Foxconn RPQN O-RU Installation and Operating Guide

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	REVISION CHART					
Version	Author	Reviewer	Date	Description of revision		
v0.1	Andrew George Garcia	Ben	2020/8/19	Initial version of RPQN O-RU Installation and Operating Guide		
v0.2	Garcia	Toru	2020/8/20	Typo correct and append more info		
v0.3	Garcia	Toru	2020/8/20	Unified style and correct typos		
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Version History

Kevin

internal/external antenna

v1.2	Kevin	Lief	2021/02/24	
v1.3	Blake			M-plane new feature list, ptp lock example, ptp profile configuration, power cycle to recover
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v1.9	Lief		2021/11/23	Add SFP+ statement

1 List of packages

Table of Contents

6

1.1 Overview of RPQN O-RU	6
1.2 Outlook	7
1.2.1 Indoor RPQN O-RU	7
1.2.2 10Gb SFP+ optics (GBIC)	8
1.2.3 1Gb Active Copper SFP	8
1.2.4 12VDC AC Adapter Power cord	8
1.2.5 Mounting Kit	9
1.3 Software Version	9
2 Regulation and Certification	10
2.1 Environmental and safety requirements	10
2.2 Federal Communication Commission Interference Statement	10
3 Cabling and assemble instruction	12
3.1 RPQN O-RU cabling instruction	12
3.1.1 For O-RAN C/U-plane connection	12
3.1.2 For O-RAN S/M-plane connection	12
3.1.3 Antenna port number	13
3.1.4 Power supply	13
3.1.5 Micro USB	13
4 Operating instruction	14
4.1 Normal operation	14
4.1.1 PTP 1588v2 clock source setting	14
4.1.2 Unicast and Multicast configuration	16
4.1.3 RPQN O-RU setting	16
4.1.4 Works with Multicast PTP	23
4.1.5 Reboot and Shutdown	24
4.1.6 Remote Connection via GM/BC	24
4.1.7 Remote Connection via directly connect	24
4.2 Firmware image upgrade	25
4.2.1 Enable OAM mode	27
4.2.2 Disable OAM mode	27
4.2.3 OAM mode command	28
4.2.4 List of M-plane Features	28
4.3 How to use the sample app to verify O-RU working properly or not?	29
4.3.1 Operation steps	30
5 FAQ	36
5.1 How to check if the O-RU is booted up and running normally?	36
5.2 Log "xran 10GbE is not ready d6fff000" is normal or abnormal?	37

	,
5.3 Why does RU's log seem not aligned?	37
5.4 Can I add Switch between O-RU and GM?	37
5.5 Can I add a Switch to connect O-RU and O-DU?	37
5.6 How to enable Auto boot up.?	37
5.7 What is the power-on sequence to bring up the Radio?	38
5.8 How to separate PTP log from console log?	38
5.9 Which firmware version matches the FlexRAN version?	39
5.10 Which prach format does RU support?	39
5.11 How to calculate Tx power?	39
5.12 How to disable/enable DPD?	40
6 Troubleshooting	40
6.1 Why DU can not receive any data from RU?	40
6.2 Recover O-RU	40

1 List of packages

- Indoor RPQN O-RU
- Model name: RPQN-7801E, RPQN-7801I, RPQN-7800E, RPQN-7800I, RPQN-7901E, RPQN-7901I
- Antenna x 4 (For external antenna type O-RU)
- Accessories: Optional. Order separately.
 - 10Gb SFP+ GBIC
 - 1Gb Copper SFP
 - 12VDC AC Adapter Power cord
 - Mounting Kit

1.1 Overview of RPQN O-RU

pics Resola Radio Unit		Technical Specification		
		Hardware Configuration		
		Experiment interface Internal Antenna Power Supplier Memory Enternal interface	O AAN option 7.2 over 306bps RNS/SFP 50 NRM 12Y DC/SA input and P0E++ DORA RDL, mon050 10bps RMS, micro058, Power lack	
Highlight Radio 5G NR TDD		3GPP R15 Frigaetics ChEW Copacity Ta/For Paths Mos Output Power Antenna Gain	1300/WHL 3800/WW 100 MHz 2 Olyn 8148; 6 Jola strokew 2 Million (per NF connector) 4 Solilion	
ERGA	intel Activity	Network Features	350, 19+4	
Throughput Dimension	up to 26kps 26kmm×242mm×42mm (L×W×H)	Synchronization Frequency Stability Frequency Synchronization	#8.5ppm PTP(#225588v2)	
Weight <2.38g		Environmental		
Power	< NDW	Ingrees protection Working temperature MTIM	Class (P3X 5*C*+40PC (option +55*C) 600,000hm	

Figure 1 RPQN O-RU specs

1.2 Outlook

1.2.1 Indoor RPQN O-RU



Figure 2 RPQN O-RU Interfaces

- Right: Power indicator (LED for Power Status)
- Middle: System state indictor (LED for system Status)
- Left: Firmware image update indicator (LED for Link & Activity Status)



Figure 3 RPQN O-RU Interfaces

- One 1Gbps Ethernet RJ-45 connector (support of S/M-Plane)
- One 10Gbps Ethernet RJ-45 connector (current software version not support of C/U-Plane)
- One 10Gbps SFP+ (support of C/U-Plane)
- Reset button, Micro USB
- Support PoE++ (10Gbps Ethernet RJ-45) or Power jack of 12VDC power adapter

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1.2.2 10Gb SFP+ optics (GBIC)



Figure 4 Accessories – 10Gb SFP+ optics NOTE: Laser Class 1 optical transceiver shall be used only.

1.2.3 1Gb Active Copper SFP



Figure 5 Accessories – 1Gb Copper SFP

1.2.4 12VDC AC Adapter Power cord



Figure 6 Accessories – 12VDC AC Adapter Power cord

This product is intended to be supplied by a Listed Power Adapter or DC power source marked "L.P.S." (or "Limited Power Source"), rated 12 Vdc, 5A minimum, Tma = 0 degree C minimum. If need further assistance, please contact Foxconn for further information.

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Figure 7 Accessories – Mounting Kit

1.3 Software Version

To show the current software version of RPQN O-RU. Please refer to the 4.1.2 RPQN O-RU setting, by typing command "cat /home/root/test/version.txt", it may looks like below:

branch: master version: c3ad3fe0608aac6d9d5c59d4c6945fca227f40e0 tag: v1.0.3q.431

In this example, the software version tag was v1.0.3q.431.

2 Regulation and Certification

2.1 Environmental and safety requirements

Environmental and safety requirements for Foxconn RPQN O-RU hardware installation.

Marning: Electric Shock.

Please notice that the RF ports should be connected to a 50 Ω load (for example, feeder with an antenna) before powering on the RPQN O-RU. The plastic caps delivered can provide electric shock protection in case RPQN O-RU is unintentionally power on. Please keep plastic caps remained in place for the unused RF ports.

🛕 Warning: Hot parts.

To avoid the risk of hot parts, please use the RPQN O-RU with caution, and wait at least 30 minutes before handling the RPQN O-RU after powering off.

Only trained and qualified personnel are recommended to install, operate, maintain or handle the RPQN O-ORU, and please carefully read the safety information applicable to this product.

Compliance distance.

2.2 Federal Communication Commission Interference Statement

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.

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 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.

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FCC Caution: Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate this equipment.

This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

Radiation Exposure Statement:

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 35 cm between the radiator & your body.

3 **Cabling and assemble instruction**

Below the figure shows the Foxconn SA L5G system.



Figure 8 SA L5G System Architecture

RPQN O-RU cabling instruction 3.1

3.1.1 For O-RAN C/U-plane connection

- 10Gb SFP+ fiber cabling
 - Intel 10Gb Short Range Optics (model: E10GSFPSR, 850 nm wavelength) + multi-mode fiber, or
 - Intel 10Gb Long Range Optics (model: E10GSFPLR, 1310 nm wavelength) + single-mode fiber.
- 10Gb RJ-45 Ethernet cabling, recommend to use Cat 6A Ethernet cable.

3.1.2 For O-RAN S/M-plane connection

1Gb RJ-45 Ethernet cabling: recommend to use Cat 5E Ethernet cable.

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3.1.3 Antenna port number



3.1.4 Power supply

- PoE++ via 10Gb RJ-45 Ethernet port: recommend to use Cat 6A Ethernet cable, or
- 12VDC power adapter: IN AC 100-240 V, 50/60 Hz, 2 A; OUT 12 V, 5 A.

3.1.5 Micro USB

■ Micro USB: for RPQN O-RU debug console.



Figure 9 Example of cabling assemble

Operating instruction 4

Normal operation 4.1

PTP 1588v2 clock source setting 4.1.1

Before starting to use a RPQN O-RU, please set your PTP 1588v2 GM or BC correctly to match the design of RPQN O-RU. In the following example, a Qulsar QG2 GM is used. The following pictures referenced from Qulsar's user manual and the setting in the pictures may not be matched to RPQN O-RU's design.

Step 1: Get or set the IP address of the port the RPQN O-RU to be connected (GM or BC). For example, the IP address of those two ports (GM/BC and RPQN O-RU) are 10.0.1.179 and 192.168.16.150, respectively. If the port does not support DHCP, please remember to configure a proper IP with the same sub-net for RPQN O-RU later. Besides, RPQN O-RU does not support VLAN in PTP. Please disable the VLAN in GM/BC.

	and	Part1		Parts	
MEMTERNE	DHCP	Trailin .		14.4.	
1995	Pré Addrese*	10.0.1.000		192,168.16,15	0
Self-Self-sense	Subret Mask	20.20.20.4		24.345.26.6	
177,044	Gateway #	100.47		192.168.16.1	
	Link State	1000keFul		1000R0 Full	
	Pvil Abbees	well-plate apoly (\$15) have duet to \$2.05 et		wells might been milling well	(iaf
	MAC	- 8. W DATE IN W		R 2016 (1110) 4C	
	VLAN Continuants		Cont.		
	Tater	int +		08	,
	VLAN D(S-40N)				
	Provide 21				

Figure 14 Get/Set IP address of PTP Clock Source GM or BC

Step 2: Set GM/BC as an Ordinary clock, OFF the "Two Step" and set or get the domain number. The suggested value is 44. If you choose other value, please set the same value in RPQN O-RU in the later step.

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Conty	Vier Description			
Clock	Clock Type Made	Cristiany Christ	•	
. 298	Stave Crity Mode	Citation		
Linear .	Two Thep	OFF		
Uncast Notes	Creek Class Clock Assuracy	4. 35		
Parent North	Clock Variance	415.25	40528 420 420	
Time	Clock Privity 2	100		
	Domain Number	44		

Figure 15 PTP Clock Source Parameter Setting

Step 3: Set the PTP network protocol to IPv4 (UDP) and delay mechanism to End-to-End. Suggest to set "Sync Interval", "Delay Request Interval" to 0, "Announce Interval" to 3 and "Announce Receipt Timeout to 3.

NOTE: If the maximum announce interval supported in your GM is 0, please set the announce interval to 0 instead of 3

Comp		Poet 1	
Glassk.	State	Eratie	
Port	Port State	Master	
(Internation	Multicast/Unicent Operation	Muttale	
100 C	Delay Mechanism	828	
Unitial Nodes:	Network Professi	1944	
Parent Node	Network Asymmetry (s)	+0.000000550	
Tirw	Sync Seterval	0	
	Delay Request Interve	0	
	Poleley Request Interval	a	
	Announce Interval	3 -	
	Annalance Record Timeted	1	

Figure 16 PTP Clock Source Port Setting

■ Step 4: Please set the PTP operation to "Unicast" mode.

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DULSAR Home	interface - PIDE - Configuration A	aima System Stade	92		
Config		Port 1		Port 2	
Clock	Unicant Operation	MASTER	2	MASTER	×
Port	Negotiation	ON		ON	Y
	Transmission Duration (s)	300		300	
Unicast	k		Apply C	ear	

Figure 17 PTP Clock Source Set to Unicast Operation

4.1.2 Unicast and Multicast configuration

	G.8275.2 Unicast	G.8275.1 Multicast
logAnnounceInterval	-3 ~ 0	-3
logSyncInterval	-4 ~ 0	-4
operLogSyncInterval	0	0
logMinDelayReqInterval	0	-4
logMaxPdelayReqInterval	0	0

4.1.3 RPQN O-RU setting

- Step 1: Use a Micro-USB cable to connect to a RPQN O-RU from your PC
- Step 2: Start the tool "Device Manager" in your PC and check the COM port number of RPQN O-RU. For example, there is a USB Serial Port with COM port number 19 after RPQN O-RU is connected.



Figure 18 Example of COM Port in Device Manager

 Step 3: Start a terminal software such as "PuTTY" on your PC and select "Serial" protocol. The baud rate is 115200 and other configurations are shown below.

RuTTY Configuration 7 X			Configure the serial line		
Category:			Speed (baud)	115200	
8	Basic options for your PuTTY session		Data bits	8	
E Terminal	Specify the destination you want to connect to Senal line Speed		Stop bits	1	
Bel	COM19	115200	Parity	None 🗸	
- Features	Connection type: O Raw O Teinet O Riogn O SSH @ Senal		Flow control	XDN/XDFF ~	

Figure 19 Baud Rate Setting of Serial Connection

Step 4: Power on the RPQN O-RU and it would run initial boot-up process automatically.

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Please DO NOT press any key when a down-count counter is shown in the boot-up process. After the following message is shown, the initial boot-up process is done correctly.



Figure 20 Example of Boot-up Process Success

- Step 5: Modify related configuration via:
 - Configuration file: /home/root/sdcard/RRHconfig_xran.xml, please reference step 5.1.
 - M-plane: please reference step 5.2. (The firmware version should > v1.0.3q.432)
- Step 5.1: In the terminal software window, use vi command to edit the configuration file, /home/root/sdcard/RRHconfig_xran.xml. Please keep the format the same as the default. For example, if a value is set in hexadecimal format, use the same format after changing to a different value. Besides, if a space character or a comma character is used, please do not remove them.
 - Set:
 - 1. BBU's MAC address in the field "RRH_DST_MAC_ADDR".
 - 2. RU's MAC address in the field "RRH_SRC_MAC_ADDR".

RRH_DST_MAC_ADDR =<br RRH_SRC_MAC_AD<br RRH_SRC_MAC_ADDR =	DR: Destination MAC address, : 00:11:22:33:44:66 DR: Source MAC address, fill w aa:bb:cc:dd:ee:ff	fill with 6 bytes and sepa with 6 bytes and separate	arate each others by colon> each others by colon>
RI MAC: aa:bb:cc:dd:ee:ff	C-Plane VLAN tag: 1 U-Plane VLAN tag: 2	C-Plane VLAN tag: 1 U-Plane VLAN tag: 2	NIC Name: enp97s0f0 MAC: 00:11:22:33:44:66 C-Plane: 0000:61:02.1
			U-Plane: 0000:61:02.0 Note: [domain:]bus:devid.func

Figure 21 Set BBU MAC Address to Be Connected with RPQN O-RU

Set the VLAN ID for C-plane and U-plane, respectively.
 The default value is 0x0001 and 0x0002.

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```
<!-- RRH_C_PLANE_VLAN_TAG: C-plane V-LAN tag express by hex number -->
RRH_C_PLANE_VLAN_TAG = 0x0001
<!-- RRH_U_PLANE_VLAN_TAG: U-plane V-LAN tag express by hex number -->
RRH_U_PLANE_VLAN_TAG = 0x0002
```

Figure 22 Set VLAN Tag ID for C/U-Plane

- Set the LO frequency of RPQN O-RU (in kHz).
 - 1. RXXN-4100: 2593000 (2496~2690MHz)
 - 2. RXXN-7800: 3352260 (3300~3600MHz)
 - 3. RXXN-7801: 3749700 (3700~3800MHz)
 - 4. RXXN-7901: 4849860 (4800~4900MHz)

```
<!-- RRH_LO_FREQUENCY_KHZ: Tx and Rx PLL LO Frequency in kHz(internal or external LO) -->
RRH_LO_FREQUENCY_KHZ = 3352260
```

Figure 23 Set LO Frequency

• Set the GM's IP address and domain number.

```
<!-- RRH_PTPV2_GRAND_MASTER_IP: IP address of grand-master -->
RRH_PTPV2_GRAND_MASTER_IP = 192.168.16.150
<!-- RRH_PTPV2_SUB_DOMAIN_NUM: The sub-domain number -->
RRH_PTPV2_SUB_DOMAIN_NUM = 44
```

Figure 24 Set PTP Clock Source IP Address to be Connected with RPQN O-RU

For other fields in the RRHconfig_xran.xml, you can keep it in default.

- Step 5.2: To connect to the NETCONF Server of RRH when M-plane is activated from a NETCONF client, please use "root/root" to login for username and password respectively. For example, we use a NETCONF Client named "yangcli" to connect to NETCONF server.
 - a. Set BBU's MAC address from NETCONF Client with xpath

"/processing-elements/ru-elements/transport-flow/eth-flow/o-du-mac-address" with the name "PEO" of ru-element's name in processing elements.

```
yangcli root0172.10.73.04> replace /processing-elements/ru-elements/transport-flow/eth-flow/o-du-mac-address
Filling mandatory lmaf /processing-elements/ru-elements/transport-flow/eth-flow/o-du-mac-address
Enter string value for lmaf <o-du-mac-address>
yangcli root0172.10.73.04:replace> 00:11:22:73:44:66
Filling key leaf /processing-elements/ru-elements/name:
Enter string value for lmaf (name)
yangcli root0172.10.73.04> FEO
Enter string value for lmaf (name)
pangcli root0172.10.73.04> FEO
EFC OK Reply 3 for mession 0:
```

• b. Set the VLAN ID for C-plane and U-plane, respectively. The default value is 1 and 2.

To modify the VLAN ID of C-plane and U-plane, the xpath is "/interfaces/interface/vlan-id" and the name of interface is "iC" and "iU" for C-plane and U-plane. There is an xpath "/processing-elements/ru-elements/transport-flow/eth-flow/vlan-id" needs to modified if VLAN ID of interface "iU" changed. It must be aligned to the VLAN

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ID of U-plane.

```
angcli root@172.18.73.84> replace /interfaces/interface/vlan-id
Filling optional leaf /interfaces/interface/vlan-id:
Enter uintl6 value for leaf <vlan-id>
yangcli root@172.18.73.84:replace> 1
Enter string value for leaf <name>
yangcli root0172.18.73.84> iC
RPC OK Reply 4 for session 6:
yangcli root@172.18.73.84> replace /interfaces/interface/vlan-id
Enter uint16 value for leaf <vlan-id>
yangcli root@172.18.73.84:replace> 2
Enter string value for leaf <name>
yangcli root@172.18.73.84> iU
RPC OK Reply 5 for session 6:
yangcli root0172.18.73.84> replace /processing-elements/ru-elements/transport-flow/eth-flow/
o-du-mac-address ru-mac-address vlan-id
yangcli root@172.18.73.84> replace /processing-elements/ru-elements/transport-flow/eth-flow/vlan-id
Filling mandatory leaf /processing-elements/ru-elements/transport-flow/eth-flow/vlan-id:
Enter leafref value for leaf <vlan-id>
yangcli root@172.18.73.84:replace> 2
Filling key leaf /processing-elements/ru-elements/name:
Enter string value for leaf <name>
yangcli root@172.18.73.84> PE0
 PC OK Reply 6 for session 6:
```

c. Set the LO frequency of RRH (in Hz). The xpath is

"/user-plane-configuration/tx-array-carriers/center-of-channel-bandwidth" with the name "TX-Ca0" of tx-array-carries.

```
yangol1 root8172.18.73.84> replace /user-plane-configuration/tx-array-carriers/center-of-channel-bandwidth
Filling mandatory leaf /user-plane-configuration/tx-array-carriers/center-of-channel-bandwidth:
Enter uint68 value for leaf ccenter-of-channel-bandwidth)
yangol1 root8172.18.73.84:replace> 450000000
Filling key leaf /user-plane-configuration/tx-array-carriers/name:
Enter string value for leaf cname>
yangol1 root8172.18.73.84> TX-Ca0
RPC CW Reply 2 for sension 6;
```

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 d. Set the GM's IP address and domain number, the xpath are "/sync/ptp-config/g-8275-2-config/master-ip-configuration/ip-address" and "/sync/ptp-config/domain-number". To set "/sync/ptp-config/g-8275-2-config/master-ip-configuration/ip-address" with NETCONF Client, the key of xpath "/sync/ptp-config/g-8275-2-config/master-ip-configuration/local-priority" must set as "128" as default
vangeli root#172.18.73.84> replace /sync/ptp-config/g-8275-2-config/master-ip-configuration/ip-address
Filling optional leaf /sync/ptp-config/g-8275-2-config/master-ip-configuration/ip-address: Enter string value for leaf <ip-address> Mangcli root@172.18.73.84:replace> 192.168.33.150</ip-address>
Cilling key leaf /sync/ptp-config/g-8275-2-config/master-ip-configuration/local-priority: Enter uint8 value for leaf <local-priority> Vangcli root8172.18.73.84> 128</local-priority>
UPC OK Reply 7 for session 6:
To let the RRH applies the new configurations, please reboot the RRH.

angcli root@172.18.73.84> reset

- Step 6: Check IP related configuration via:
 - IP Configuration: "ifconfig" command to check, please reference step 6.1.
 - M-plane: please reference step 6.2. (The firmware version should > v1.0.3q.432)
- Step 6.1: Use a network cable to connect RPQN O-RU and GM/BC you use. If the GM/BC supports DHCP server, RPQN O-RU should get an IP address after connecting. You can use "ifconfig" command to check. If the GM/BC does not support DHCP server, please use "ifconfig eth0 xxx.xxx.xxx netmask 255.255.255.0" to configure the RPQN O-RU's IP address. Please make sure to use the same sub-net number as the GM/BC uses.
- Step 6.2: Use a network cable to connect RRH and GM or BC you use. If the GM supports DHCP, RRH should get an IP after connecting. When the M-plane is activated, you can use "./set_oam_mode -e" command to enable DHCP. If the GM does not support DHCP, please use "./set oam mode -e IP ADDR 255.255.0.0 GATEWAY IP ADDR" to configure the RRH's IP. Please make sure to use the same sub-net number as the GM uses. Then please reboot the RRH.

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Figure 25 Subnet Mask Confirmation

Note: You can use the "ping" command to make sure that the link connects correctly.

Step 7: After finishing the above configuration, go to the "~/test" folder and run command



Figure 26 Start up the RPQN O-RU

Within about one minute, the following messages are shown. If there is no message shown like below, please check if the GM/BC's IP and domain number in RRHconfig_xran.xml are the same as those in GM/BC.

ptp41[86238.390]:	master offset	-17785928649442221	5.0	freq	+8	path	delay	443
ptp41[86239.390]:	master offset	-17785920649442213	50	freq	+6	path	delay	441
ptp41[86240.390]:	master offset	-17785920649442213	50	freq	+3	path	delay	441
ptp41[86241.390]:	master offset	-17785920649442208	50	freq	+4	path	delay	442
ptp41[86242.390]:	master offset	-17785920649442208	50	freq	+3	path	delay	442
ptp41[86243.398]:	master offset	-17785928649442298	50	freq	+2	path	delay	442
ptp41[86244.390];	master offset	-17785920649442213	50	freq	+1	path	delay	443

Figure 27 Example of PTP Sync Up

If you want to re-run "init_rrh_config_enable_cuplane" command after correcting some setting issue, please power cycle the RPQN O-RU and go to step 6 to set the IP address and then you can re-run the command.

■ Step 8: After master offset converge to -40~40, it will start to initialize C/U-plane

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Step 9: When the following messages are shown, the RPQN O-RU has done the normal process and can start to work with a BBU.

atub ist ipps time-ffffffff mirr-034090ac diff=0 Latub 3nd ipps time-DeBb90ac curr-0+9000ac RRM_state=1 1081 sec=0 hps=1590400423 44n=0 65to125=0 total=0 uni=0 uni>1156=0 multi=0 crc_err=0 state=1 start=0 adj=0 rstont=0 1091 aec=0 hps=1590400423 44n=0 65to120=0 total=0 uni=0 uni>1156=0 multi=0 crc_err=0 state=1 start=0 adj=0 rstont=0 mirMax=13us 8 4010, aliMax=40us 8 4010 15ee253a 15ee355d 00000000 00000000 00000000 0
Latch later lpps time-15ee96ac sw14010-15ee98ac sram_sec+15ee98a8 acc_diff[1]=0 hps_sec+1590400423 cur_sec+0 FA_CM TDD curr dBF3 of CRx = 54311 24392 0 0
Figure 28 Example of RPQN O-RU Start up Success
<pre>sRAN: log=0 toD(1) sec=656 tick=4009 smp cnt=0f115740 pkt_en=0f115740 c_arr=00000000 lpps=cc6e5744 f2t_en=dlc134bc jead_en=dlc156fc diff: sec=656 tick=4009 c_arr_vs_lpps=1000000us f2t_vs_lpps=7040004us jead_vs_lpps=7040084us Cmsg1_p0: 00000000 00000000 00000000 000000000</pre>

Figure 29 Example of xRAN packet coming to O-RU

- Step 10: When you power cycle the RPQN O-RU, you can start the RPQN O-RU from step 6 if the GM/BC's setting and LO frequency is not changed.
- Step 11: Please make sure ALL of RF connectors have been connected to loads exactly before a BBU starts to send data to a RPQN O-RU.
 - Please make sure a BBU stops sending any data to a RPQN O-RU before loads of RF connectors are released.
 - If a load is not connected well when a BBU is sending data, RF components may be damaged. Users have to be responsible for the consequences.

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4.1.4 Works with Multicast PTP

Work start from VERSION: v1.1.5q.432

- (conditional) If you have already enabled M-plane(v1.1.4q.432) before, you need to disable it first.
 - ./set_oam_mode -d
- 2. Download firmware .tgz file and move it to RRH /home/root/test/
- 3. Unzip file tar xzvf v1.1.5q.432.tgz
- 4. Update firmware ./data_restore v1.1.5q.432
- 5. Go to folder v1.1.5q.432, run script ./install_patch.run
- Modify /home/root/sdcard/RRH_config_xran.xml
 i. Change mode to multicast

```
<!-- RRH PTPV2 GRAND MASTER MODE: 0: Unicast, 1:Multicast -->
```

RRH PTPV2 GRAND MASTER MODE = 1

- ii. Change domain number (align with GM)
 <!-- RRH_PTPV2_SUB_DOMAIN_NUM: The sub-domain number -->
 RRH_PTPV2_SUB_DOMAIN_NUM = 24
- 7. Once the ptp start to sync, After ptp locked, it will start to enable C/U-plane

```
ptp41[112 611]: rms
                       9 max
                                11 freq
                                            -3 +/-
                                                      1 delay
                                                                298 +/-
                                                                          2
                       8 max
                                8 freq
                                            +0 +/-
                                                     0 delay
                                                                          0
ptp41[113.620]: rms
                                                                297 +/-
                      10 max
                                            +0 +/-
                                                                298 +/-
                                                                          1
ptp41 114.611 : rms
                                11 freq
                                                     0 delay
                                            +0 +/-
                       8 max
                                                                297 +/-
ptp41[115.630]: rms
                                11 freq
                                                     0 delay
                                                                          2
                       5 max
                                            +1 +/-
ptp41[116.611]: rms
                                8 freq
                                                   1 delay
                                                                297 +/-
                                                                          1
ptp41[117_611]: rms
                       8 max
                              12 freq
                                            -7 +/-
                                                     7 delay
                                                                300 +/-
                                                                          2
                       7 max
                               8 freq
                                            -6 +/- 1 delay
ptp41 118 611 : rms
                                                                296 +/-
                                                                          1
                                                   0 delay
ptp41[119.611]: rms
                                            -4 +/-
                              12 freq
                                                                300 +/-
                      11 max
                                                                          1
                                           -18 +/- 41 delay
ptp41[120.611]: rms
                      13 max
                               21 freq
                                                                300 +/-
                                                                          1
                                                   0 delay
0 delay
ptp41[121.611]: rms
                      11 max
                               11 freq
                                            +0 +/-
                                                                300 +/-
                                                                          0
ptp41[122.611]: rms
                      11 max
                                           +0 +/-
                                                                300 +/-
                                                                          Θ
                                11 freq
                                            +0 +/-
                                                                299 +/-
                                                                          Θ
ptp41[123.611]: rms
                      10 max
                                                   0 delay
                                11 freq
 148.494758 Load cuplane on 0x2e800000
NULL ADRV9025 device pointer
RRH_state=0
RRU Interface SHA1 value
74f9ffb1ce98fa9d4bd109575d01399851d53b26
RRU Branch information
master
RRU Commit information
0fafdb573911fafd3a0279f522646450cc548de0
ALT interrupt init!
INFO: Setting up global interrupts.
INFO: Setting up CPU interrupts.
INFO: Configuring buttons.
INFO: Enabling CPU interrupts.
INFO: Enabling global interrupts.
Interrupt init!
New L01=3352260000Hz L02=0Hz
ad9025 init...
```

4.1.5 Reboot and Shutdown

If rebooting or shutting down a RPQN O-RU is needed, a user must connect the RPQN O-RU via terminal software to run the command, "./reboot.sh" or "./shutdown.sh" respectively. There are two methods to do that.

P.S. If O-RU cannot return to normal state, please **POWER CYCLE** O-RU.

4.1.6 Remote Connection via GM/BC

The first method is via a GM/BC if the GM/BC supports IP routing or forwarding.

- Step 1: To set IP address of a user's PC followed the description in *4.1.2 RPQN O-RU setting*. For example, the IP address can be 192.168.16.50 for the user's PC where the IP address of a RPQN O-RU above is 192.168.16.49.
- Step 2: Users can use the command "ping" to check if an echo is replied. If yes, users can create a remote connection to the RPQN O-RU as follows.



Figure 30 Example of RPQN O-RU Remote Connection Success

Step 3: After a remote connection is established, the user can enter "./reboot.sh" or "./shutdown.sh" to reboot or shut down the RPQN O-RU.

4.1.7 Remote Connection via directly connect

The second method to connect RPQN O-RU is to directly connect both RPQN O-RU and the user's PC by setting the correct IP address of a user's PC.

- Step 1: Eject the network cable from a GM/BC and plug into the user's PC.
- Step 2: Set the IP address of the user's PC as the same as the IP address of the GM/BC, which the RPQN O-RU connects to. For example, user can set the IP to 192.168.16.150 as the example in 4.1.2 RPQN O-RU setting.
- Step 3: Users can use the command "ping" to check if an echo is replied. If yes, users can create a remote connection to the RPQN O-RU and then enter "./reboot.sh" or "./shutdown.sh" to reboot or shut down the RPQN O-RU.
- Step 4: After that, restore the network cable back to the GM/BC.

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4.2 Firmware image upgrade

- Step 1: Use a Micro-USB cable to connect to a RPQN O-RU from your PC
- Step 2: Start the tool "Device Manager" in your PC and check the COM port number of RPQN O-RU. For example, there is a USB Serial Port with COM port number 19 after RPQN O-RU is connected.



Figure 31 Example of COM Port in Device Manager

 Step 3: Start a terminal software such as "PuTTY" on your PC and select "Serial" protocol. The baud rate is 115200 and other configurations are shown below.

S PuTTY Configurati	on	7 X	Configure the setal line	
Category			Speed (baud)	115200
B Benitri	Basic options for	your PuTTY session	Data bts Stop bits	8
Esging Terminal Keyboard Bell	Specify the destination you Setal line	want to connect to Speed		1
	COM19 115200	115200	Parity	None 🗠
- Features	Connection type O Raw O Teinet O	Rogin () SSH ()) Senal	Flow control	XON/XOFF ~

Figure 32 Baud Rate Setting of Serial Connection

Step 4: Power on the RPQN O-RU and it would run initial boot-up process automatically.
 Please DO NOT press any key when a down-count counter is shown in the boot-up process.
 After the following message is shown, the initial boot-up process is done correctly.

The Angstrom Distribution arrial0 tty50	
Angstrom v2014.12 - Kernel 5.2.0-rcl-g6cc558e	
arrial@ login: root (automatic login)	
Last login: Tue Sep 3 04:54:05 UTC 2019 on ttyS0 mount /dev/mmcblk0p1 to ~/sdcard [11:938223] FAT fs (mmcblk0p1): Volume was not properly unmounted. Some data may be corrupt. Please run fsc C:\intelFPGA pro\Tom\xran\20200317 rootbarrial0:~/test# []	k.

Figure 33 Example of Boot-up Process Success

Step 5: Next, your PC and RPQN O-RU must be located on the same network and there must be a DHCP server in that network to allocate IP to your PC and the RPQN O-RU automatically. After connecting RPQN O-RU to the network, use the command, "ifconfig", to check what IP address the RPQN O-RU gets.

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Figure 34 Subnet Mask Confirmation

 Step 6: After the IP address is obtained, use WINSCP at the PC side to connect RPQN O-RU. After v1.4.12q.524, it needs a password. In non-oam mode, the default password is "123456". If ever enabled OAM, the default password will be "cj/6c93zj4g4d;".

BACKUP the original files before any updating.

- Backup the following 3 files under /home/root/test,
 - 1. bootimage_cuplane.bin
 - 2. init_rrh_config_enable_cuplane
 - 3. version.txt

/head/roof/tool restDertrialDic/testH ls bentimes_taplans.bun brnch257 wi_Htestrh_ts_Rr_20001100 data_restore demu_los inti_rth_config_enable_coulane problem way is_R_27 res lance_log.tot lag.tot release release	rdi-yet_coplane_status rdi.recaning.rf.pacam ret_use mode set_part.sh shuther.sh sottpag.art.sl@_sscdk_comec.dtk.see test.sh v1.0.34,452 e1.2.462 e1.2.462 e1.2.452 e1.2.452 e1.2.452 e1.2.452
--	---

- Backup the following 4 files under /home/root/sdcard folder,
 - 1. ghrd_10as066n2.core.rbf
 - 2. ghrd_10as066n2.periph.rbf
 - 3. RRHconfig_xran.xml
 - 4. hw_ver.txt

_	
/home/root/sdcard root@arria10:-/sdcard# ls RRHconfig_xran.xml RRHconfig_xran_default.xml System Volume Information ghrd_10as066n2.core.rbf ghrd_10as066n2.periph.rbf bw ver.txt	socfpga_arria10_socdk_sdmmc.dtb zImage zImage_backup z_version.txt zimag_bak

- Step 7: Update configuration via:
 - Firmware files: Upload the firmware installation file to */home/root/test* by WINSCP or any SFTP tools.
 - M-plane: please reference step 11 to step 13. (The firmware version should above v1.0.3q.432)
- Step 8: Go back to the Putty window. Before running the installation program, <u>please check</u> <u>if the spare disk space is larger than 100MBytes.</u> If not, please clean up the disk to get enough space for installation.
- Step 9: Change directory to **/home/root/test** and execute:
 - 1. chmod 755 firmware_name.run
 2. ./firmware_name.run

```
root@arria10:~/test/fw_upgrade# chmod 755 install_oam_v1_3_8q_32.run
root@arria10:~/test/fw_upgrade# ./install_oam_v1_3_8q_32.run
Start to install v1.3.8q.52...
Current folder = /home/root/test/fw_upgrade
org=d9fdf50d7197b37f7151e7d8631fa21aa2358de8
new=e300d65e7ed3fe9a147a31dfe3fb047266348442
org=bb66bc4ac9d617dab5ec57975155bd03a2f94c0a
new=3718c24fbb1457a6fb7cea6654a20f68be60f032
Enter new UNIX password: Retype new UNIX password: passwd: password updated successfully
Change to Non-OAM mode. Ready to reboot...
```

■ Step 10: Connect the network cable back to the GM/BC port and do the normal operations in the section 4.1.2 RPQN O-RU setting.

4.2.1 Enable OAM mode

Step 11: After the installation is done, the RRH would be re-booted automatically. If the re-booting is done, please use the following command to activate OAM mode with flexible IP assigned by a DHCP server because the default RRH mode does not apply M-plane feature:

./set_oam_mode -e

Step 12: If the GM or BC doesn't support DHCP server and a static IP has to assign to RRH manually, please use the following command to set static IP, gateway and activate OAM mode.

./set_oam_mode -e IP_ADDR 255.255.0.0 GATEWAY_IP_ADDR

Step 13: After rebooting, the installation is done and RRH will automatically run M-plane.

4.2.2 Disable OAM mode

Disable OAM mode:

./set_oam_mode -d

4.2.3 OAM mode command

Command script at /home/root/test/set_oam_mode
root@arria10:~/test# ./set_oam_mode -h Usage: set_oam_mode [OPTION] [IP ADDR] [NETMASK] [GATEWAY ADDR] This command can change the RRH mode to OAM or NON-OAM mode.
Examples: set_oam_mode -d #Disable OAM mode set_oam_mode -e #Enable OAM mode set_oam_mode -e 192.168.33.49 #Enable OAM mode set_oam_mode -e 192.168.33.49 255.255.0.0 #Enable OAM mode set_oam_mode -e 192.168.33.49 255.255.0.0 192.168.33.150 #Enable OAM mode
Main options: -d: Disable OAM mode -e: Enable OAM mode -h: Help

4.2.4 List of M-plane Features

Version v1.1.4q.432

- 1. Transport and Handshake in IPv4 Environment
 - DHCP Enable/Disable
 - VLAN Settings (Searching Range/VLANs)
 - Static IP Settings (Interface IP/Network Mask IP)
 - Static CallHome IP & Port settings
 - Getting CallHome IP from DHCP option 43(only if DHCP is enabled)
- 2. Software Upgrade (Download, Installation, Activation)
 - Download: Download an image from a SFTP server site.
 - Installation: Install a downloaded image of a slot.
 - Activation: Activate an installed image of a slot.
- 3. Supervision implementation to check connectivity between NETCONF Server and Client

 User could reset the watchdog timer after receiving the Notification from RRH (NETCONF Server)
- 4. User Management
 - Users could create users which belong to the specified groups.
- 5. Alarm Management

 Subscribe: NFTCONF Client subscribes with RR
 - Subscribe: NETCONF Client subscribes with RRH (NETCONF Server) for getting notifications generated from RRH.
 - Active Alarm Lists: NETCONF Client could get active alarm lists from RRH.
- 6. U-Plane Configurations
 Static profiles of RRH now.

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- LO frequency is configurable.
- 7. S Plane Configurations
 - GM IP settings of the YANG module 'o ran sync.yang'.
- 8. VLAN ID settings for C Plane & U Plane
 - Configurable VLAN ID s for the interfaces 'iC' (C Plane) and 'iU' (U Plane).

Version v1.2 .6q.432

Add new features:

- 1. S Plane Configurations
 - G.8275.1 profile support
 - PTP status support
- 2. Delay Management Profile
 - Static profile support only
- 3. Log Management
 - Troubleshooting log support
 - 4. U Plane Configurations
 - TX/RX Arrays support
 - Configurable gain settings of TX/RX array carriers
- 5. RU information
- 6. Heartbeat for RRU M Plane service
 - Check if the service is still alive every 30 seconds.
 - Will restart the service in 30 seconds if the service isn't alive.
 - The configuration will be set to default values if the service cannot be restart successfully in 5 times.

Version v1.3.8q.52

Add new features:

■ 1. Trace Log Management (o ran trace

Fix bugs:

1. Fix notification payload error of file management response content.

 2. Correct the value of the leaf sync state and supported reference types of the module o ran sync.yang

4.3 How to use the sample app to verify O-RU working properly or not?

The sample app was built based on the O-RAN SC bronze 1.1 release. It can simulate DL/UL I/Q data patterns as BBU.

While you are using sample app with O-RU:

- If you can see normal spectrum waveform and constellation, it means PTP sync status, O-RU and front-haul connection were correctly configured.
- If not, you may need to check PTP configuration, O-RU software/hardware/configuration, front-haul connection.

The software name would be: *oran_bronze_release_v1.1_sample_app.tar.gz*

Foxconn RPQN O-RU Installation and Operating Guide HON HAI Technology Group HON LIN TECHNOLOGY CO., LTD.

4.3.1 Operation steps

- 1. Untar gz file
 - a. # tar zxvf oran_bronze_release_v1.1_sample_app.tar.gz
 - b. You will get **O-du** directory
 - c. Take **/root/o-du** as an example.
- Before running sample-app, you have to use DPDK to bind the VFs of 10GbE NIC used for C/U-plane

 Assume your NIC information as below:
 - i. Name: *enp216s0f1*
 - ii. PCIe address: 0000:d8:0a
 - b. Create VF for CU-Plane
 - i. # ip link set enp216s0f1 vf 0 vlan 2
 - ii. # ip link set enp216s0f1 vf 1 vlan 1
 - iii. # ip link set enp216s0f1 vf <mark>0</mark> mac 00:11:22:33:44:66
 - iv. # ip link set enp216s0f1 vf 1 mac 00:11:22:33:44:66
 - c. Modify ./o-du/phy/fhi lib/app/dpdk.sh according to your setup

Ethernet device name used to connect to RU (Please change according to your setting) ethdevice=enp216s0f1

PCIe address of network devices using DPDK-compatible driver (Please change # according to your setting) pcieaddr="d8:0a.0 d8:0a.1"

dpdk_iodev=igb_uio

MAC address DPDK used to bind (Please change according to your setting) macaddr=00:11:22:33:44:66

- 3. Enable DPDK for once after system reboot
 - a. #cd./o-du/phy
 - b. # source setupenv.sh
 - c. # cd fhi_lib/app
 - d. Make sure the 10GbE fiber cable is connected between the BBU and RRH
 - e. #./dpdk.sh

(0000:d8:0a.0 and 0000:d8:0a.1 are example, you should see the PCIe address of the 10GbE NIC on BBU)

- 4. Edit setupenv.sh
 - a. #cd./o-du/phy
 - b. # vi setupenv.sh
 - c. Change DIR_ROOT=/root

- 5. Set duMac and ruMac address and VLAN tag according to your setting.
 - a. # cd ./o-du/phy/fhi_lib/app/usecase/mu1_100mhz
 - b. edit config_file_o_du.dat



- 6. Set PCIe address of network devices using DPDK-compatible driver
 - a. # cd ./o-du/phy
 - b. # source setupenv.sh
 - c. # cd fhi lib/app
 - d. edit run o du.sh

<pre>ulimit -c unlimited echo l > /proc/sys/kernel/core_uses_pid</pre>		
./build/sample-app -c ./usecase/mu1_100mhz/config_file_o_du.dat	-р 3	2 0000:d8:0a.0 0000:d8:0a.1

- e. #./run o du.sh
- f. Modify the configuration of VSA(vector signal analyzer)
 - i. SS/PBCH

Meas01 - 5G NR Den	nod Propertie	s				8
Configuration	Time D	ecode	Advanced			
Save As Quick Setup	Quick Setu	ıps				
Component Carrier:	CC0 🗆 N	/lanually a	pply settings			
Format BWP	SS/PBCH	PDCCH	PDSCH	CSI-RS	PUSCH	PUCCH
SS/PBCH						
Lmax:	L4	- SS	B Transmitted	l: 0:3		
Auto Detect Act	tive Block	D	et Power Three	hold: -30		
RB Offset(15kHz):	ffset(15kHz): 0 RB			Numerology: µ = 1 : 30		
kSSB(15kHz):	0	S:	SS Block Pattern:		seB	
Periodicity:	10 ms	- 7.	2 MHz bandwi	dth -45.54 I	MHz from cer	nter
- Power Boosting -						
PSS power boost	ing 0 dB		PBCH powe	er boosting	0 dB	
3GPP Version:	atest (2018-06) -				
						Para l



Assessed - 30 MM Deput	d Properties					(Date
Configuration	Time Decode	Advanced				
we As Quick Setup	Quick Setups					
omponent Carrier:	cco Manually ap	ply settings				
Format SWP 1	арван россн	POSCH CSER	S. PUSCH	PUCCH		
Add PDSCH	Remove PDSCH	Date POTICHE				
POSCHE 👩 -						
	8	Resulting Fo	mat 00000	0000000000		
Transport Block Si	E 278770	RB Offset	0 RB	IS Number	273.88	
ng anore	20		terile BW			
1000	0		Umrited	REI I Allecuted RB	8	
RS Sequence						
DMRS Config	lypd 👘	ng DMIG Source	From REC	🗐 🗇 Enable PTRS:		
DMRS Mai Length	i :	ng ^{Nord}	390	RPTRS		
DMRS Length	Single Symbol -	Note	0	LPTRS.		
DMRS AddPos	Past =	OMRS Inst Option	NR Standard	PTRS RE Office		
		DMRS Init:				
Power Boostin	as.					
Power Boosting	US DMI	C Prover Scotting	0 dB	PTHS Power Boosting	r-048	
Constant Constant Constant			*****			
Antenna Port						. 😁
Antenna Port Analy	2ed \$300					
V Use Antenna Po	rts Index					
Antenna Ports Inde	e 0	Code	word Number:			

Start XAA Set debug O-DU: thr Start C-p Start C-p Start U-p Start U-p C-plane t Start Sym Interval,	i traffic xtop 1, debug ead_run start lane 0L 71 us lane 0L 200 ur lane 0L 200 ur lane 0L 75 us o U-plane del timer 71428 us 500	g stop count time: 01/01/ after TT1 f s after TT1 s before 0TA 0TA f ay 125 us aft fts	0 70 17:40:11.00 trigger on sym [trigger on sym [affset in sym offset in sym offset in sym ar TTI	0000005 UTI 1 2] m 0] m -5] 1 3]	: [500]		
Press 1	to start 50	AR KRAN traff					
Press 3	to quit	Tuture uve					
a. Ia-duller	0 ppa	o kbas	011ts		0 kbeis	101	fon time 0 early 0 late 0 corrunt 0 ckt dupl 0 Total 0] 10 Util: 44.13 %
la-duller	O DOWN	D kburs	plite		CONTRACT	0	Ion time 0 early 0 late 0 corrupt 0 skt dupl 0 Total 01 10 util: 44.12 %
lo delle	0.008	0 kbps	elitx	0 501	0 kbps		Ion time & early & late & corrupt & skt dupl & Total & 30 Util: 44.33 %
In duller	0 001	0 kbps	plitz	0 001	o kbps	10	Ion time 0 early 0 late 0 corrupt 0 pkt dupl 0 Total 0 10 Util: 88.23 %
[a-du][ra	0 pps	0 kbps	plits	0 201	o ktore	ioi/	Ion time 0 early 0 late 0 corrupt 0 pkt dupl 0 Total 01 10 Util: 44.12 %
lo-dul[rs	0 pps	Ø ktern	p][ts	0.564	0 kbps	101	Ion time 0 early 0 late 0 corrupt 0 pkt dupl 0 Total 0 10 Util: 44,11 %
le-dullra	0.008	0. kbprs	oi(tx	0 001	0-kbps	101	ion time 0 early 0 late 0 corrupt 0 pkt dupl 0 Total 0] IO Util: 44.00 %
fo-dullrn	5478 pps	5478 kbps	olitx	31948 005	31948 kbps	01	ion time 5478 early 0 late 0 corrupt 0 pkt_dupl 56 Total 5478] IO Util: 44.82 %
lo-duller	38678 pps.	33200 kbps	138655][tx 2	26364 pp1	194416 kbps	1593307]	Ion time 38678 early 0 late 0 corrupt 0 pkt_dupl 406 Total 18870] IO Util: 47,76 %
lo-dullers	71678 pps	33260 kbpv	172509][ts 4	20700 ppk	194416 kbps	1991027	Ion time 71878 early 0 late 0 corrupt 0 pkt_dupl 866 Total 71878] IO Util: 47.66 %
[a-du][fa	105078 pp+	11200 kbps	1725691[ta 0	15198 pp+	194416 kbps	19910271	Ion time 105078 early 8 late 0 corrupt 0 pkt_dupl 1286 Total 105078] 10 util: 47.65
lo-dullra	138279 pp+	33200 kbps	172569][tx #	09612 pps	194416 kbps	19910271	on time 130278 early 8 late 0 corrupt 0 pkt_dupl 1666 Total 130278] IO Util: 47.64
lo-dulina	171479 pps	33290 kbps	172569][tx 10	04022 pps	194410 kbps	19910271	Ion time 171478 early 0 late 0 corrupt 0 pkt_dupl 2066 Total 171478] IO Util: 47.61
lo-dullra	204679 pps	33200 kbps	172569][tx 1]	99444 pps	194422 kbps	1991027	[on_time 204670 early 0 late 0 corrupt 0 pkt_dupl 2466 Total 204678] IO Util: 47.62
[o-du][ra	237878 pps	33290 kbps	1725691[t# 17	42860 pps	194416 kbps	1991027	[on_time 237878 early 0 late 0 corrupt 0 pkt_dupl 2006 Total 237078] IO Util: 47.61
[e-du][rm	27107% pps	33200 kbps	1725691 ts 15	#7276 pps	194416 kbps	1991027	[on_time 271078 early 0 late 0 corrupt 0 pkt_dupl 3266 Total 271078] 10 Util: 47.62
to-dulling	304278 pps	33200 kbps	172569][tx:17	81592 pps	194416 kbps	1991027	[on_time 304278 early 8 late 0 corrupt 0 pkt_dupl 3666 Total 304278] IO Util: 47.61
lo-dallrs	337478 pps	33200 kbps	17256911tx 19	76188 pps	194416 kbps	19910271	[on_time 337478 early H late 0 corrupt 0 pkt_dupl 4066 Total 337478] IO Util: 47.63
lo-dullra	270679 pps	33200 kbps	1725691(tx 2)	79515 pps	194408 kbps	19910271	[on_time 370678 early 0 late 0 corrupt 0 pkt_dupl 4466 Total 370678] IO Util: 47.62
o-dullta	403978 pps	33200 kbps	172569[[tx 23	64932 pps	194416 kbps	19910271	[on_time 403070 early 0 late 0 corrupt 0 pkt_dupl 4866 Total 403078] 10 Util: 47.62
[s-du][fa	437078 pps	33200 kbps	172569[[tx 25	.99356 pps	194424 kbps	19910271	[on_time #37078 early 0 late 0 corrupt 0 pkt_dupl 5266 Total 437078] 10 Util: 47.62
lo-dullfa	476278 pps	33200 kbps	172569115x 27	53772 pps	194416 kbps	19910271	[on_time 470278 early 0 late 0 corrupt 0 pkt_dupl 5666 Total 470278] 10 util: 47.64
to-dullfra	563478 pps	33200 kbps	172569][tx 29	48188 pps	194416 kbps	1991427	ion_time 503478 early 0 late 0 corrupt 6 pkt_dupl 6066 Total 503478] IO Util: 47.61
0-dul[17	536678 pps	33306 kbps	1725691 [tx 3]	42596 pps	194408 ktps	19910271	[on time 536678 early 0 late 0 corrupt 0 pkt dupl \$466 Total \$36678] IO Util: 47.61

