The Evolving Hyperscaler/ Cloud-based Telecom Networks:
Design and Testing Challenges

White paper

Introduction

The evolution of wireless technology to 5G and beyond with synergistic expansion of use cases into new verticals, such as autonomous vehicles, telemedicine, smart manufacturing, and smart grids, is having a disruptive change on network design. Mobile operators now share network responsibilities with hyperscalers and other third parties utilizing private 5G networks. A new "open" and collaborative approach to network testing is required to verify that key performance indicators (KPIs) are met consistently.

Perhaps the biggest disruptor in this New World Order of public and private networks is the rise of hyper scale data centers. By 2026, hyperscalers will operate well over 1,000 such data centers, which are categorized as facilities with more than 5,000 servers and 10,000 square feet, according to Synergy Research Group (figure 1).

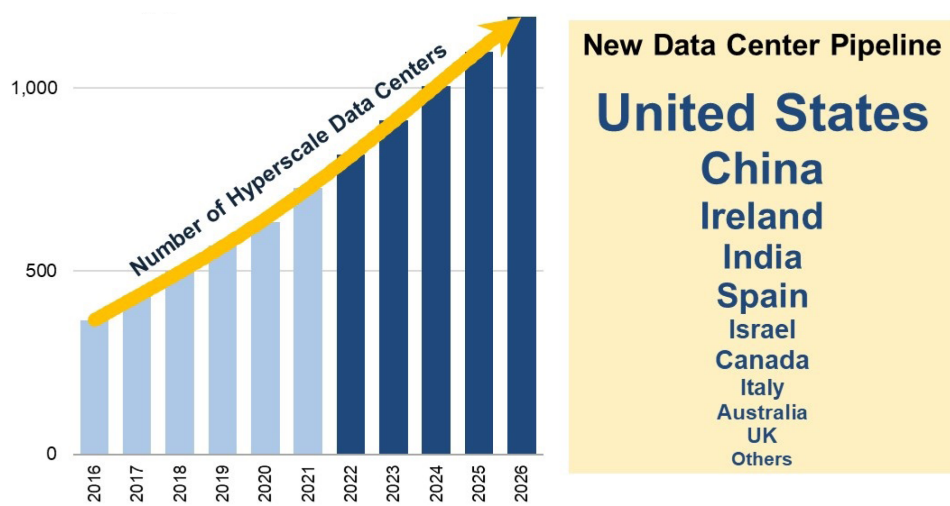

Figure 1: *Hyperscale data centers will exceed well over 1,000 by 2026.*
(Courtesy of Synergy Research Group.)

Open Radio Access Network (O-RAN) and cloud computing play prominent roles in hyperscale data centers. The integration of open systems and the cloud help give such enormous facilities the necessary agility to scale and add compute power to meet varying load requirements, as well as extend out to the network edge.

Network Design Evolution

This new approach is a far cry from how networks have historically been designed and operated. In traditional networks, the mobile operators owned all the assets. They controlled the RF spectrum that transmitted the data, as well as the data itself. Figure 2 showcases how the traditional radio access network (RAN) operated in 3G and 4G. It consists of the baseband unit, remote radio heads, radio, and antennas.

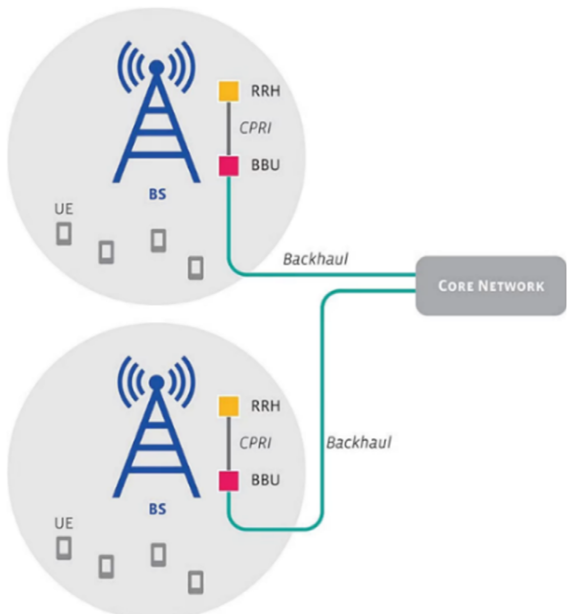

Figure 2: *Traditional mobile network in which the operator owned all assets.*

Such legacy architectures have been in operation for two decades, however, so they are not suited for 5G. They cannot meet the current and emerging dynamic, application-driven use cases, just as mobile devices from that period are incapable of operating in a 5G world.

5G network designs (figure 3) utilize a distributed unit (DU) and centralized unit (CU) in the RAN. The CU supports higher layer protocols, such as Service Data Adaptation Protocol (SDAP), Packet Data Convergence Protocol (PDCP), and Radio Resource Control (RRC). Lower layer protocols are handled by the DU. These include Radio Link Control (RLC), Medium Access Control (MAC), and Physical layers..

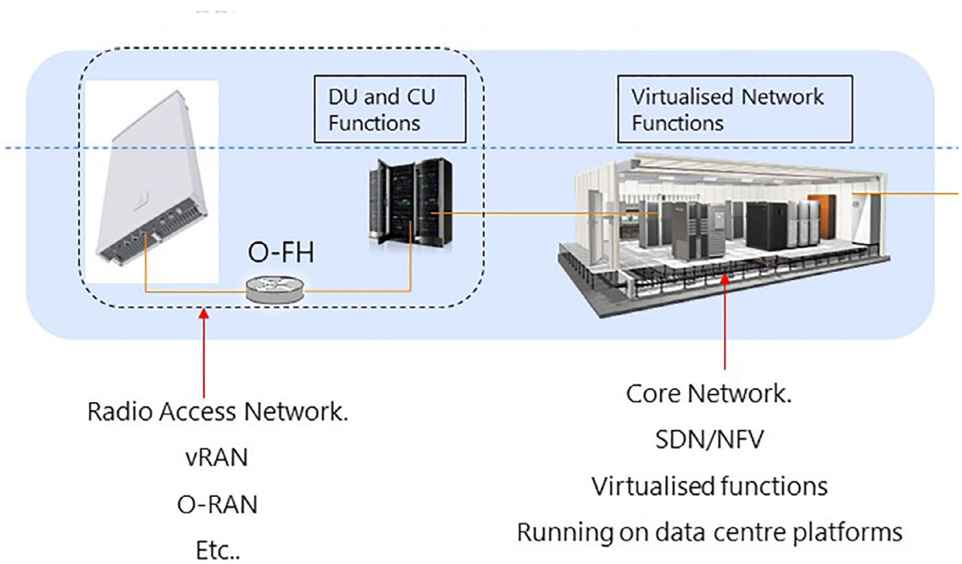

Figure 3: *5G networks split the distributed unit and centralized unit.*

Splitting the CU and DU helps 5G meet its three main use cases – enhanced Mobile Broadband (eMBB), Ultra Reliable Low Latency Connection (URLLC), and massive Machine Type Connection (mMTC) – to fulfill its performance specifications. It aids in network scalability and simplifies coordination of performance features, load management, and real-time performance optimization. Splitting the CU and DU also aids in ensuring 5G networks are cost efficient.

The Rise of Hyperscalers

The data explosion that is being created by 5G has also influenced the near meteoric rise of hyperscale infrastructure. Managed by global companies such as Google, Microsoft, Amazon, and IBM, these data centers are classified by more than massive amounts of servers and square footage. Network speed and agility are also imperative. A recent survey noted that 93% of hyperscalers expect network connections of 40 Gbps or faster. Respondents also stated that networks must also meet the challenges of increased data storage.

Hyperscale data centers have distinctly different design and management issues to support the enormous data, storage, and scalability of today's use cases. For example, hyperscalers rely on much more than vast amounts of servers to satisfy need. Hyperscale data centers are also leveraging automation, software-defined infrastructure, and machine learning to optimize operation. Hyperscalers have quickly adopted Multi-access Edge Computing (MEC) solutions that push compute functions, which traditionally have been conducted in the data center, to the network edge. By doing so, hyperscalers can best meet the demand for continued emergence of high-speed and data-intensive use cases, especially those that are mission-critical.

Benefits of the Move to the Edge

MEC reduces round-trip latency by processing and storing data at the network edge. Latency-tolerant workload tasks, as well as similar bulk or batch processes, reside in the centralized cloud. Edge computing provides a number of benefits:

- Network load is reduced
- Data transmission to the user is improved
- Enhanced network scalability
- Faster processing
- Bandwidth on existing network is preserved
- Improved security and privacy

More than reduced latency is achieved by bringing the network closer to the end user. It also optimizes routing to ensure the shortest path between the user or device and the edge compute environment is used. Additionally, the distance between the device making the request and the servers responding to it is optimized through MEC.

There are two types of MEC:

Public MEC – All compute and storage resources are at the edge of a public wireless network provided by a mobile operator. It establishes an IT service environment and cloud-computing capabilities at the network edge for the larger general population.

Private MEC – Has similar compute and storage resources as the public option but is co-located with a dedicated onsite 5G RAN (aka private 5G). Combining the RAN, compute, storage and devices onpremises supports ultra-critical and latency-sensitive applications. Security is also enhanced using a private MEC.

To ensure edge performance, mobile operators must conduct Precision Time Protocol (PTP) and optical time-domain reflectometer (OTDR) measurements. An OTDR is an optoelectronic instrument used to characterize an optical fiber. PTP is a protocol used to synchronize clocks throughout a computer network and is defined in IEEE 1588 as Precision Clock Synchronization for Networked Measurements and Control Systems. A test solution, such as the Anritsu Network Master™ Pro MT1000A, can conduct time error PTP wander measurements. PTP wander is a key index expressing long-term time synchronization stability to ensure network quality meets the specifications for emerging use cases.

Figure 4 shows how to measure PTP protocol and time error in a network. The MT1000A conducts time error measurements to ensure packet latency asymmetry and variation.

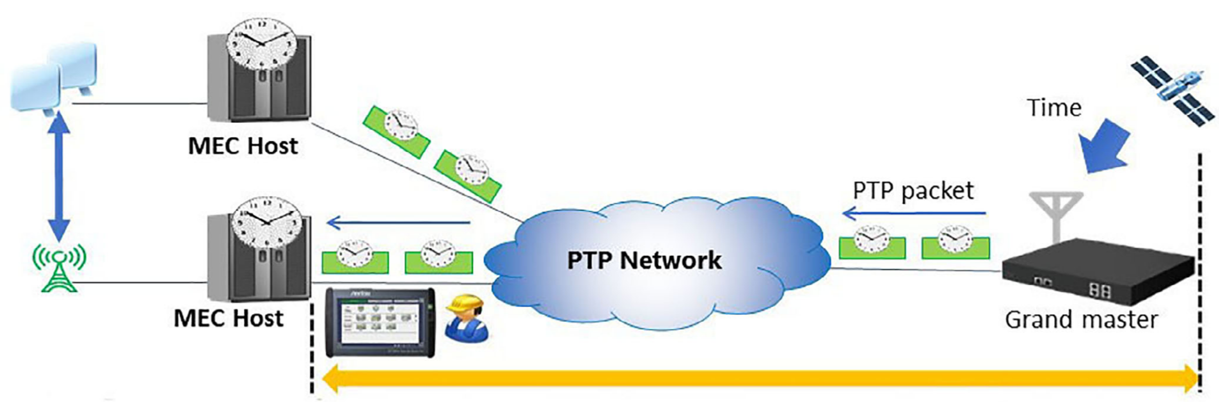

Figure 4: *Using the MT1000A to conduct PTP protocol and time error.*

Why Open Architectures are Necessary

Legacy RANs were designed using only 3GPP standards as the blueprint. Mobile operators integrated RAN equipment with various network elements from designated vendors into their networks. Further constricting flexible network design was that equipment vendors optimized performance by combining and tuning multiple elements themselves. Such a business model limited the ability for mobile operators to configure and procure RAN equipment from multiple vendors.

A similar "closed" design approach is not preferred with 5G, as wider coverage and more services need to be offered to customers economically. The result is a paradigm shift whereby hyperscalers, mobile operators and others in the industry are developing open specifications supplementing the 3GPP standards.

Open system designs are truly necessary as the networks are being built on hyperscaler clouds and utilized by operators and third parties with private 5G networks. While the quest is to create a much freer environment in which multiple vendors can be used and networks become more flexible to meet ever-changing conditions, there still must be structure. The O-RAN ALLIANCE, of which Anritsu is a member, is the stabilizing influence in this new open world.

The open architecture established by the O-RAN ALLIANCE (figure 5) has two sides. The radio element includes Near-RT RIC, O-CU-CP, O-CU-UP, O-DU, and O-RU. On the management side is the Service Management and Orchestration Framework that contains a Non-RT-RIC function.

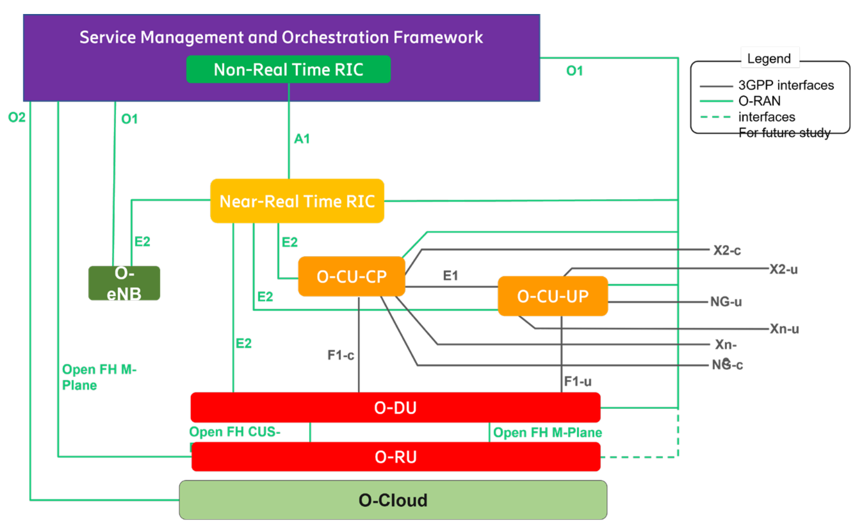

Figure 5: *Overview of the O-RAN architecture.*

Creating an open environment will do more than bring greater competition for cost efficiencies. It will help create flexibility, so networks can move to the edge and be spliced for specific use cases and customers.

Value of Network Slicing

5G network slicing is a network architecture that enables the multiplexing of virtualized and independent logical networks on the same physical network infrastructure. Each network slice is an isolated end-to-end network tailored to fulfil diverse requirements requested by a particular application.

The evolving mobile network integrates network slicing, to help operators optimize return on investment (ROI) on their massive 5G expenditures. Framework for network slicing was a major addition to the 5G Standalone (SA) standards. The architecture allows multiple virtual private networks to be overlaid on a shared network. By doing so, network slicing enables operators to spread dedicated network access across more private network verticals to create new revenue streams.

Slices can be allocated based on specific application, use case, or customer. Operators must establish Service Level Agreements (SLAs) when allocating network slices to truly optimize the business opportunity. SLAs specify requirements of the traffic class, enterprise customer, mission critical application, and/or KPIs that are agreed to by both parties.

Mobile operators must manage all SLAs, adding a new challenge than they historically had to consider. Because each network slice has specific specifications and requirements, quality of service (QoS), security, and allocation of dynamic resources also must be monitored and managed independently. For these reasons, on-going end-to-end testing of the network takes on greater importance with 5G networks.

The Anritsu Radio Communication Test Station MT8000A is able to simulate the base station and the core network to enable testing of device connectivity on network slices in terms of device integration tasks, including provisioning and slice selection.

Creating a Cloud Environment

Often synonymous with edge cloud computing, cloud infrastructure is its own standalone technology to aid in 5G. Cloud environments can bring considerable applicable-ready data to the edge but they can also bring benefits to the network core. In either scenario, cloud infrastructure provides several benefits to mobile operators and hyperscalers, including:

- Lower infrastructure costs due to shared resources
- Easy to scale network
- Applications can be deployed faster and easily
- More efficient management and operations

Three common cloud deployments exist:

Telco Cloud Deployment (figure 6) – A traditional mobile operator owns the edge cloud and core cloud while the hyperscaler owns the data cloud.

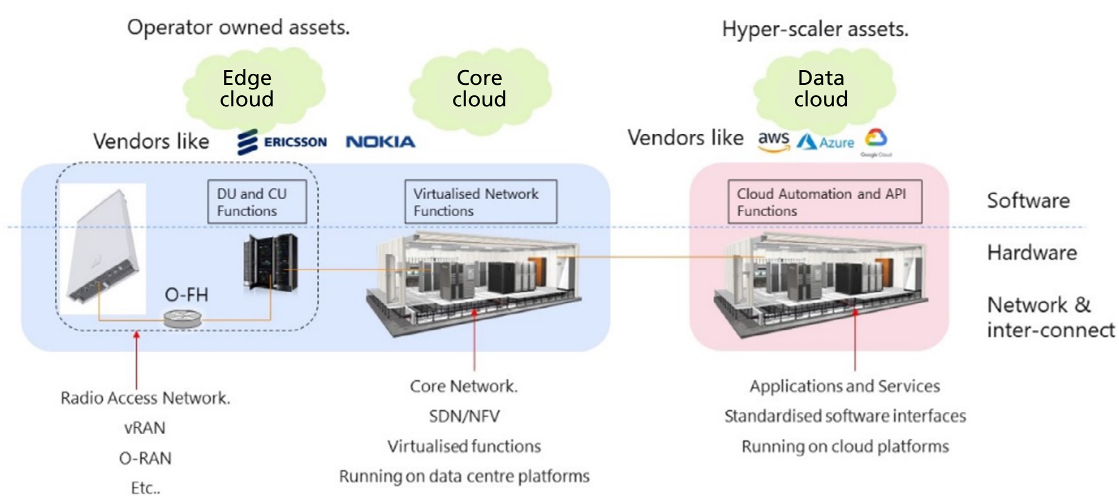

Figure 6: *Traditional telco cloud deployment*

Hyperscale Hosted (figure 7) – In this scenario, the data gets closer to the edge, as the hyperscalers own the core and data assets. The software remains with the mobile operators but the hardware is owned by the hyperscalers.

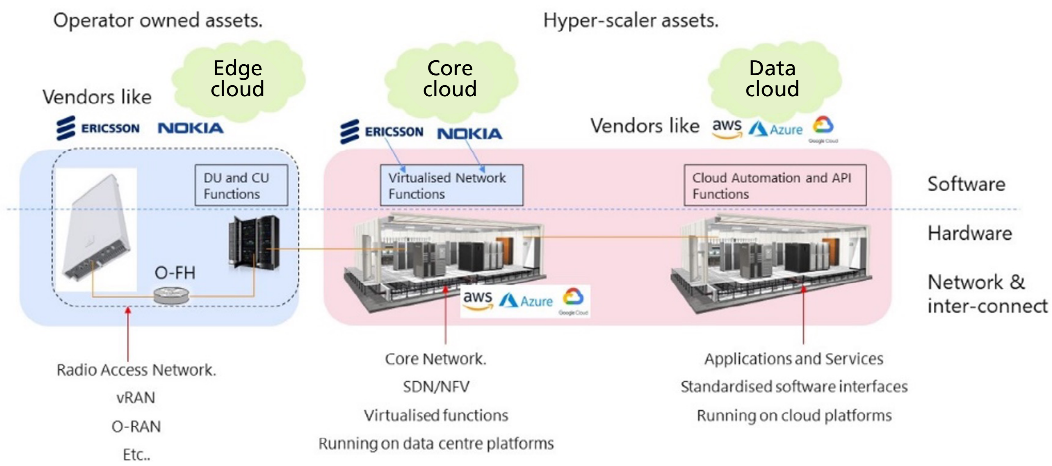

Figure 7: *Example of a hyperscale hosted cloud environment.*

Hyperscale Hosted Private Network (figure 8) – The hyperscalers add DU and CU functions, leaving only the RAN with the private network operator or enterprise.

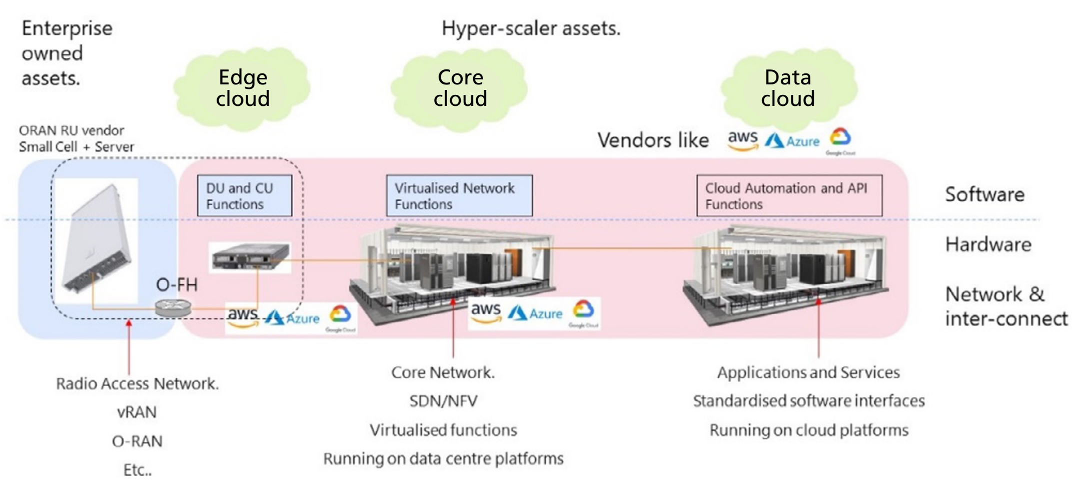

Figure 8: *A hyperscale hosted private network.*

Cloud services provided by hyperscalers come in many different flavors. The combinations are based on capability, deployment, and required resources.

Capabilities – CPU resources are within the data center and containers and virtual machines execute the code. As it relates to storage, the memory resources area is within the data center. Database creation and management, and data storage/retrieval/analytics are provided by the hyperscaler. The network backbone links data centers and can be extended into customer premises and local access, as necessary.

Deployment – A public cloud has shared resources for storage and computing. Those resources are allocated dynamically and users don't control their location. In a private cloud, storage and computing have dedicated resources. Hardware is usually reserved for the user, as well. All resources are usually allocated on a fixed basis with specific location and resources reserved for use.

Resource Location – Shared storage and computing are typically located in a central data center with shared hardware and infrastructure. Resources are usually at a specific location within exclusive infrastructure for edge locations. Resources located on customer premises are connected to hyperscaler infrastructure and typically managed by a hyperscaler. The latter is normally associated with a private cloud.

Keeping Networks Up to Specification

As the networks become more open, testing must evolve. There is a greater need to conduct end-toend testing to measure KPIs, such as throughput and latency. Regular and accurate testing can also help achieve lower total cost of ownership (TCO).

As we have noted, latency is a key test for 5G networks. When conducting URLLC measurements, it is important to remember there are two types of latency. Round trip latency is the time it takes for data to travel from the terminal back to the server. One-way latency is the time necessary for data to travel from the terminal to the server.

Round trip latency can be measured using the PC-based ping technique. It is a lower cost alternative but has difficulty accurately measuring high-accuracy latency and packet jitter, due to its 1-ms to 100-us order accuracy. Ping is also not true measurement of latency, especially under load as it measures using Internet Control Message Protocol (ICMP), which exercises the network layer as opposed to the transport layer. The MT1000A, we can use UDP or TCP packets which are at the transport layer.

Therefore, a better approach is to use a dedicated test instrument, such as the MT1000A with a reflector application (figure 9). With such a solution, round trip latency is measured by starting the reflector application in the far-end MT1000A. The primary MT1000A can start the far-end secondary MT1000A using an in-band control function. Consequently, round trip latency can be accurately measured without controlling the far-end secondary MT1000A.

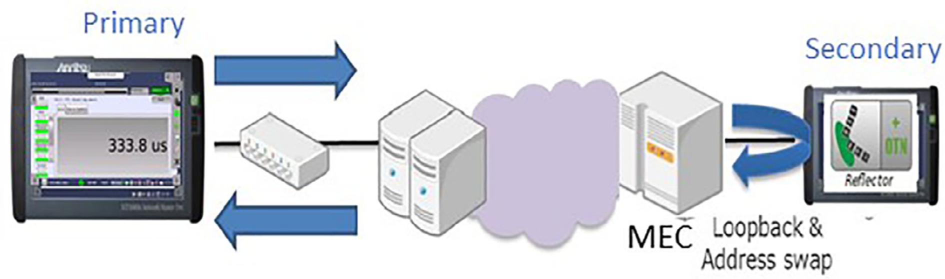

Figure 9: *Example of measuring round trip latency using two optical test solutions.*

The MT1000A also helps conduct key one-way latency tests through various MEC implementations that are critical for applications that require URLLC. Figure 10 shows how the MT1000A can synchronize the time between the three units using GPS receivers. Using this configuration, it is possible to measure the one-way latency between segments in different buildings or countries. Moreover, if an inside measurement must be made but GPS time synchronization cannot be obtained, latency can be measured in a holdover state by acquiring GPS synchronization in advance.

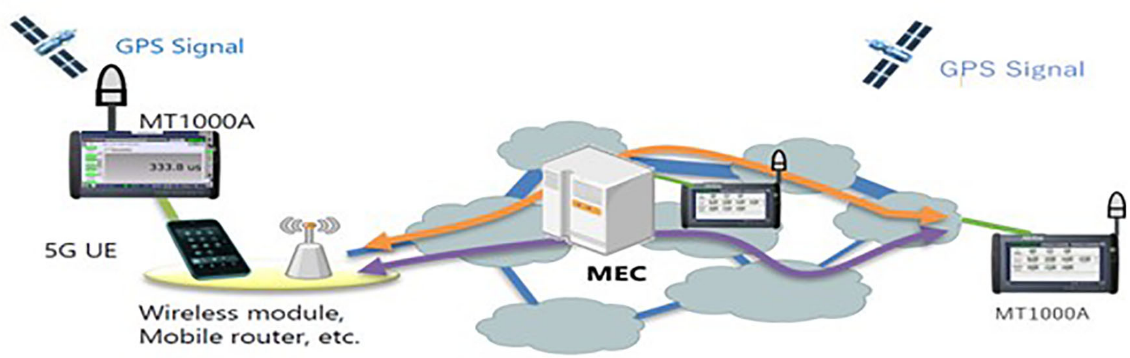

Figure 10: *Example of a one-way latency measurement on a MEC.*

Because of the open environments, interoperability testing has gained greater importance. Tests need to be made on Small Form Factor Pluggable (SFP) interconnects, as well as transport measurements. Connectivity measurements such as these made with an integrated BERT-based solution, including the Anritsu Signal Quality Analyzer-R MP1900A and BERTWave™ MP2110A, are necessary to ensure the data center infrastructure can meet network demands.

Conclusion

Various technologies, open architectures, and cloud environments are changing network designs to meet the explosion in data being created by 5G and beyond. To optimize this new era of networking, mobile operators, hyperscalers, and other providers must implement advanced testing processes. It goes beyond individual instruments, as partnering with a test provider active in global standards organizations and who develops solutions at every stage of the ecosystem is necessary for optimal ROI.

Advancing beyond

Specifications are subject to change without notice.

• **United States**
Anritsu Company
450 Century Pkwy, Suite 109,
Allen, TX, 75013 U.S.A.
Toll Free: 1-800-267-4878
Phone: +1-972-644-1777
Fax: +1-972-671-1877

• **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 Electrônica 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.
Av. Ejército Nacional No. 579 Piso 9, Col. Granada
11520 México, D.F., México
Phone: +52-55-1101-2370
Fax: +52-55-5254-3147

• **United Kingdom**
Anritsu EMEA Ltd.
200 Capability Green, Luton, Bedfordshire LU1 3LU, U.K.
Phone: +44-1582-433280
Fax: +44-1582-731303

• **France**
Anritsu S.A.
12 avenue du Québec, Batiment 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: +39-06-509-9711
Fax: +39-06-502-2425

• **Sweden**
Anritsu AB
Kistagången 20B, 164 40 KISTA, Sweden
Phone: +46-8-534-707-00
Fax: +46-8-534-707-30

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

• **Denmark**
Anritsu A/S
Kay Fiskers Plads 9, 2300 Copenhagen S, 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
P O Box 500413 - Dubai Internet City
Al Thuraya Building, Tower 1, Suite 701, 7th floor
Dubai, United Arab Emirates
Phone: +971-4-3670352
Fax: +971-4-3688460

• **India**
Anritsu India Pvt Ltd.
2nd & 3rd Floor, #837/1, Binnamangla 1st Stage,
Indiranagar, 100ft Road, Bangalore - 560038, India
Phone: +91-80-4058-1300
Fax: +91-80-4058-1301

• **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.
27th Floor, Tower A,
New Caohejing International Business Center
No. 391 Gui Ping Road Shanghai, Xu Hui Di District,
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: +81-46-225-8359

• **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

12-2022 The Evolving Hyperscaler/Cloud-based Telecom Networks (1.0)