /dev/i2c-0 0x57 -w 0x17E:0x01:0x35

eeprog_cp60 -f -x -16 /dev/i2c-0 0x57 -w 0x17F:0x01:0x31

eeprog_cp60 -f -x -16 /dev/i2c-0 0x57 -w 0x180:0x01:0x2E

eeprog_cp60 -f -x -16 /dev/i2c-0 0x57 -w 0x181:0x01:0x36

eeprog_cp60 -f -x -16 /dev/i2c-0 0x57 -w 0x182:0x01:0x38

eeprog_cp60 -f -x -16 /dev/i2c-0 0x57 -w 0x183:0x01:0x30

registercontrol -w 0xC036B -x 0x88000488

7.18 Read & Adjust Tx1 Attn Settings

Following on from the power adjustment outlined in **RF Power Adjustment**, the user can stored the new

EEPROM Start Address: 0x30C [780 decimal]

EEPROM Storage Size: 5 bytes

EEPROM Format: ASCII representing mdB RF Power

Example: 15000

Query Command: *eeprog_cp60 -q -f -16 /dev/i2c-0 0x57 -r 780:5*

```
root@benetelru:/# eeprog_cp60 -q -f -16 /dev/i2c-0 0x57 -r 780:5
15000root@benetelru:/#
```

Write Commands:

registercontrol -w 0xC036B -x 0x88000088

eeprog_cp60 -f -x -16 /dev/i2c-0 0x57 -w 0x30C:0x01:0x31

eeprog_cp60 -f -x -16 /dev/i2c-0 0x57 -w 0x30D:0x01:0x35

eeprog_cp60 -f -x -16 /dev/i2c-0 0x57 -w 0x30E:0x01:0x30

eeprog_cp60 -f -x -16 /dev/i2c-0 0x57 -w 0x30F:0x01:0x30

eeprog_cp60 -f -x -16 /dev/i2c-0 0x57 -w 0x311:0x01:0x30

registercontrol -w 0xC036B -x 0x88000488

7.19 Read & Adjust Tx3 Attn Settings

Following on from the power adjustment outlined in **RF Power Adjustment**, the user can stored the new

EEPROM Start Address: 0x424 [1060 decimal]

EEPROM Storage Size: 5 bytes

EEPROM Format: ASCII representing mdB RF Power

Example: 15000

Query Command: *eeprog_cp60 -q -f -16 /dev/i2c-0 0x57 -r 1060:5*

```
root@benetelru:/# eeprog_cp60 -q -f -16 /dev/i2c-0 0x57 -r 780:5
15000root@benetelru:/#
```

Write Commands:

registercontrol -w 0xC036B -x 0x88000088

eeprog_cp60 -f -x -16 /dev/i2c-0 0x57 -w 0x424:0x01:0x31

eeprog_cp60 -f -x -16 /dev/i2c-0 0x57 -w 0x425:0x01:0x35

eeprog_cp60 -f -x -16 /dev/i2c-0 0x57 -w 0x426:0x01:0x30

eeprog_cp60 -f -x -16 /dev/i2c-0 0x57 -w 0x427:0x01:0x30

eeprog_cp60 -f -x -16 /dev/i2c-0 0x57 -w 0x428:0x01:0x30

registercontrol -w 0xC036B -x 0x88000488

8. Appendix 2: Sample EEPROM Write

This appendix provides sample commands to set O-DU MAC address, IP addresses and checksums in the EEPROM. These values can be edited as needed.

```
# Setup EEPROM comms
echo -n "0-0057" > /sys/bus/i2c/devices/0-0057/driver/unbind
registercontrol -w 0xC036B -x 0x88000088

# Program the O-DU MAC Address - 6c:b3:11:08:a4:e0
eeprog_cp60 -f -x -16 /dev/i2c-0 0x57 -w 0x1A:0x01:0x6C
eeprog_cp60 -f -x -16 /dev/i2c-0 0x57 -w 0x1B:0x01:0xB3
eeprog_cp60 -f -x -16 /dev/i2c-0 0x57 -w 0x1C:0x01:0x11
eeprog_cp60 -f -x -16 /dev/i2c-0 0x57 -w 0x1D:0x01:0x08
eeprog_cp60 -f -x -16 /dev/i2c-0 0x57 -w 0x1E:0x01:0xA4
eeprog_cp60 -f -x -16 /dev/i2c-0 0x57 -w 0x1F:0x01:0xE0

# Program the O-DU IP Address - 10.10.0.1
eeprog_cp60 -f -x -16 /dev/i2c-0 0x57 -w 0x20:0x01:0x0A
eeprog_cp60 -f -x -16 /dev/i2c-0 0x57 -w 0x21:0x01:0x0A
eeprog_cp60 -f -x -16 /dev/i2c-0 0x57 -w 0x22:0x01:0x00
eeprog_cp60 -f -x -16 /dev/i2c-0 0x57 -w 0x23:0x01:0x01

# Program the O-RU Control IP Address - 10.10.0.100
eeprog_cp60 -f -x -16 /dev/i2c-0 0x57 -w 0x12:0x01:0x0A
eeprog_cp60 -f -x -16 /dev/i2c-0 0x57 -w 0x13:0x01:0x0A
eeprog_cp60 -f -x -16 /dev/i2c-0 0x57 -w 0x14:0x01:0x00
eeprog_cp60 -f -x -16 /dev/i2c-0 0x57 -w 0x15:0x01:0x64

# Program the O-DU UDP Port - 0xABE0
eeprog_cp60 -f -x -16 /dev/i2c-0 0x57 -w 0x24:0x01:0xAB
eeprog_cp60 -f -x -16 /dev/i2c-0 0x57 -w 0x25:0x01:0xE0

# Program the O-RU UDP Port - 0xABE0
eeprog_cp60 -f -x -16 /dev/i2c-0 0x57 -w 0x16:0x01:0xAB
eeprog_cp60 -f -x -16 /dev/i2c-0 0x57 -w 0x17:0x01:0xE0

# Program the O-RU RSP IP Checksum - 0x264D
eeprog_cp60 -f -x -16 /dev/i2c-0 0x57 -w 0x50E:0x01:0x26
eeprog_cp60 -f -x -16 /dev/i2c-0 0x57 -w 0x50F:0x01:0x4D

# Program the O-RU ADV IP Checksum - 0x2645
eeprog_cp60 -f -x -16 /dev/i2c-0 0x57 -w 0x18:0x01:0x26
eeprog_cp60 -f -x -16 /dev/i2c-0 0x57 -w 0x19:0x01:0x45

# Program the O-RU Uplink Checksum - 0x1C59
eeprog_cp60 -f -x -16 /dev/i2c-0 0x57 -w 0x510:0x01:0x1C
eeprog_cp60 -f -x -16 /dev/i2c-0 0x57 -w 0x511:0x01:0x59

# Confirm settings and close EEPROM comms
benetel_read_ru_eeprom.sh
registercontrol -w 0xC036B -x 0x88000088
```