Application Note

Anritsu envision : ensure

1914.3 (RoE) and eCPRI Transport Testing

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

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Background

Test equipment requires upgrading to meet new requirements as operators migrate from CPRI/OBSAI MFH networks to the recently standardized 1914.3 (RoE) or eCPRI MFH networks. Along with the MFH reshaping comes the requirement for upgrading MBH; MFH and MBH are commonly called xHaul networks.
xHaul upgrades are required to meet high traffic demands, stricter timing requirements, and more stringent latency demands, so modern test equipment must evolve with these requirements.

MFH and MBH Networks

With new xHaul networks come very strict timing requirements for both accuracy (stability of time synchronization) and network latency. Allowing the mobile network to support very stringent URLLC and M2M demands places µs-level requirements on the transport network. Supporting this requires changes to the network architecture, splitting the work of the BBU into two sections a DU and a CU. Multiple DUs can work with the same CU depending on the traffic type. Testing these three key RU, DU, and CU elements, and more importantly the network elements between them is required because confirming the data-path performance is critical to ensuring network QoS.

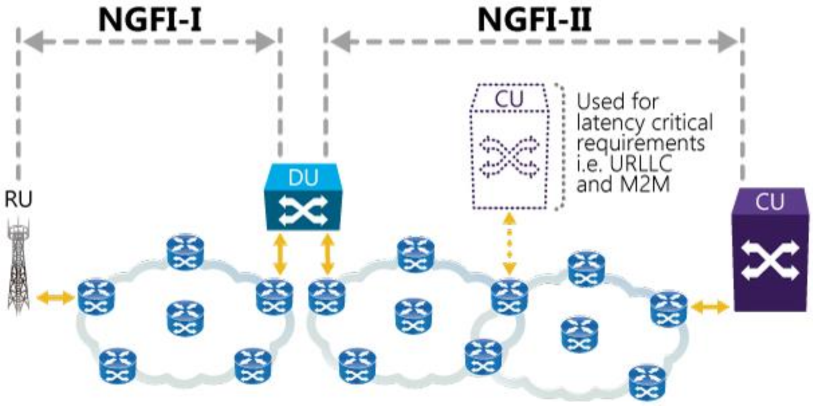

Figure 1 xHaul network with double split

NGFI-I

This section between the RU and DU commonly uses transport rates up to 25 Gbps with different transport technologies, which are commonly eCPRI or 1914.3 frame formats.

NGFI-II

This section between the DU and CU commonly uses transport rates up to 100 Gbps often over DWDM or CWDM links with a currently unconfirmed transport technology (at early 2018), but could use the 1914.3 frame format.

Testing xHaul (MFH/MBH) Networks

There are several tests that should be performed on these types of networks. A couple of very critical areas timing and latency have much tighter requirements than traditional networks. These two areas are critical because the data throughput drops significantly if the timing at the two RUs is not the same as the 5G device moves from one RU to another, because the data transfer to the 5G device is via TDD over the air interface.

Timing

With extremely high accuracy required at the RU and many RUs unable to have a direct GNSS connection, 5G networks must often carry the network timing over Ethernet frames. This is commonly completed via one or several of the IEEE (802.1CM™/1588v2™) and ITU-T (G.826x/G.827x) protocol standards, commonly grouped under the terms PTP or PTP & SyncE.

Any Ethernet license on the Network Master Pro includes the ability to generate and analyze PTP and SyncE, allowing both testing during installation of all network elements (switches and routers) and connection of 5G elements (CU, DU, or RU) to confirm timing accuracy in this critical area of the network.

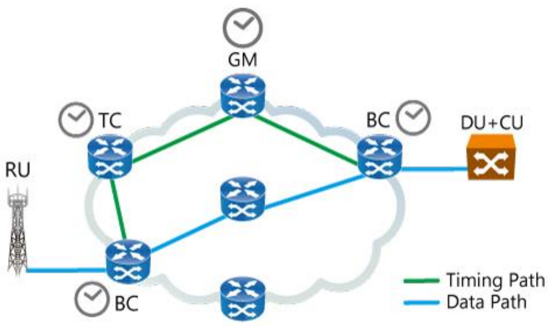

Figure 2 Network timing and data paths

Since network time is often not delivered over the same path as traffic (Figure 2), it is critical to test each network element is capable of distributing very accurate timing. This can be achieved by terminating with a Network Master Pro at key points in the network to replace the CU, DU, or RU and confirm:

- 1PPS accuracy over time
    - Connecting the Network Master Pro to any network element allows the user to confirm whether the network can transfer the phase accurately across the network.
    - This is achieved by comparing the phase of the signal received across the network from the Grand Master clock against the Network Master Pro with installed High Performance GPS Disciplined Oscillator Module MU100090A.
    - The 1PPS results presented as the max|TE|, cTE, and dTE give the operator insight to all required Time Error details occurring during the test.

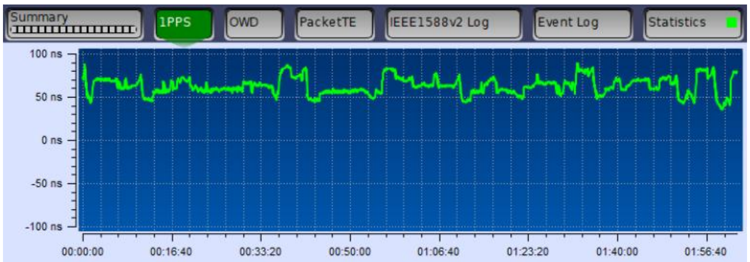

Figure 3 Network Master Pro time error

- Master Port Time Transfer Error (Terr) measurement over time
    - Terr can also be measured while measuring 1PPS. This is calculated by monitoring the timestamp within each received PTP message and then comparing this time against the Network Master Pro reference time, also called "two-way time error".
    - Terr measurement allows observation of how accurately the network distributes time at the network edge without access to a 1PPS signal.

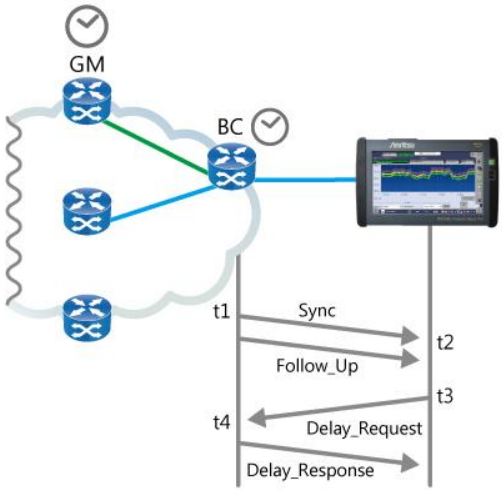

Figure 4 Network Master Pro Terr measurement

LTE-TDD transport networks require a timing accuracy at the network edge (UNI) of 1.1 µs referenced to UTC via GNSS. In 5G use cases, such as MIMO and TX diversity, the required accuracy is even more stringent with requirements of 200 ns, 70 ns, or 20 ns within an antenna cluster, and the reference timing coming from the local MFH segment, not via GNSS. Although each section (NGFI-x) has different timing requirements, it is very likely the full network will have to comply with the more stringent requirements because RUs are likely to be placed at all network access points. This is completely dependent on the network architecture, which will depend on many factors, such as traffic density.

Latency

Latency across the network is almost as critical as timing and has become far more important in 5G networks because devices are placing strict latency requirements on the network. These devices are commonly placed into two main M2M and URLLC groups, which depending on the application require sub-1 ms latency, leaving sub-100 µs latency end-to-end across the NGFI-I network.
Ideally, testing one-way latency across the network would require two testers both synchronized via GNSS.

- Completing BER test over RoE or eCPRI
    - Replacing the RU, CU, or DU with a Network Master Pro at strategic points in the network (Figure 1) allows a field engineer to measure latency across the network accurately.
    - It is important to configure the BER test to use the same protocols as the end devices (that they are replacing) because the network can be configured for different

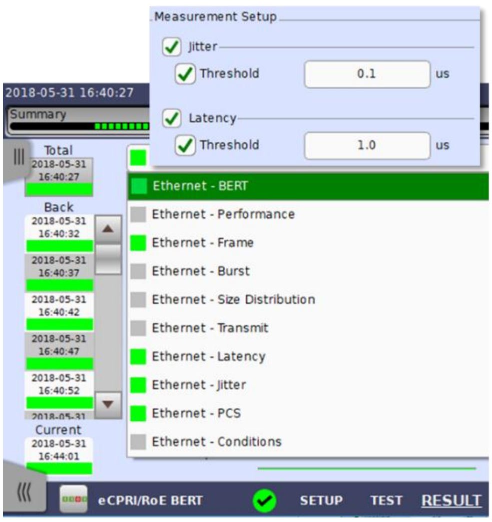

Figure 5 Network Master Pro RoE/eCPRI BERT testing latency and jitter

priorities based on the RoE or eCPRI protocols in use. Network slicing is seen as a key function of 5G networks to optimize network bandwidth and configure priorities across the network.

- Measuring jitter and latency across RoE and eCPRI networks will be key to confirming network performance issues. Also confirming that the latency result does not change under high throughput is another key to ensuring the network can scale to tomorrow's 5G requirements.

Routing

CPRI is a Point-to-Point non-routed protocol, while both 1914.3 (RoE) and eCPRI are based on routable Ethernet frames. Consequently, ensuring network connectivity requires testing the end-to-end connection using the 1914.3 (RoE) or eCPRI framed header. Since NGFI-I and NGFI-II can be routed across multiple network connections each with multiple traffic streams from different end points, confirming end-to-end connectivity with a low BER ensures network connection stability.

Network Switching Time

Since timing and latency are so critical, especially within NGFI-I networks, the ability to test network recovery time from a failure is also critical.
When an RU is not connected for some defined time, the CU can take that RU offline permanently, causing roll-on effects on loading of other nearby RUs and affecting user throughput.
This requires testing the time a network takes to switch from a break until fully restored (called service disruption time), enabling the operator to ensure the network can recover within the required time and minimizing customer downtime.
Completing a service disruption time test for RoE or eCPRI using the Network Master Pro is the same as completing it over Ethernet. Simply select the option to turn it on and set the defined service disruption, such as "lost packets greater than count x", or "LOS for longer than time x". The results not only display the count/time but are also highlighted in green or red, based on the settings.

Figure 6 Network Master Pro interface for Service Disruption Time

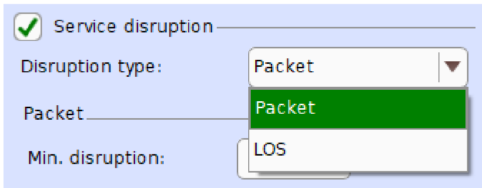

Figure 7 Service Disruption Time settings

Summary

With the move to more complicated xHaul networks utilizing CU, DU, and RU elements within a routed network, comprehensive testing is required to ensure network reliability. This makes for a much more complex transport network in combination with end devices, placing even more stringent demands on areas such as network timing and latency.
Many people talk about how good or bad their mobile connection is, but the mobile connection will always seem to be not up to the expected standard without a strong and reliable wired network behind it.

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OBSAI http://www.obsai.com

Acronyms

5G	5th Generation (telecom network)
BBU	Base-Band Unit
BC	Boundary Clock
BER	Bit Error Rate
CPRI	Common Public Radio Interface
CU	Central Unit
cTE	constant Time Error
DU	Distributed Unit
dTE	dynamic Time Error
eCPRI	e Common Public Radio Interface
GM	Grand Master Clock
GNSS	Global Navigation Satellite System
LOS	Loss of Signal
M2M	Machine to Machine
max|TE|	maximum Time Error
MBH	Mobile Back Haul
MFH	Mobile Front Haul
NGFI	Next Generation Fronthaul Interface
OBSAI	Open Base Station Architecture Initiative
OWD	One Way Delay
PPS	Pulse Per Second
PTP	Precision Time Protocol
QoE	Quality of Experience
RoE	Radio over Ethernet (IEEE 1914)
RRH	Remote Radio Head
SyncE	Synchronous Ethernet
TC	Transparent Clock
TDD	Time Division Duplex
UNI	User Network Interface
URLLC	Ultra-Reliable Low Latency Communications

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• **United States**
Anritsu Company
450 Century Parkway, Suite 190, Allen,
TX 75013 U.S.A.
Toll Free: +1-800-267-4878
Phone: +1-972-644-1777

• **Canada**
Anritsu Electronics Ltd.
700 Silver Seven Road, Suite 120, Kanata,
Ontario K2V 1C3, Canada
Phone: +1-613-591-2003
Fax: +1-613-591-1006

• **Brazil**
Anritsu Eletronica Ltda.
Praça Amadeu Amaral, 27 - 1 Andar
01327-010 - Bela Vista - Sao Paulo - SP
Brazil
Phone: +55-11-3283-2511
Fax: +55-11-3288-6940

• **Mexico**
Anritsu Company, S.A. de C.V.
Blvd Miguel de Cervantes Saavedra #169 Piso 1, Col. Granada
Mexico, Ciudad de Mexico, 11520, MEXICO
Phone: +52-55-4169-7104

• **United Kingdom**
Anritsu EMEA Ltd.
200 Capability Green, Luton, Bedfordshire, LU1 3LU, U.K.
Phone: +44-1582-433200
Fax: +44-1582-731303

• **France**
Anritsu S.A.
12 avenue du Québec, Bâtiment Iris 1- Silic 612,
91140 VILLEBON SUR YVETTE, France
Phone: +33-1-60-92-15-50
Fax: +33-1-64-46-10-65

• **Germany**
Anritsu GmbH
Nemetschek Haus, Konrad-Zuse-Platz 1
81829 München, Germany
Phone: +49-89-442308-0
Fax: +49-89-442308-55

• **Italy**
Anritsu S.r.l.
Via Elio Vittorini 129, 00144 Roma, Italy
Phone: +39-6-509-9711
Fax: +39-6-502-2425

• **Sweden**
Anritsu AB
Isafjordsgatan 32C, 164 40 KISTA, Sweden
Phone: +46-8-534-707-00

• **Finland**
Anritsu AB
Teknobulevardi 3-5, FI-01530 VANTAA, Finland
Phone: +358-20-741-8100
Fax: +358-20-741-8111

• **Denmark**
Anritsu A/S
Torveporten 2, 2500 Valby, Denmark
Phone: +45-7211-2200
Fax: +45-7211-2210

• **Russia**
Anritsu EMEA Ltd.
Representation Office in Russia
Tverskaya str. 16/2, bld. 1, 7th floor.
Moscow, 125009, Russia
Phone: +7-495-363-1694
Fax: +7-495-935-8962

• **Spain**
Anritsu EMEA Ltd.
Representation Office in Spain
Edificio Cuzco IV, Po. de la Castellana, 141, Pta. 5
28046, Madrid, Spain
Phone: +34-915-726-761
Fax: +34-915-726-621

• **United Arab Emirates**
Anritsu EMEA Ltd.
Dubai Liaison Office
902, Aurora Tower,
P O Box: 500311- Dubai Internet City
Dubai, United Arab Emirates
Phone: +971-4-3758479
Fax: +971-4-4249036

• **India**
Anritsu India Private Limited
6th Floor, Indiqube ETA, No.38/4, Adjacent to EMC2,
Doddanekundi, Outer Ring Road, Bengaluru – 560048, India
Phone: +91-80-6728-1300
Fax: +91-80-6728-1301

• **Singapore**
Anritsu Pte. Ltd.
11 Chang Charn Road, #04-01, Shriro House
Singapore 159640
Phone: +65-6282-2400
Fax: +65-6282-2533

• **P.R. China (Shanghai)**
Anritsu (China) Co., Ltd.
Room 2701-2705, Tower A,
New Caohejing International Business Center
No. 391 Gui Ping Road Shanghai, 200233, P.R. China
Phone: +86-21-6237-0898
Fax: +86-21-6237-0899

• **P.R. China (Hong Kong)**
Anritsu Company Ltd.
Unit 1006-7, 10/F., Greenfield Tower, Concordia Plaza,
No. 1 Science Museum Road, Tsim Sha Tsui East,
Kowloon, Hong Kong, P.R. China
Phone: +852-2301-4980
Fax: +852-2301-3545

• **Japan**
Anritsu Corporation
8-5, Tamura-cho, Atsugi-shi, Kanagawa, 243-0016 Japan
Phone: +81-46-296-6509
Fax: +81-46-225-8352

• **Korea**
Anritsu Corporation, Ltd.
5FL, 235 Pangyoyeok-ro, Bundang-gu, Seongnam-si,
Gyeonggi-do, 13494 Korea
Phone: +82-31-696-7750
Fax: +82-31-696-7751

• **Australia**
Anritsu Pty. Ltd.
Unit 20, 21-35 Ricketts Road,
Mount Waverley, Victoria 3149, Australia
Phone: +61-3-9558-8177
Fax: +61-3-9558-8255

• **Taiwan**
Anritsu Company Inc.
7F, No. 316, Sec. 1, NeiHu Rd., Taipei 114, Taiwan
Phone: +886-2-8751-1816
Fax: +886-2-8751-1817

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