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Profit Telecom Day

5G Network Latency and Time Synchronization ZR/ZR+ Transceivers for Data Center Interconnect

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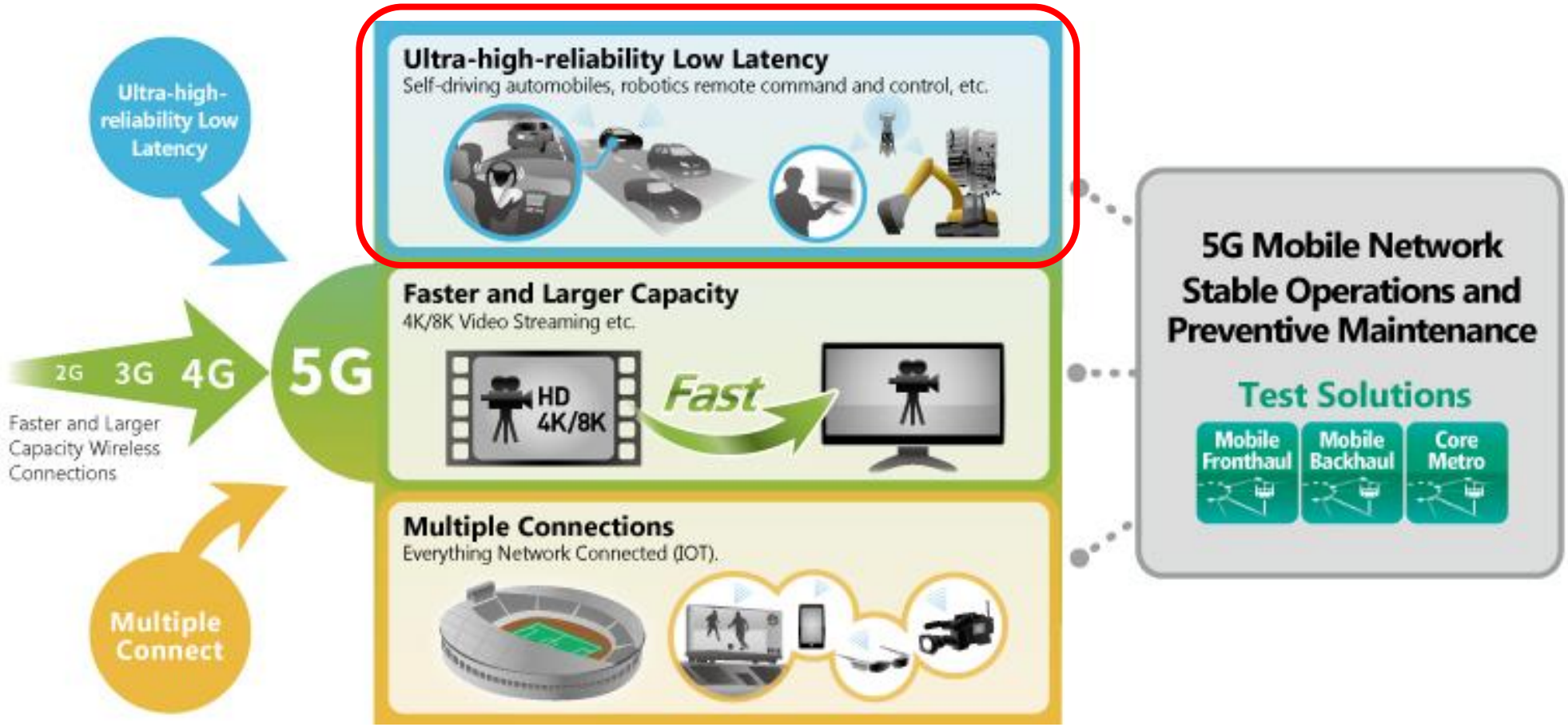
Latency and Synchronization Matters

5G Network Pillars: Low Latency

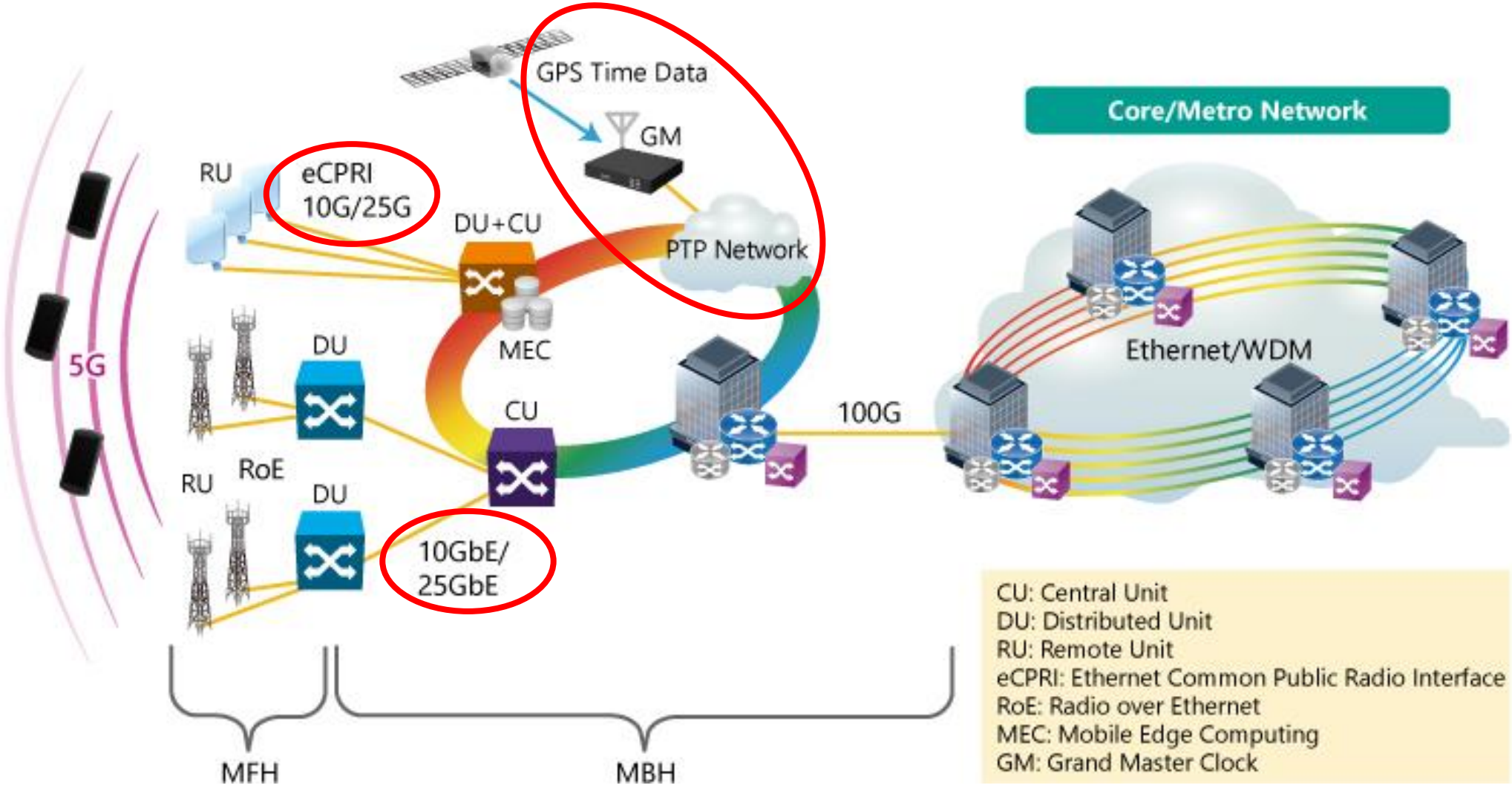
To rollout new applications in fields such as self-driving vehicles, remote control of heavy machinery, UHD video streaming, telepresence at sports events, etc. there is a need to implement **3 pillars of 5G (low latency, high capacity, multiple connections)**.



5G Mobile Backhaul and Fronthaul

New **eCPRI/RoE** improves the transmission rate by using Ethernet, it can use the **10/25G high-speed interfaces**.

Precision Time Protocol (PTP) based time synchronization is being deployed, since **PTP is unaffected by installation location**, it is being proposed for 5G networks.

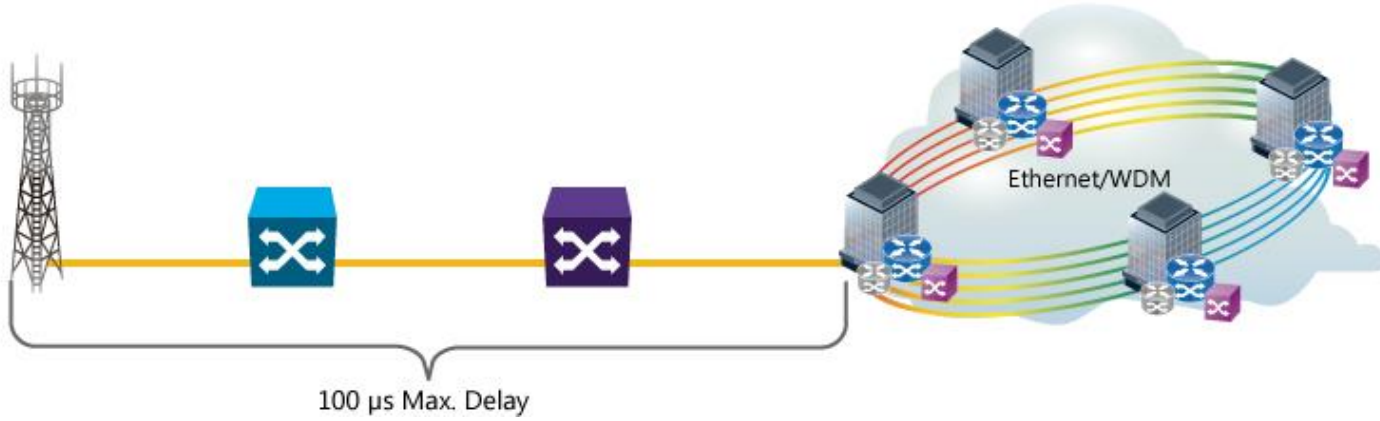


Low Latency Networks

Network Latency

5G mobile networks require one-way latency of the wired section about 100 µs.

Low latency can be achieved by implementing **high-accuracy latency measurements** during network equipment installation.

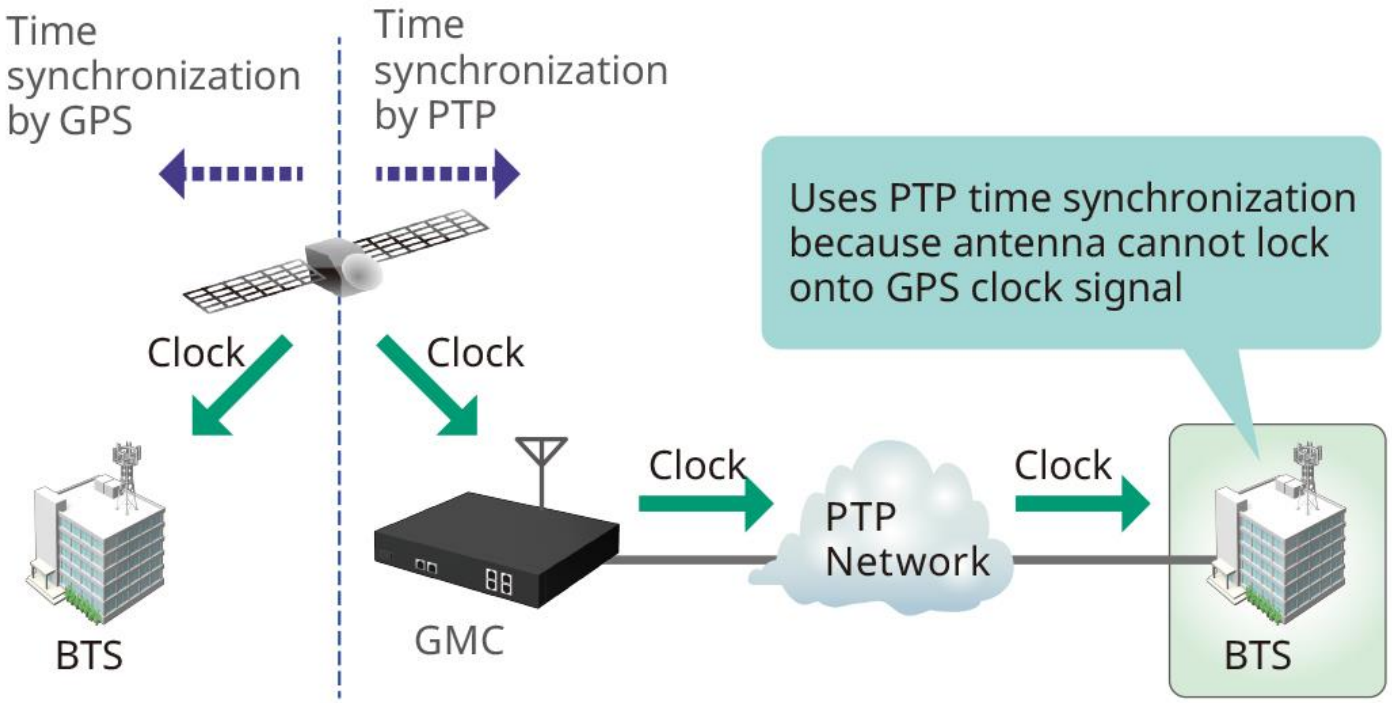


Network Synchronization

Because of the smaller coverage range of 5G base stations, it is difficult to always use direct GPS timing.

PTP and Synchronous Ethernet (SyncE) technologies are used to synchronize time between base stations.

There is a need to test both PTP/SyncE to be sure that **time synchronization is within the limits.**



Latency vs PC-based Ping

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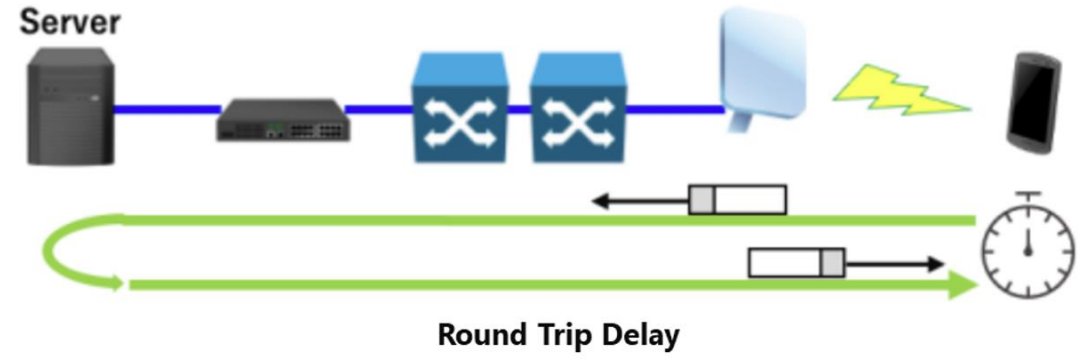
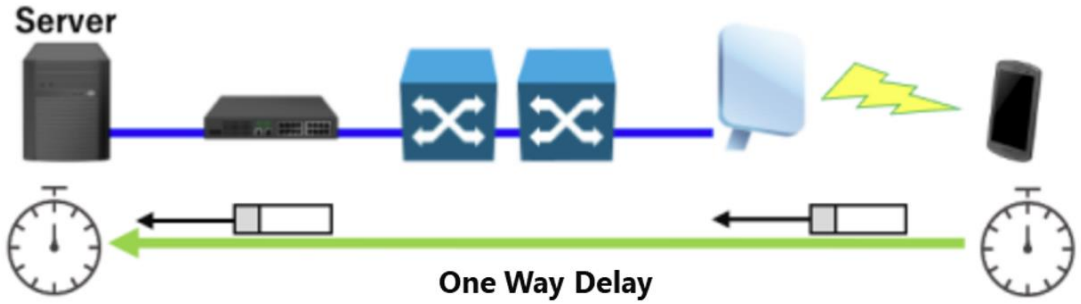
Latency time changes with the UL/DL transfer direction and load rate. **Round Trip Delay** measurement, such as Ping testing, is not suitable since it cannot account for the difference in UL/DL Latency.

It is essential to measure **One Way Delay (Latency)** of the UL/DL connections and make sure they are within acceptable limits.

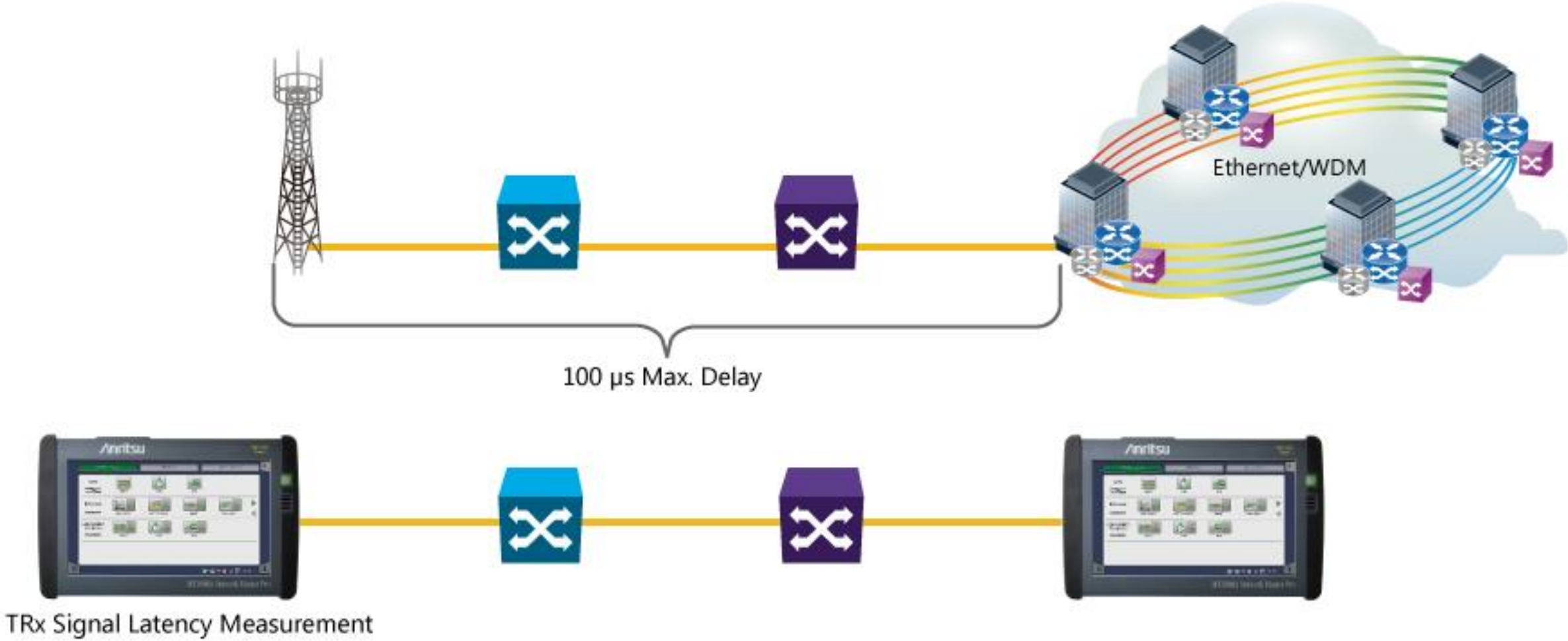




	MT1000A	PC Ping
Latency	One Way Delay, Accurate UL/DL latency	Round Trip Delay, Latency approximation includes PC processing time
Symmetry information	Available	N/A
Traffic Load	Real IP traffic	ICMP, sparce load Windows: 1s interval MAC: 100 ms interval

High-Resolution Latency Measurements

The maximum one-way latency for 5G mobile networks is 100µs, minimizing the latency of network devices is a key point. The one-way latency between two separate points can be measured using two MT1000A units.



PTP/SyncE Measurements

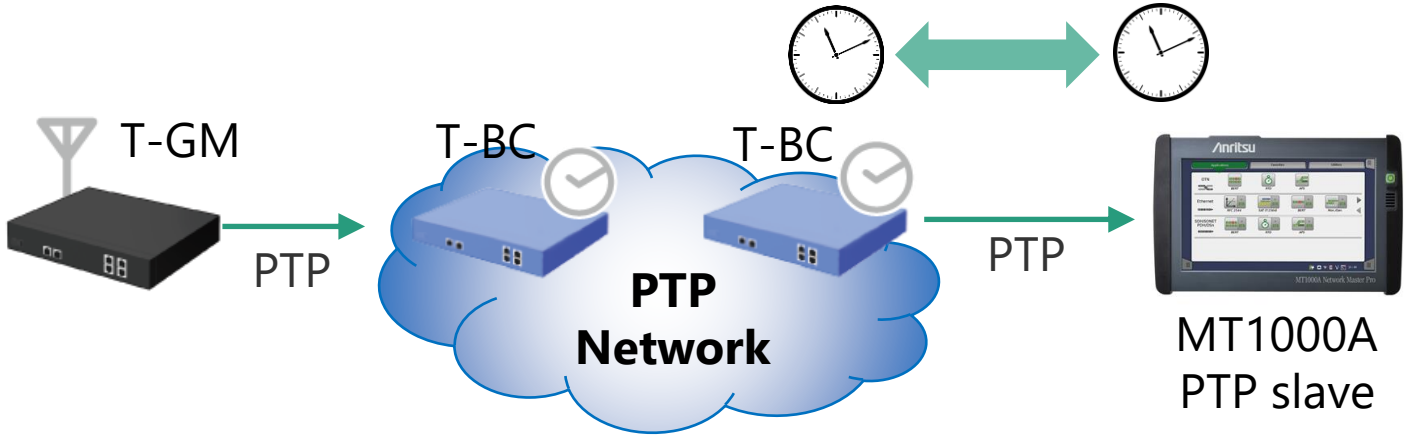
MT1000A emulates both the master and/or slave clocks on each port separately and independently. It joins PTP/SyncE network and tests the network/devices from two perspectives.

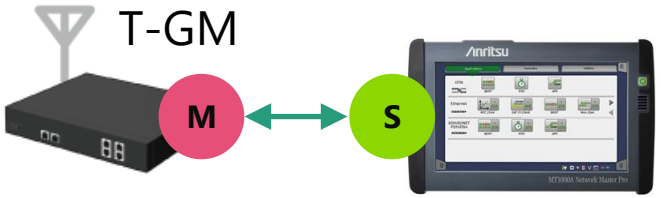
Protocol Functional Test

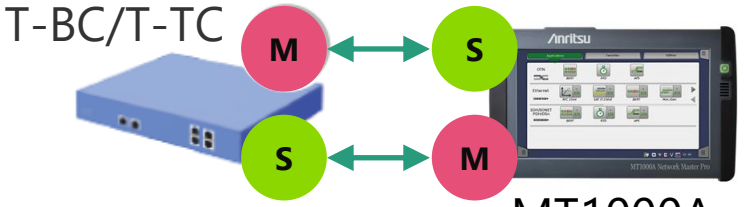
- Interoperability of multi vendor clocks, network configurations, redundancy

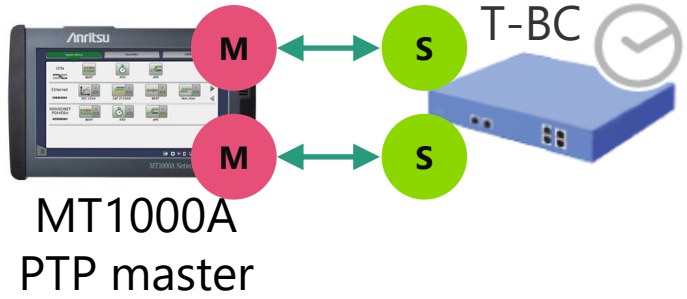
Synchronization Test

- Measure TE (Time Error), comparing the time from the network with reference inside of the tester







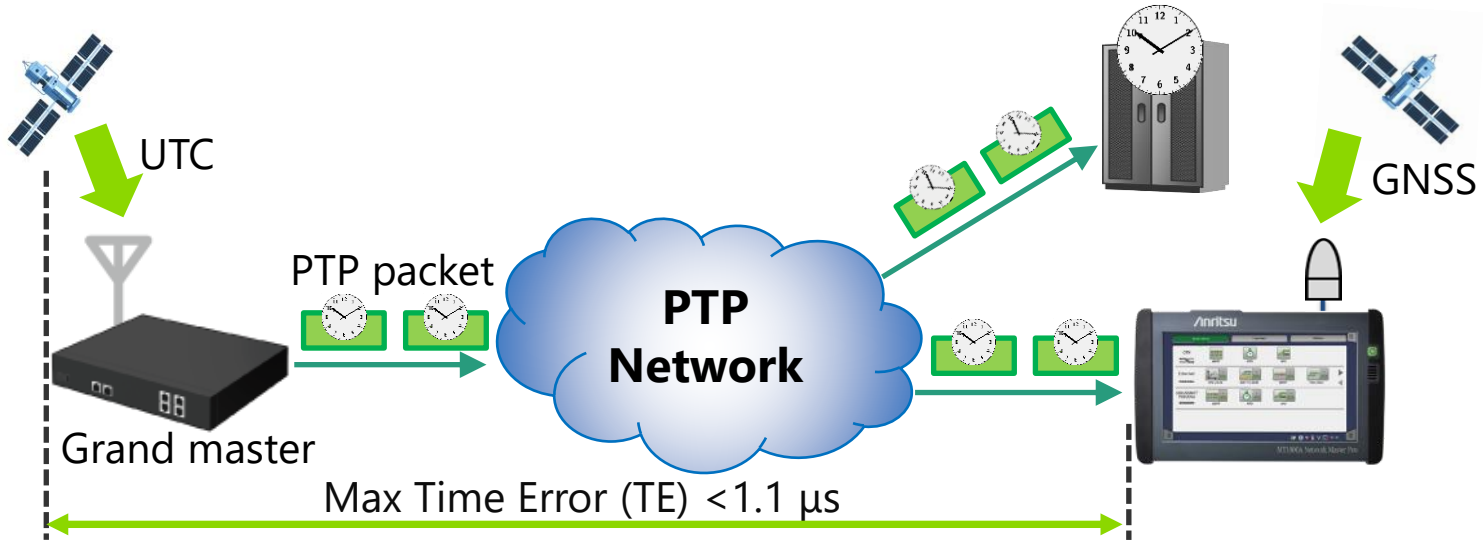


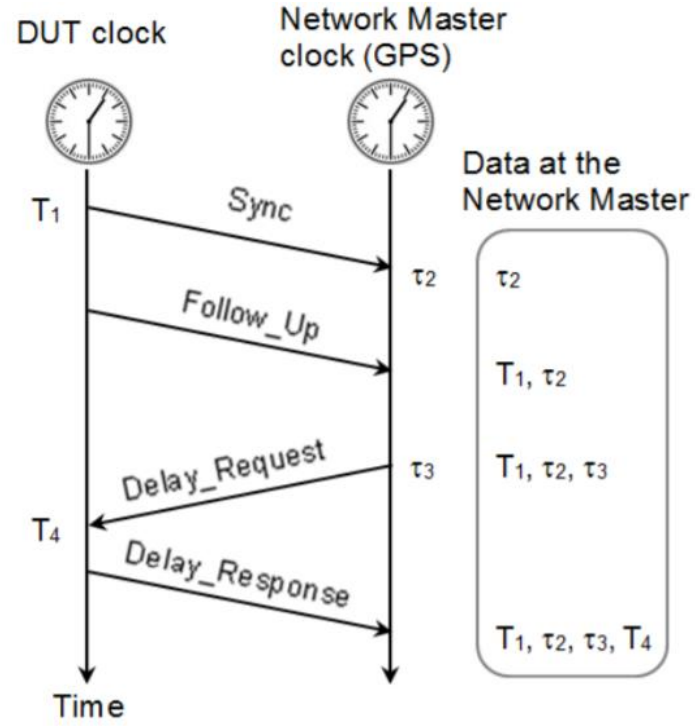
Synchronization Test

5G frequency is mainly assigned with **TDD bandwidth**, which requires base stations to be synchronized in terms of time/phase. Phase misalignment causes collisions between UE and base station.

MT1000A emulates a slave clock and observes time information in the PTP packet from the adjacent master clock. Then MT1000A compares it with reference clock.

In this test MT1000A needs **reference timing from GNSS**, or 1PPS synchronized with GNSS.





$$Terr = \frac{(t2 - t1 - X) + (t4 - t3 - X)}{2}$$

t2-t1 is delay(ns) from T-BC to MT1000A.
t4-t3 is delay(ns) from MT1000A to T-BC.
The cable delay is known as X(ns) and it's symmetric.

MT1000A PTP/SyncE Synchronization Test

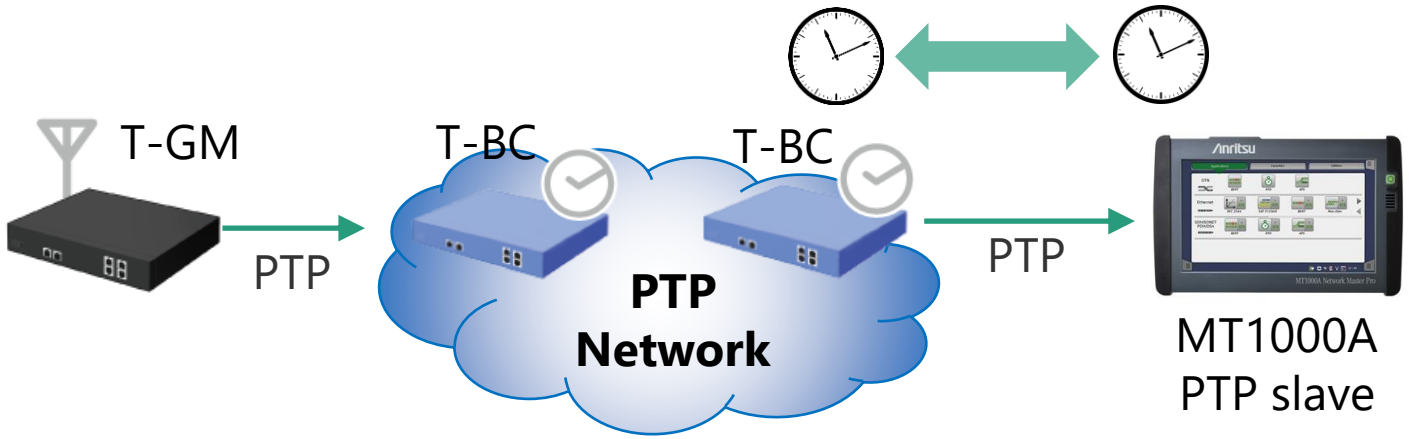
Sync Test application provides One Pulse Per Second (1PPS) measurement, One Way Delay (OWD) / Packet Time error (Packet TE) measurement, and SyncE Wander measurement.

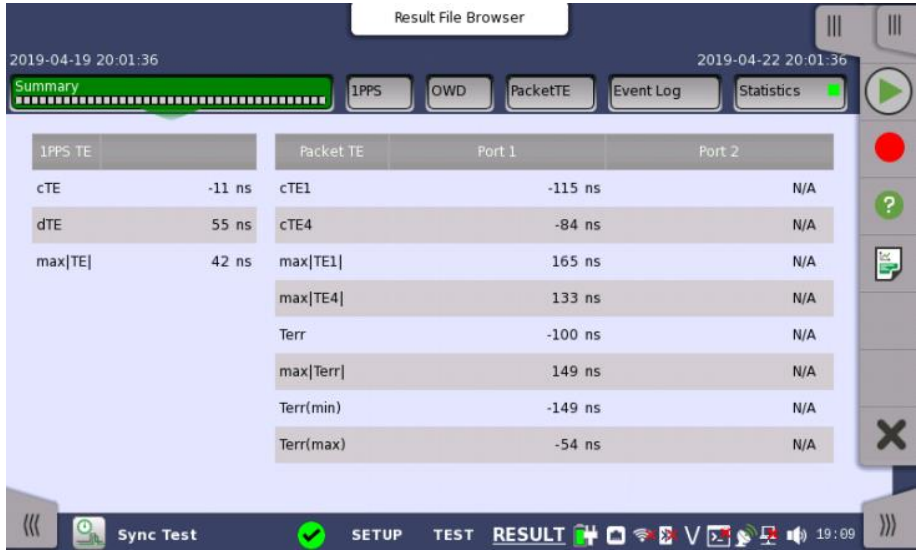
Precision Time Protocol Test

Measurement of PTP G.8275.1/2 networks, the time and phase synchronization with high accuracy, max|TE| (Absolute Time Error), cTE (Constant Time Error), dTE (Dynamic Time Error), and MTIE metrics.

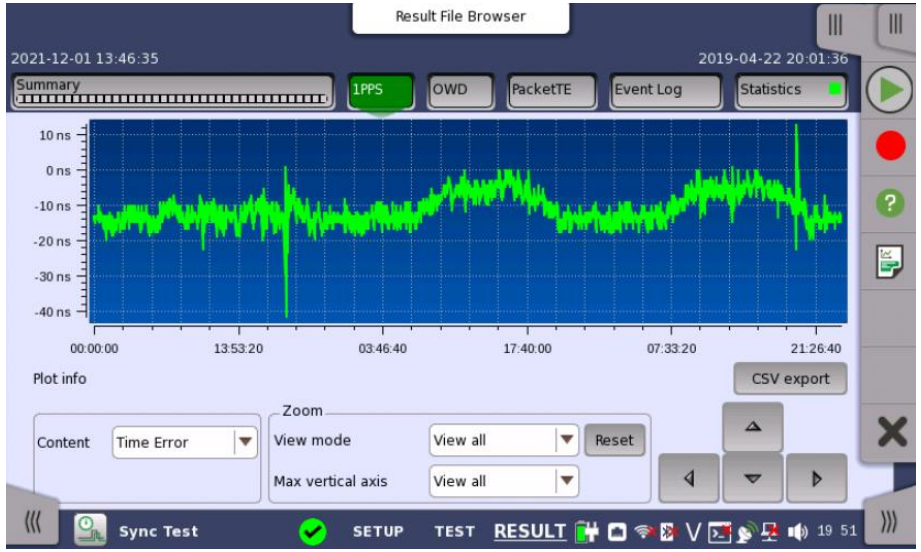
Synchronous Ethernet Test

Optionally MT1000A can measure SyncE Wander. It allows to do pass/fail tests in the field with MTIE/TDEV mask complied with ITU-T G.8261.1





Sync Test Summary Screen



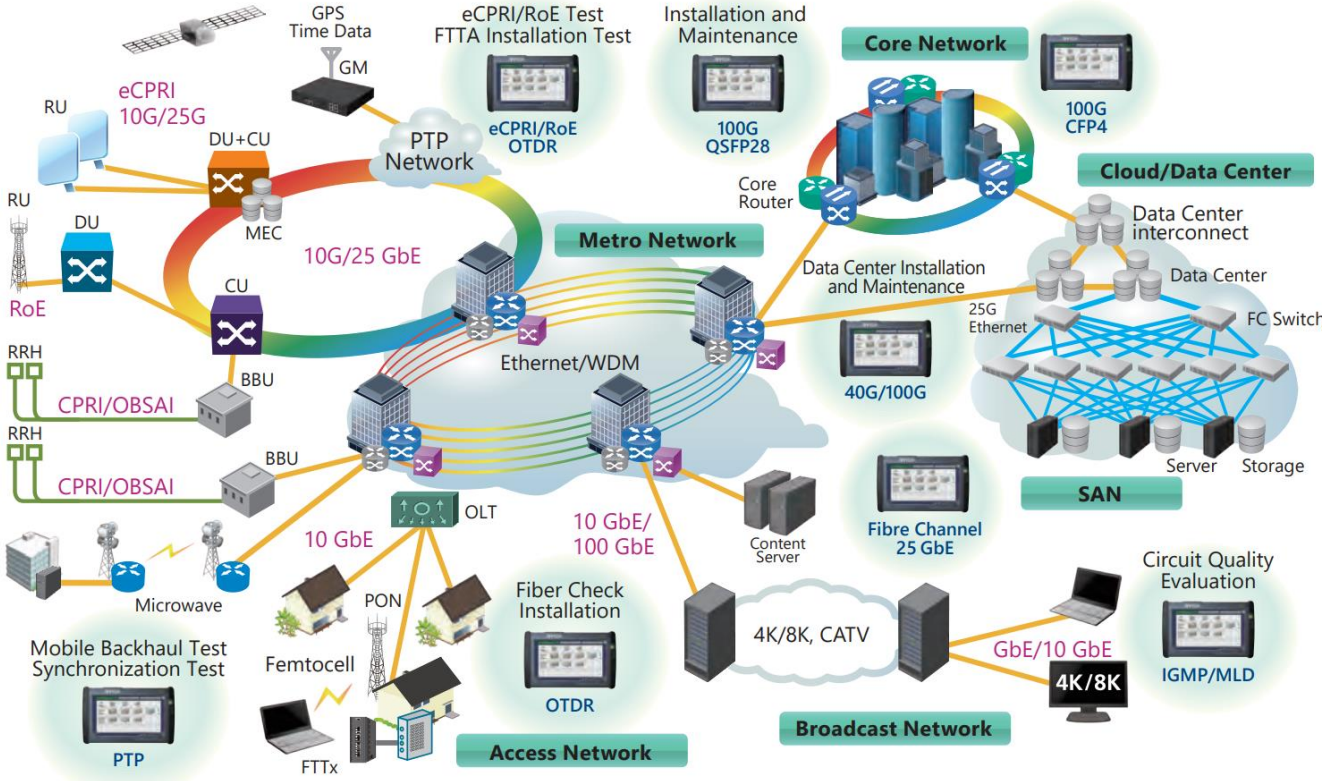
1PPS Time Error Result Screen

MT1000A Summary

MT1000A is an all-in-one transport tester which provides everything needed for I&M of 4G to 5G Mobile Networks in a rugged, field portable package.

MT1000A Network Master Pro

- Support speeds from 1.5M to 100G
- Support Ethernet, OTN, Fibre Channel and legacy SONET/SDH/PDH/DSn
- Full suite of Ethernet benchmark tests RFC2544, Y.1564, RFC6349
- Support eCPRI/RoE/CPRI/OBSAI
- Support sync testing PTP/SyncE/1PPS, Packet TE, One-way Delay together with GNSS disciplined oscillator module
- OTDR measurements together with OTDR module
- Cloud/WLAN/Bluetooth/LAN connections
- Test reports in PDF, CSV and XML formats



Higher Throughput – Higher Quality

5G Network Pillars: High Capacity

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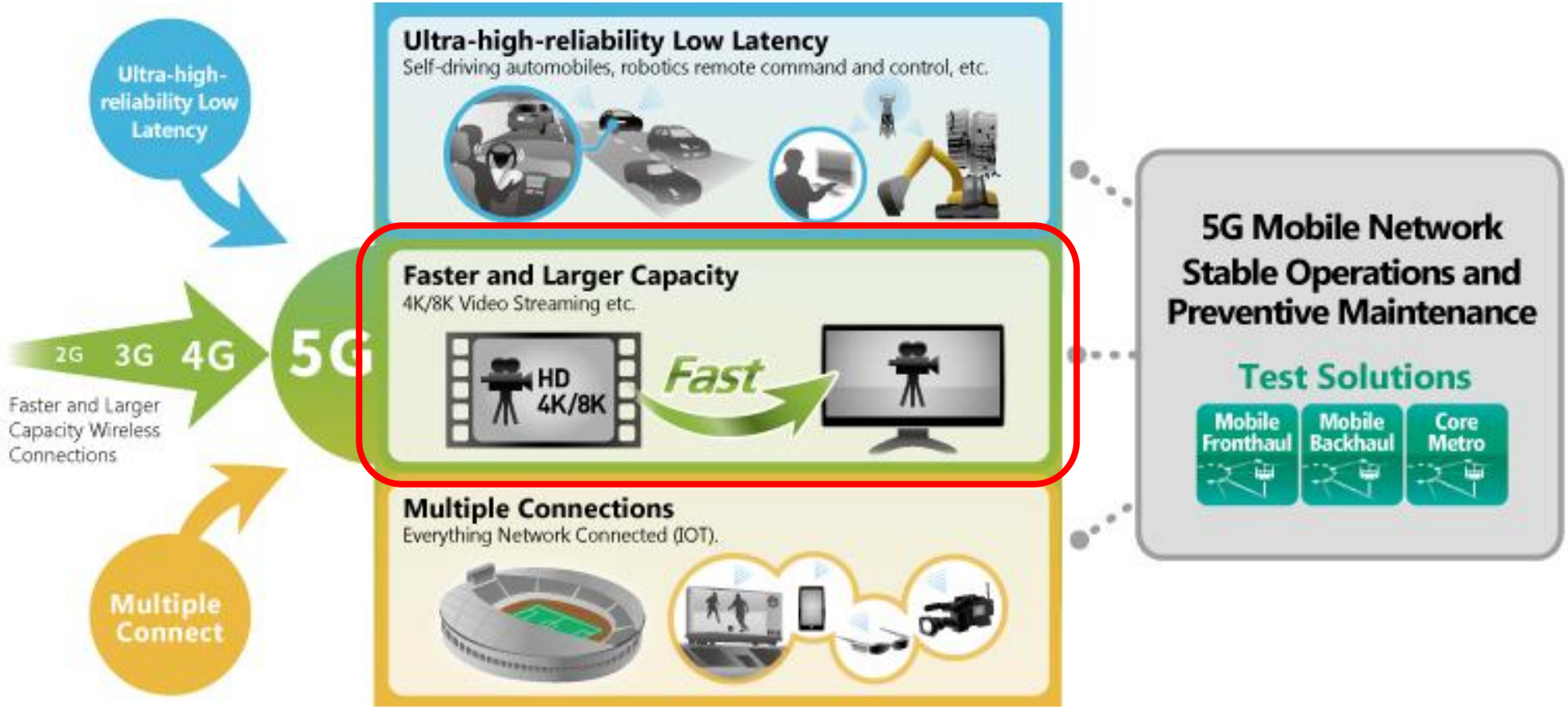

Data Center Market Trend: Centralized to Distributed

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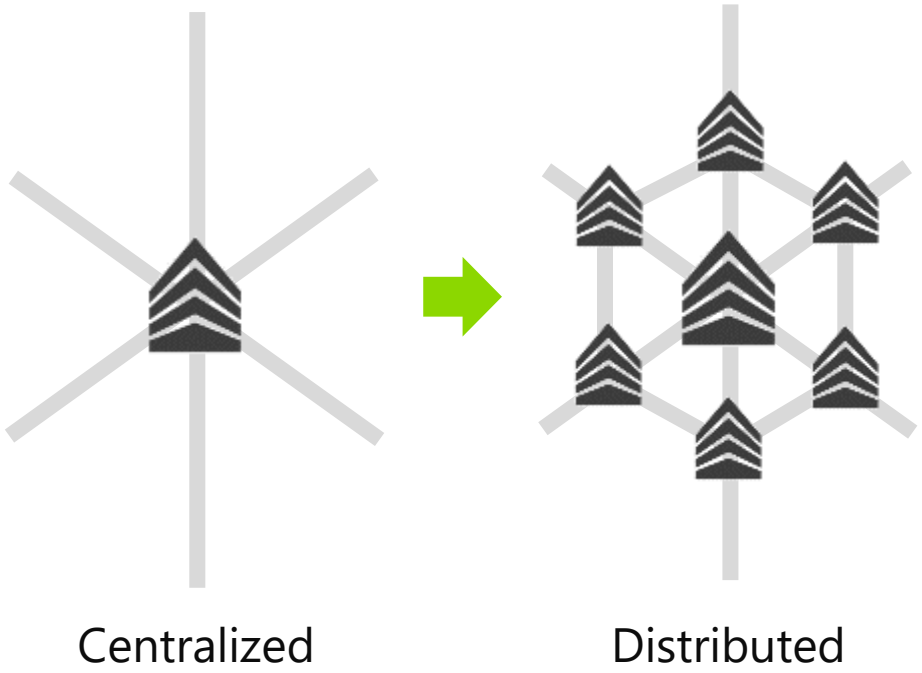
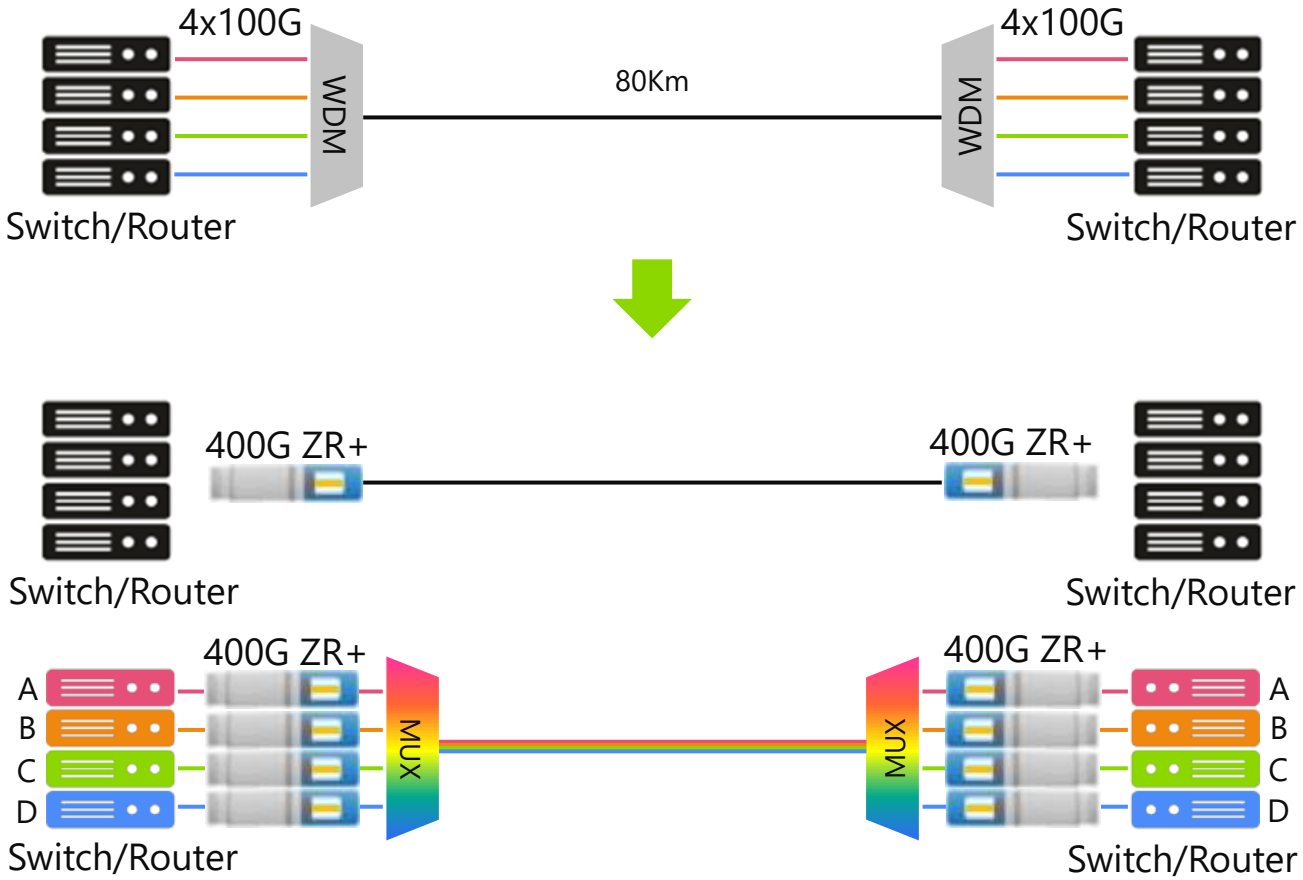
Data center location model is changed from Centralized to Distributed and Interconnected which improves redundancy and security, achieve low latency. To maintain high level SLA in distributed network 400G ZR/ZR+ can be used instead of WDM systems.

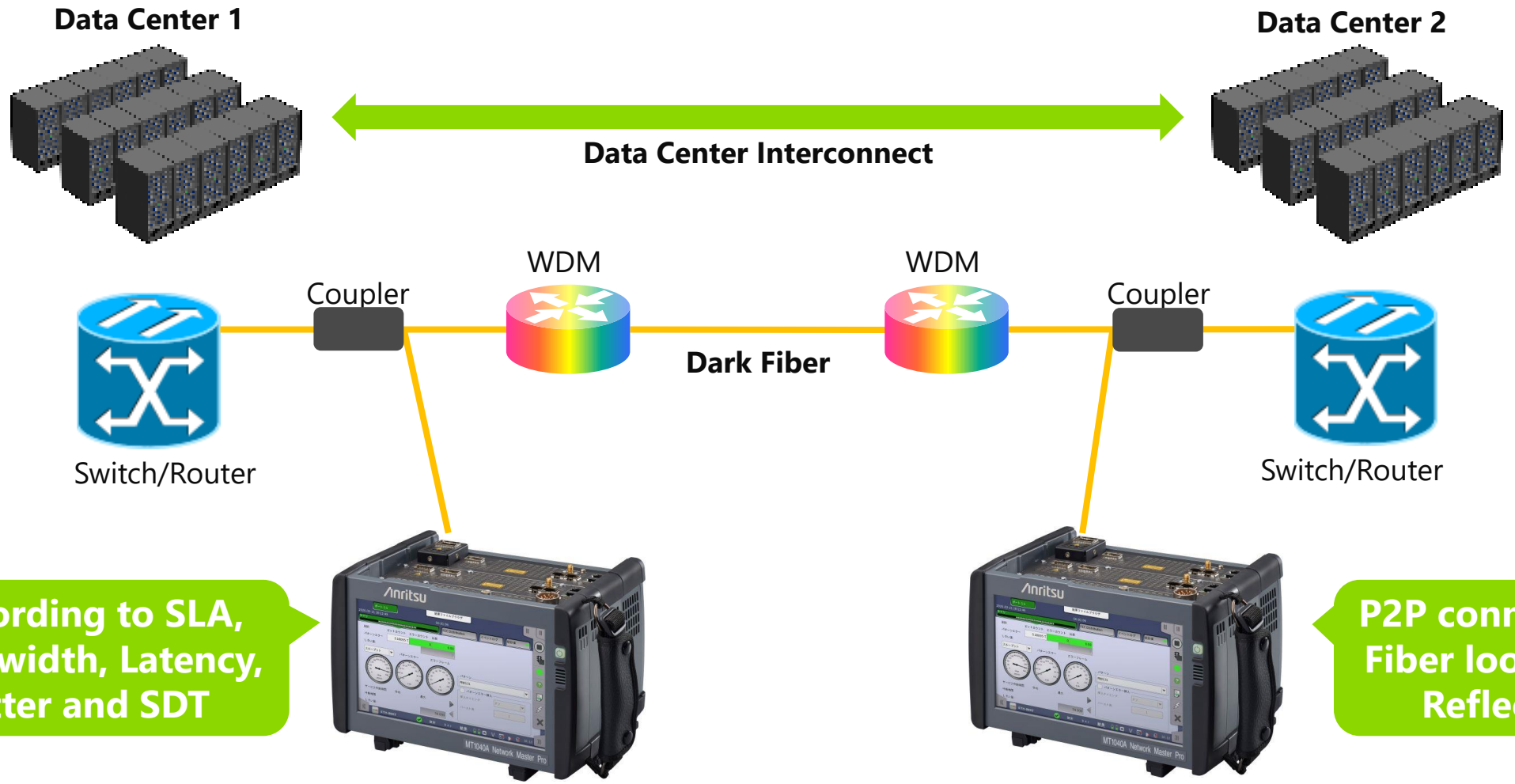
400G-ZR/ZR+ provides more capacity and cost reduction comparing to common WDM systems.





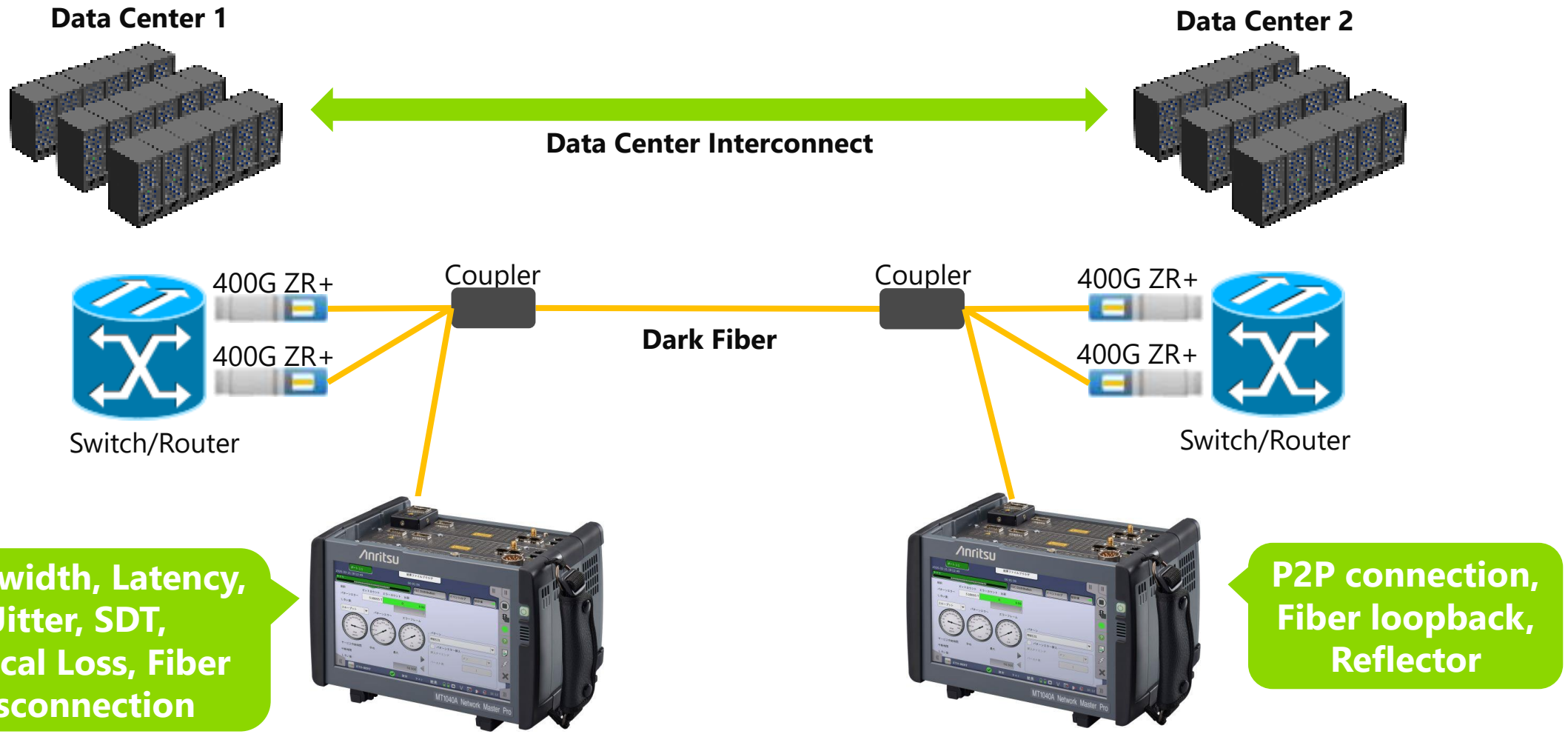
MT1040A DCI with WDM Solution

MT1040A covers all required SLA tests of active WDM systems including physical fiber measurement.
Two MT1040As can be used for P2P connection testing.



MT1040A DCI with ZR/ZR+ Solution

Introducing ZR/ZR+ transceivers in network allows to exclude WDM system from network.
MT1040A provides optical performance check from the register information in ZR/ZR+ transceiver.



MT1040A 400G ZR/ZR+ Support

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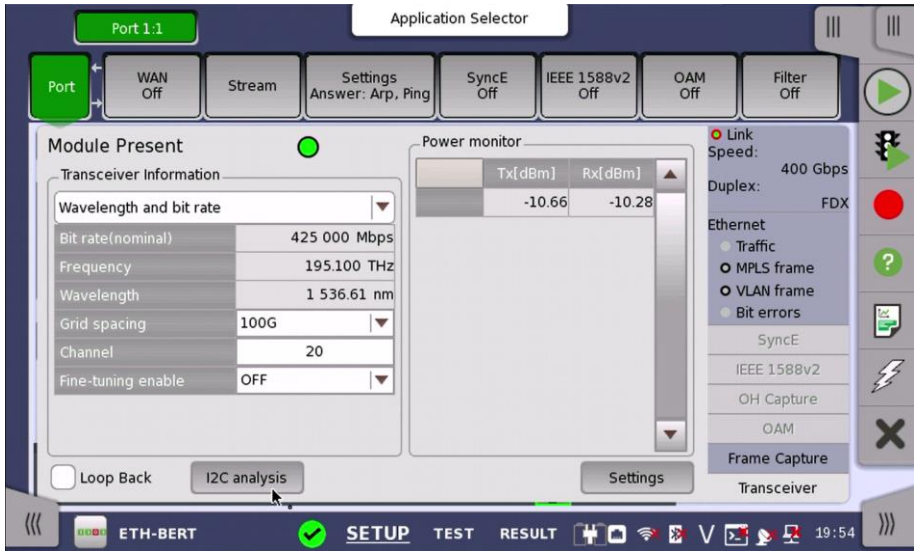
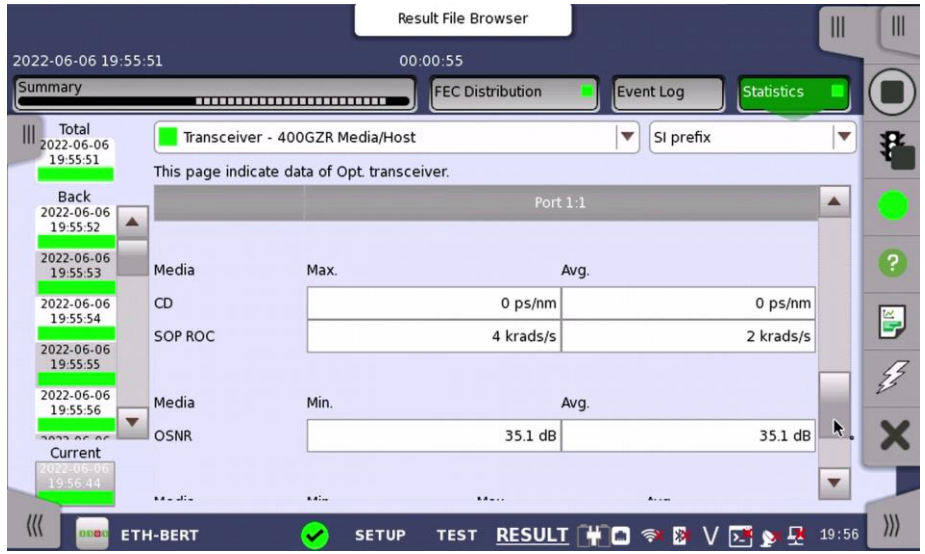


400G ZR/ZR+ Transceiver Settings Screen

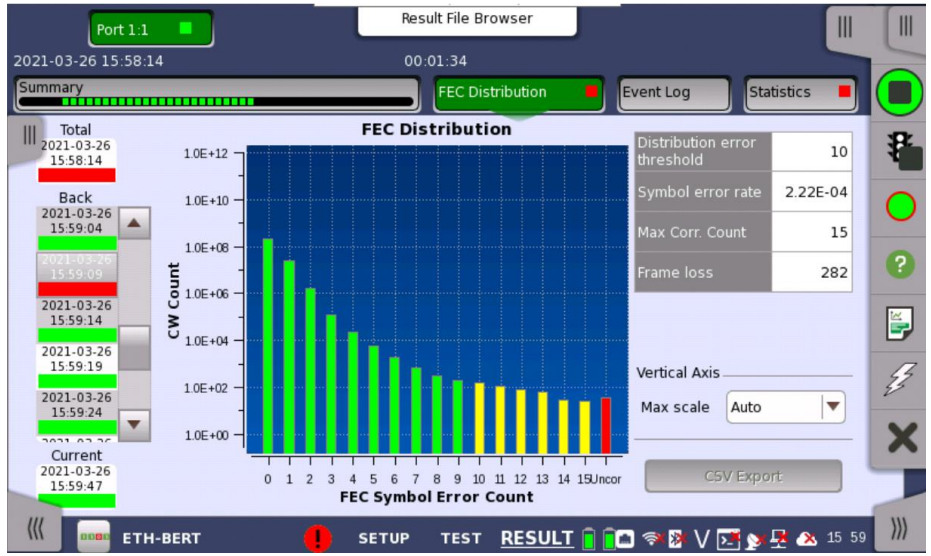


400G ZR/ZR+ Transceiver Result Screen

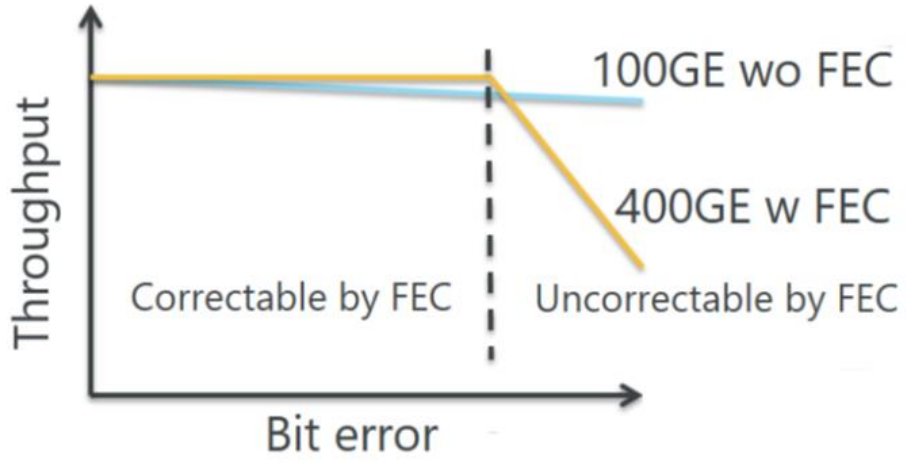
MT1040A Ethernet FEC Distribution

Ethernet FEC Distribution

While in the 100G case it was possible to observe the signal quality degradation from error free conditions to error conditions due to aging or increased distance, **when testing 400G the error rate is "masked" by FEC** correcting errors. But when the number of errors becomes "un-correctable" the link signal quality experiences a sudden degradation which could not be predicted before.



FEC Distribution Result Screen

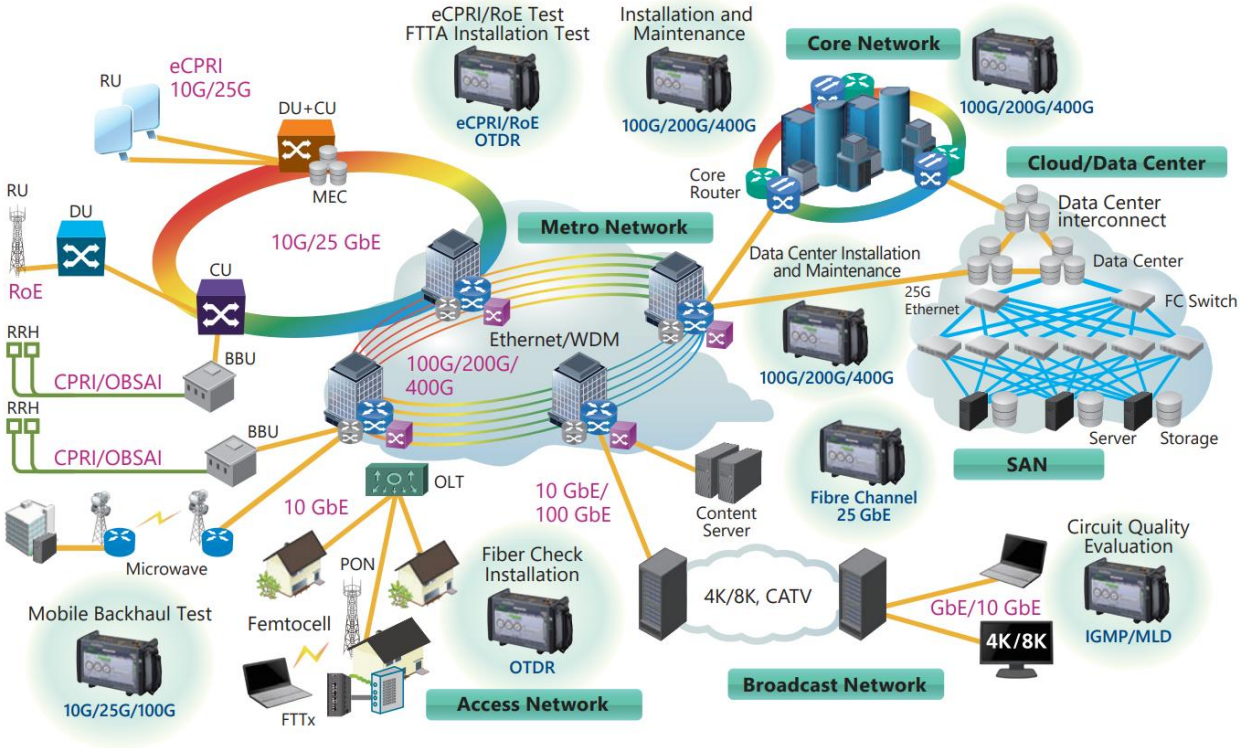


MT1040A Summary

MT1040A is an all-in-one transport tester which provides everything needed for I&M of Core & Metro Networks, Data Center networks.

MT1040A Network Master Pro

- Support speeds from 10M to 400G
- Unique FEC Distribution graph
- Support Ethernet, OTN, Fibre Channel and legacy SONET/SDH/PDH
- Full suite of Ethernet benchmark tests RFC2544, Y.1564, RFC6349
- Support eCPRI/IEEE1914.3/CPRI/OBSAI
- Support Dual 400G or Quad 100G
- Support Breakout type optical transceivers
- Support 400G ZR optical modules
- OTDR measurements together with OTDR module
- Cloud/WLAN/Bluetooth/LAN connections
- Test reports in PDF, CSV and XML formats



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