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1914.3 (RoE), eCPRI Testing to O-RAN

Network Master Pro MT1000A
10G Multirate Module MU100010A
100G Multirate Module MU100011A

Contents

Background

Many operators today are implementing the O-RAN standard to carry RF data over the NGFI-I (mobile fronthaul) network segment. The RoE (IEEE 1914.3) and eCPRI low-layer transport protocols carry the O-RAN protocol. O-RAN, which is a relatively new standards group formed mainly by operators, is expanding quickly to include network-equipment and silicon suppliers. Major parts of the standard are taken from the xRAN group, which was also an operator-focused group.
This Application Note focuses on the xRAN (implemented in O-RAN) network requirements and how to test them.

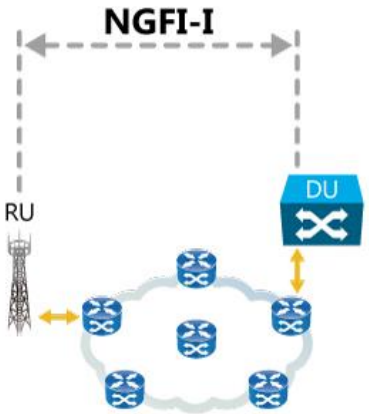


Figure 1 NGFI-I (Mobile Fronthaul) network

xRAN Over NGFI-I

The NGFI-I network segment between the RU (Remote Unit) and DU (Distributed Unit) is the most time-critical part of the wireline mobile network (between RU and CU (Central Unit)).
To manage traffic across the NGFI-I network, xRAN defines multiple traffic types, or profiles. These profiles are defined over different Ethernet layers and have different QoS (Quality of Service) requirements.

xRAN Profiles

The four defined xRAN profiles are C-plane, U-plane, S-plane and M-plane, which are used for transfer control, user data, synchronization, and management, respectively.
The C-and U-plane Ethernet stack shown in Figure 2 commonly uses a UDP (User Datagram Protocol) to carry eCPRI or RoE. If RoE is selected, it is carried over Ethernet L2 with a VLAN; eCPRI can be carried over Ethernet L2, or UDP. The C- and U-plane both have the highest priority via the VLAN (priority 7) and within the IP layer are defined as Expedited Forwarding.

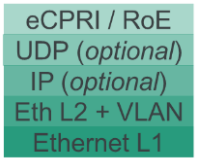


Figure 2
C and U plane stack

The S-plane Ethernet stack shown in Figure 3 uses Ethernet to carry PTP (Precision Time Protocol) and/or SyncE (Synchronous Ethernet) traffic so that end mobile elements are time synchronized. In 5G networks, it is very important that each RU, especially RUs in the same segment or adjoining segments (locations where UE (User Equipment) may be in contact with multiple RUs), is time synchronized, allowing the 5G network to maintain high throughput while downloading data from multiple RUs at once, or while transferring from one RU to another.

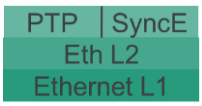


Figure 3
S-plane stack

The M-plane Ethernet stack shown in Figure 4 uses TCP (Transmission Control Protocol) to carry the management messages between the RU and DU. xRAN defines a NETCONF/YANG profile to be carried over this layer via SSH (Secure Shell), allowing communication between the RU and DU.

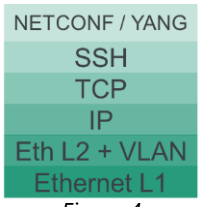


Figure 4
M-plane stack

QoS of xRAN Planes

Each of the xRAN planes has different QoS expectations over the NGFI-I network, which allows each FTN (Fronthaul Transport Node) to set the right priority across the network for every frame traversing the network. The FTNs' priority settings are via standard Ethernet Layer 2 and Layer 3 methods, allowing use of standard Ethernet network elements. But due to the FTNs' very tight timing and latency requirements, it is likely that only more modern elements will be viable options. Also, with discussions on NFV (Network Functions Virtualization) to dynamically control priority across NGFI networks, FTNs will probably have to support these functions.
Table 1 lists the xRAN priority settings for the different planes described above with the S-, U-, and C-plane having the highest priority, while the M-plane is much lower, with other traffic traversing the NGFI-I network at best effort.

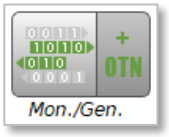
Table 1 xRAN QoS priorities

Plane	Eth L2 CoS (Priority–VLAN)	Eth L3 DSCP Code (hex value)
S-plane	Default: 7[*1]	N/A
U-plane	Default: 7	EF (Expedited Forwarding) – B8h
C-plane	Default: 7	EF (Expedited Forwarding) – B8h
M-plane	Default: 2	AF (Assured Forwarding) – 28h
Other traffic	Default: 1	BE (Best Effort) – 00h

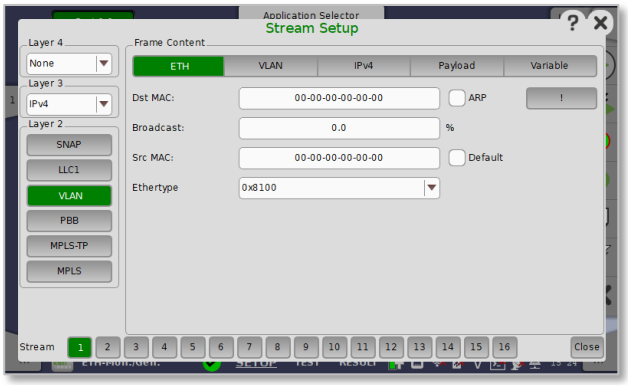
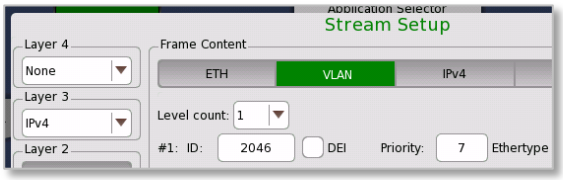
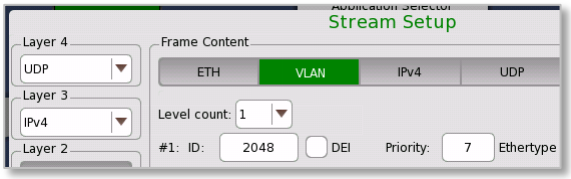
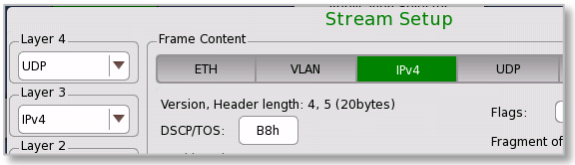
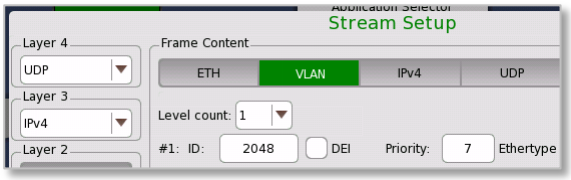
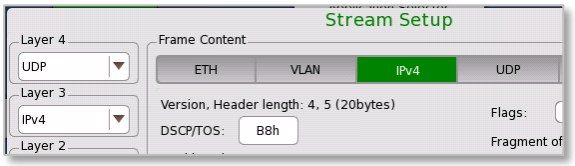
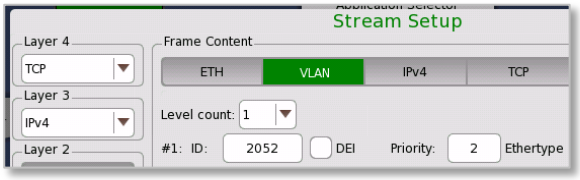
[*1]VLAN possible in future

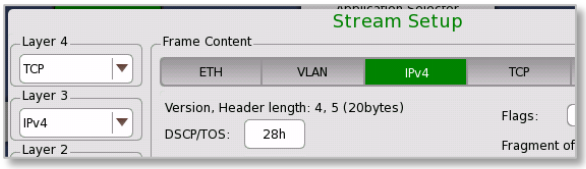
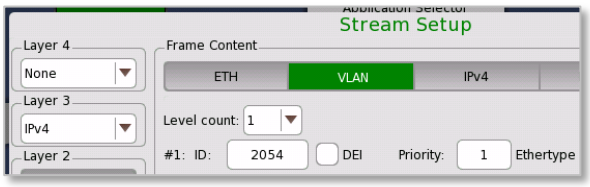
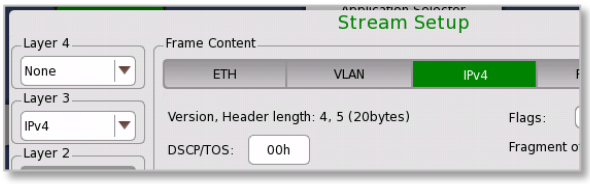
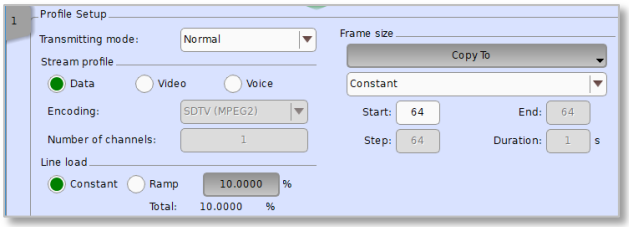
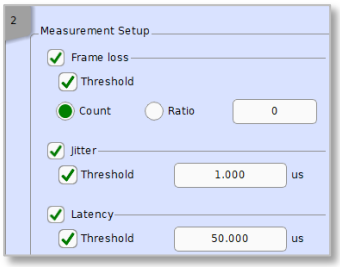
Testing NGFI-I

The Network Master Pro allows users to configure multiple Ethernet streams via the **Mon/Gen App**; each stream is fully independently configurable, including QoS settings. Configuring each stream independently can emulate each of the xRAN QoS settings, making it possible to confirm that FTNs are configured correctly for different traffic priorities across the NGFI network.

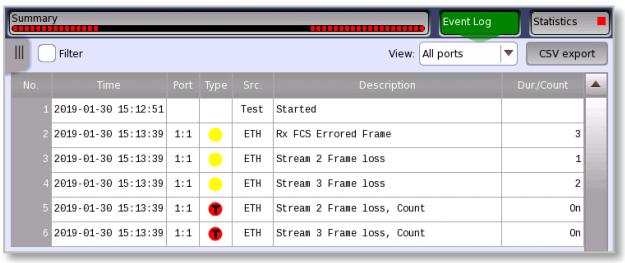


Configuring Network Master Pro

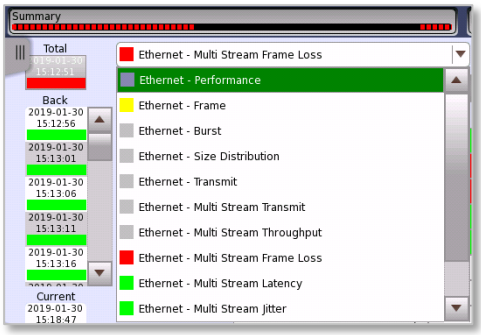
Selecting the Streams tab in the SETUP section supports quick configuration of each stream (up to 16 streams) via selecting the required stream button at the bottom. The MAC Src and Dst, IP Src and Dst as well as the VLAN must be configured as expected by the network. Sections can be added from the left panels for Layer 4, Layer 3, or Layer 2. Selecting the relative section in the Frame Content section allows access to full details.	
The example on the right shows **stream 1** configured as S-plane with a VLAN Priority of 7 (as per Table 1) and no IPv4 layer priority. ***Note:*** *VLAN ID must be configured per network requirements*	
The example on the right shows **stream 2** configured as U-plane with a VLAN Priority of 7 and UDP over IPv4. The DSCP within IPv4 has been configured to hex of B8 (Expedited Forwarding). ***Note:*** *VLAN ID must be configured per network requirements*	 
The example on the right shows **stream 3** configured as C-plane with a VLAN Priority of 7 and UDP over IPv4. The DSCP within IPv4 has been configured to hex of B8 (Expedited Forwarding). ***Note:*** *VLAN ID must be configured per network requirements*	 
The example on the right shows **stream 4** configured as M-plane with a VLAN Priority of 2 and TCP over IPv4. The DSCP within IPv4 has been configured to hex of 28 (Assured Forwarding).	

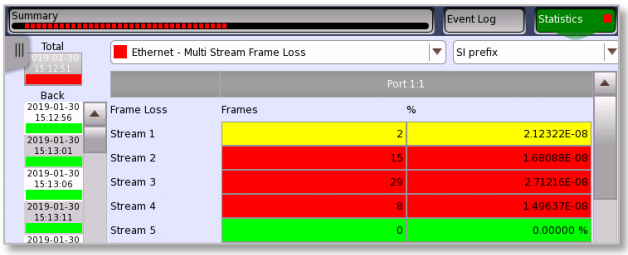
Note: *VLAN ID must be configured per network requirements*	
The example on the right shows **stream 5** configured as Other with a VLAN Priority of 1. The DSCP within IPv4 has been configured to hex of 00 (Best Effort). ***Note:*** *VLAN ID must be configured per network requirements*	 
Entering Stream – Profile under the TEST section enables configuration of the required Line load and frame size per stream. Turning on the Frame loss, Jitter and Latency sections with the Stream – Meas. section allows analysis of these results. It is also possible to set thresholds for these areas, simplifying analysis of results. On starting the test, all five streams will generate frames as per the above configuration, emulating real-world traffic across the NGFI-I network.	 

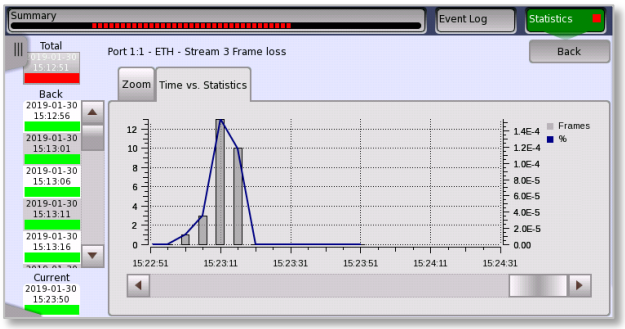
Reviewing Results on Network Master Pro

On starting measurement, the RESULT screen displays a Summary window, allowing the user to see critical information at-a-glance. Selecting the Stream Measurement pull-up tab shows summary details per stream. This is a quick and simple way to see the current overview status (outside Statistics) of each stream. The results for stream 5 are in gray, because a threshold was not configured for Latency or Jitter.	 
The Event Log tab gives a second-by-second overview of any errors or alarms as they happen on the link. The right figure shows a total of three FCS errors causing one lost frame in stream 2 and two lost frames in stream 3, resulting in streams 2 and 3 exceeding the specified frame loss count threshold.	

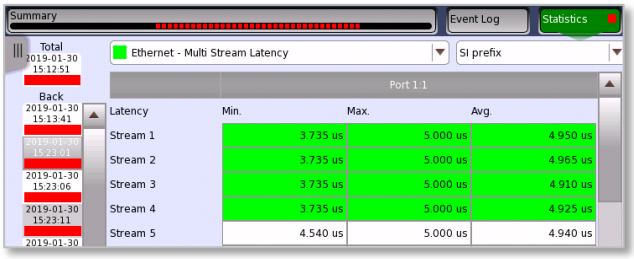
The Statistics tab gives better insight into errors, because it is divided into 5-second increments (default and configurable) across total test time.
Using the pull-down menu supports selection of the statistics section to focus on, and highlighting icons shows errors or exceeded thresholds.
Selecting Multi Stream Frame Loss here (with Total selected) gives a view of all errors during the total test time.
The top left tab shows the user Error or Alarm times (for quick troubleshooting).
Selecting any of the numeric sections provides a magnified or graphical view of selected results.
In the figure on the right, selected Stream 3 has a total of 29 lost frames during the test. Selecting the graph view shows when this frame loss was concentrated as well as the maximum per 5-second interval (13 lost frames).



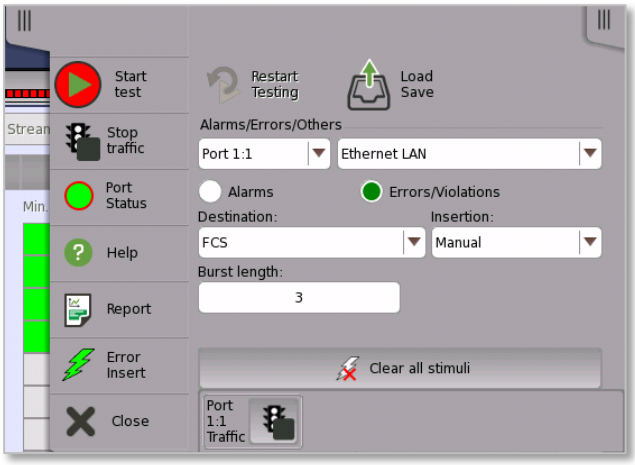




Latency is another key area of interest in 5G networks.
Selecting Multi Stream Latency displays the Min, Max, and Avg latency per stream on the network.
This can be viewed per interval (here the 15:23:01 time interval has been selected), which can also be displayed graphically.



When the test is stopped, all results are saved automatically (default). The user can save the results in multiple formats (Network Master Pro, PDF, or CSV) entering a preferred user name. The Network Master Pro format also allows for displaying results on a PC emulating display on the Network Master Pro.



Summary

The networks of tomorrow require very stringent QoS functions; to ensure they can manage real-world traffic correctly, it is more important than ever to test for compliance with required standards, such as IEEE 1914.1 and 802.1CM (for NGFI-I latency requirements), when configured for xRAN or O-RAN requirements.

References

IEEE 1914(Working Group) *http://sites.ieee.org/sagroups-1914*
IEEE Std 802.1CM™ *http://www.ieee802.org/1/pages/802.1cm.html*
- *IEEE Standard for Local and metropolitan area networks – Time-Sensitive Networks for Fronthaul.*

O-RAN Alliance *https://www.o-ran.org*
xRAN *http://www.xran.org*

Acronyms

5G	5th Generation (telecom network)	RoE	Radio over Ethernet
CU	Central Unit	RU	Remote Unit
DU	Distributed Unit	SSH	Secure Shell
FTN	Fronthaul Transport Node	SyncE	Synchronous Ethernet
NFV	Network Functions Virtualization	TCP	Transmission Control Protocol
O-RAN	Open Radio Access Network	UDP	User Datagram Protocol
PTP	Precision Time Protocol)	UE	User Equipment
QoS	Quality of Service	xRAN	x Radio Access Network

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