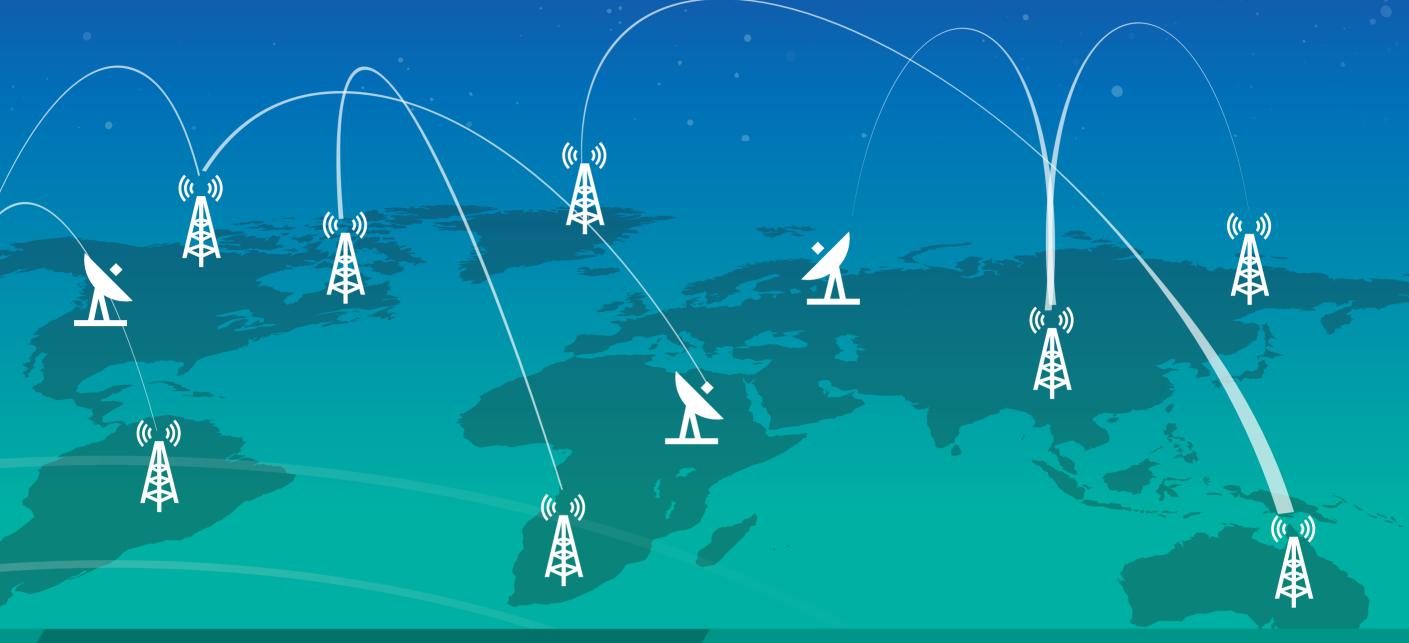


# TIMING Solution TIMING and SYNCHRONIZATION

**Vital for 5G-NR TDD Network Success** 



#### NEW USE CASES

#### **5G Enables the Flexibility to Support:**



# Timing and Synchronization Plays a Critical Role in Varied Network Configurations and Features

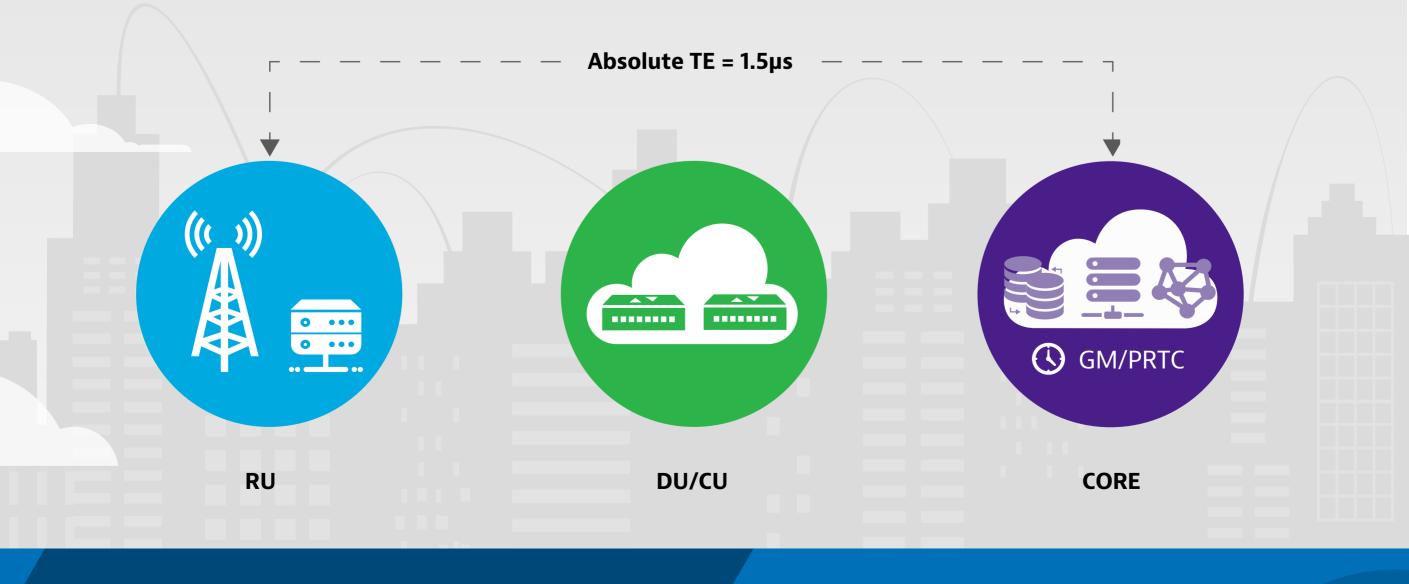
Frame Sync	LTE/ 5G-NR TDD	Absolute	Slot Frame Coordination with Adjacent LTE or 5G	Signal Drift between Adjacent Cells	Poor Cell Performance (Capacity, Throughput, etc.).	More
		/ qd			Leastion Accuracy Constral	E
Time Sync	LTE/ 5G-NR /CoMP/OTDOA	500pp	<1µs Relative OTA	RF Signal Coordination	Location Accuracy, Spectral Efficiency	nizatio
		=				ē
 Time Sync	LTE/ 5G-NR TDD/ eCIC	izatior	~1.5µs Absolute	Interference Management/ Coordination	Poor Performance, (Interference, Capacity, etc.)	t Synch
		lo				
Time Sync	LTE/ 5G-NR/eMBMS/CA	/ Synch	~3-5µs Absolute	Video Decoding Carrier Aggregation	Poor Video Quality and CA Failure, Low Throughput	String



#### 5G Raises the Bar on Synchronization, Speed and Accuracy

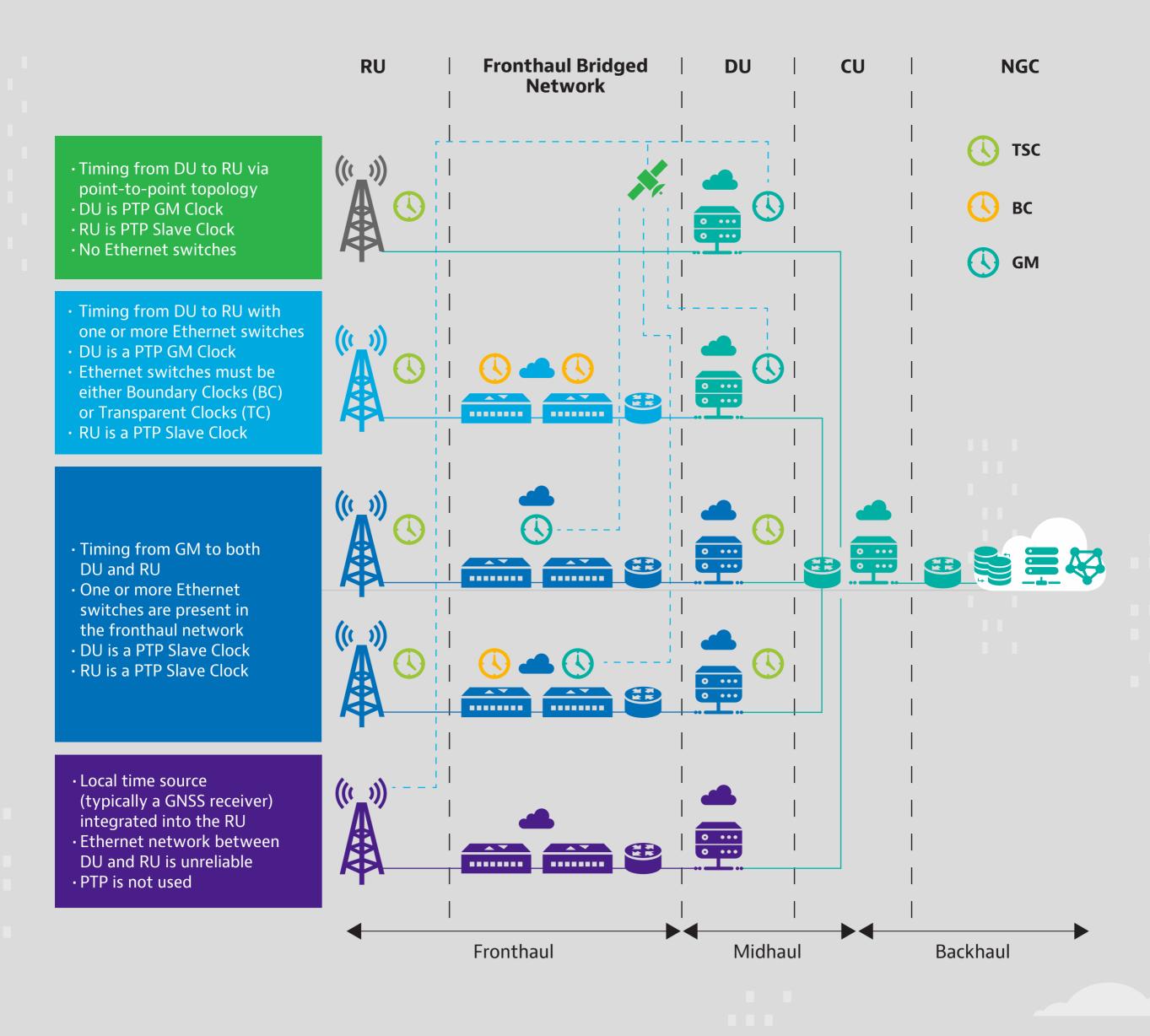
Frequenc

Regardless of RU, DU and CU location, Total Time Error between RU and the Grand Master cannot exceed 1.5µs.



# THE TECHNOLOGY

# **Timing and Synchronization Configuration Options**



#### **Forms of Synchronization**

- Frequency
- **Phase** Two clocks that are aligned in terms of their repeating interval (i.e., frequency), and also phase (a one-second interval), but without a common time origin.

$$T=TO$$

$$Time(f)$$

**Frame** — A compatible frame structure to avoid simultaneous UL/DL transmission, which determines a specific DL/UL transmission ratio and frame length.

**Frequency** — Two clocks that are aligned in terms of their repeating interval (i.e., frequency) but not in terms of phase or time.

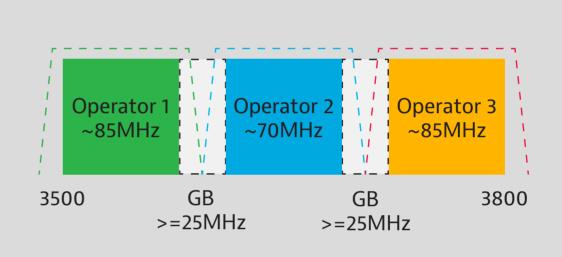
Phase

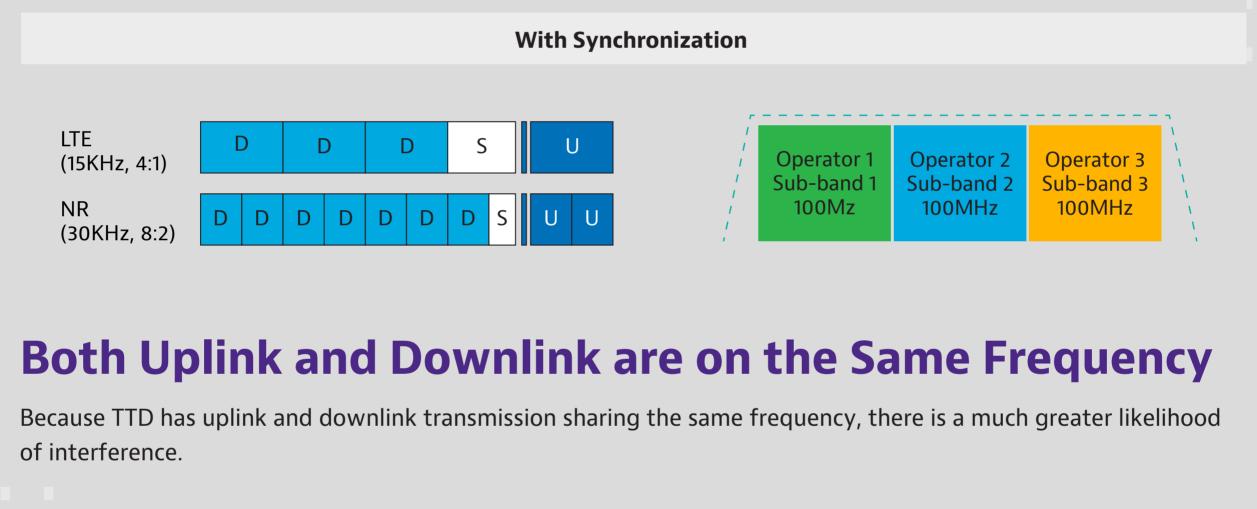
**Time** — Two clocks that are aligned in terms of their repeating interval (i.e., frequency), their phase (a one-second interval), and sharing a common time origin.

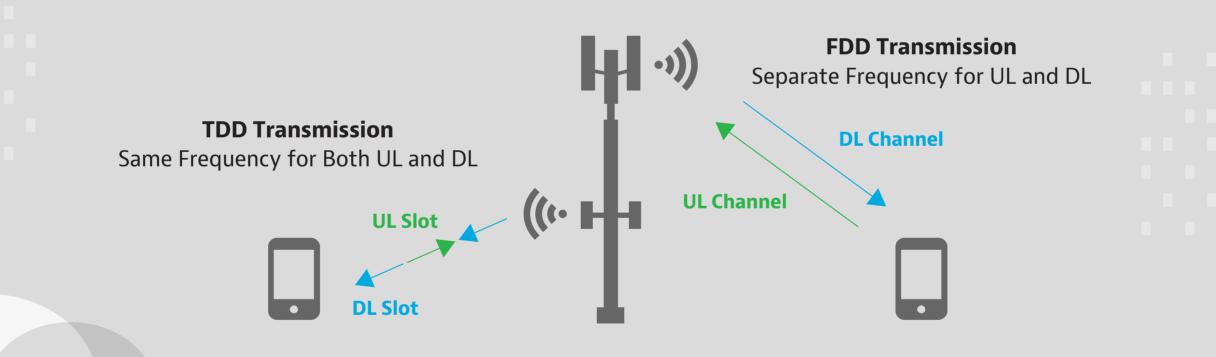
Getting Interference Out...Better Performance In

				Interference			
NR Carrier 1	DL	DL	DL	DL	UL		
NR Carrier 2	DL	DL	DL	UL	DL		
LTE Carrier	D	L		DL	UL		

#### Without Synchronization



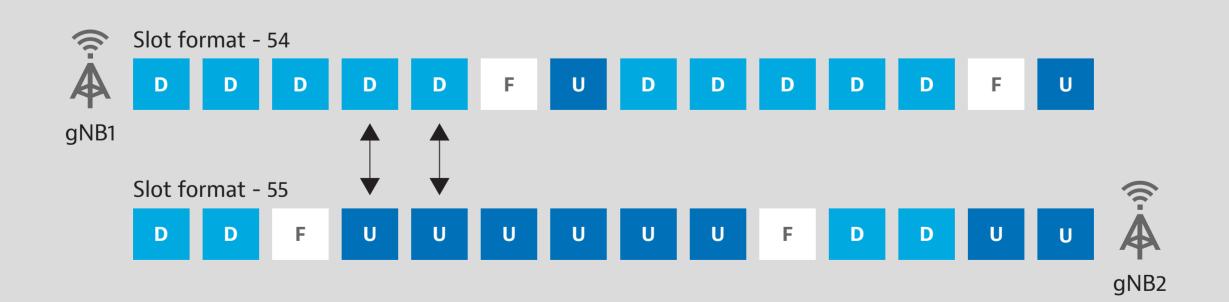




#### A Matter of Filling the Right Slots

Just like LTE, 5G radio frames have a fixed duration of 10ms. Each radio frame contains ten 1ms subframes. How it differs from LTE is that in 5G-NR, subcarrier spacing changes the number of slots and symbols per subframes.

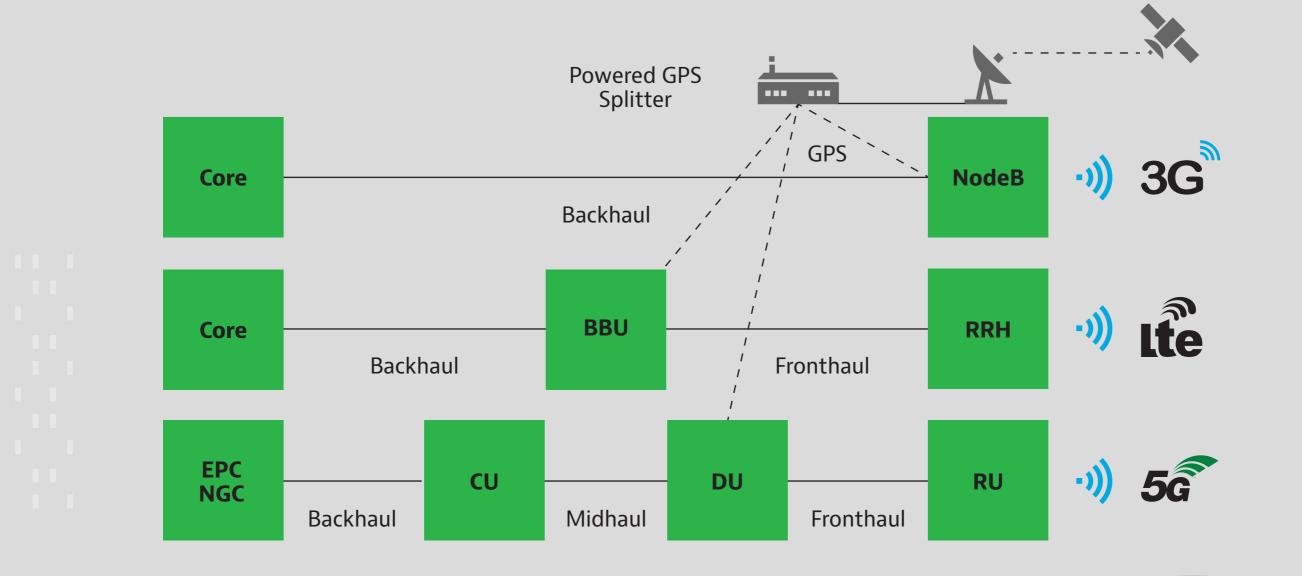
Release 15 version of 3GPP 38.213 has defined 56 slot formats, each of which is a predefined pattern of downlink/flexible/uplink symbols during one slot. Service providers can use these different formats to flexibly accommodate different types of service. QoS issues may arise when two networks offering different types of service are located next to each other. Though they may be synchronized in time, interference can result if their slot formats are not synchronized.



#### **5G Network Topology Changes**

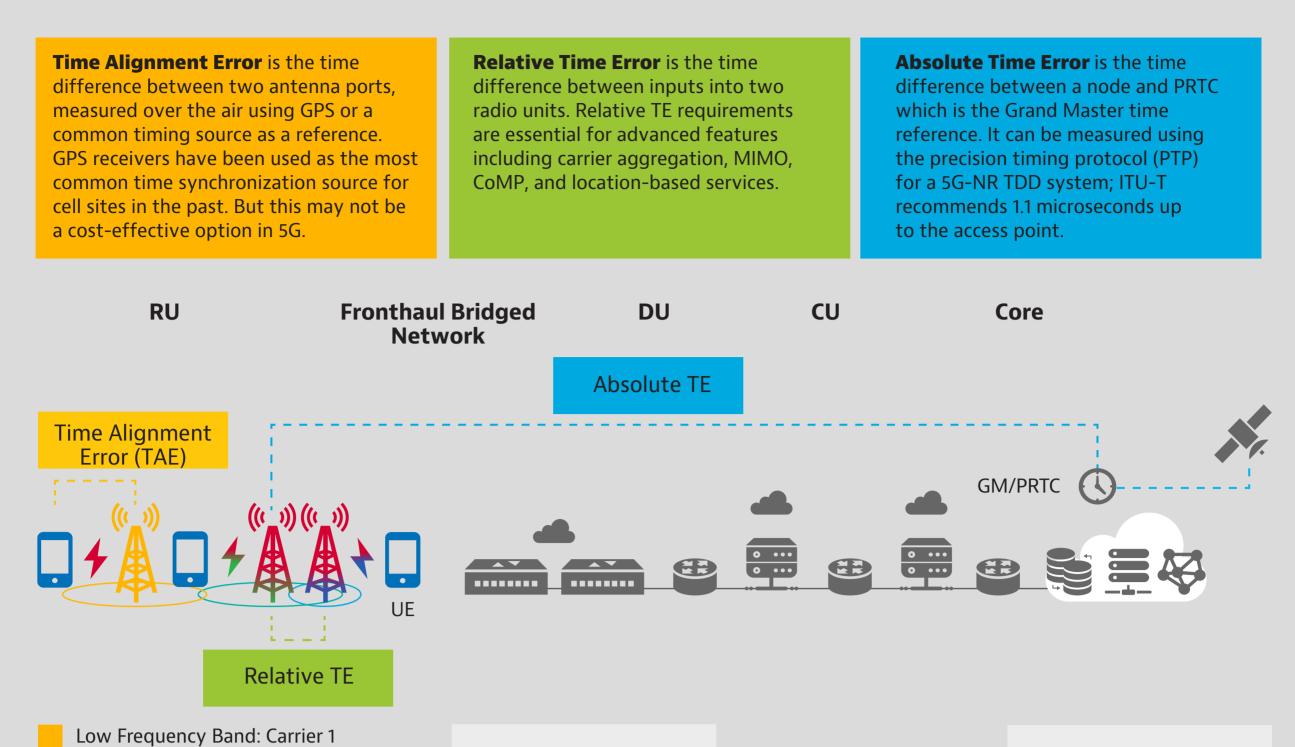
CPRI, (a synchronous fronthaul interface) which is the technology used today for LTE, may not be practical for all 5G use cases. CPRI enforces stringent delay requirements which are well-suited for centralization, but can cause difficulties with bandwidth and node flexibility.

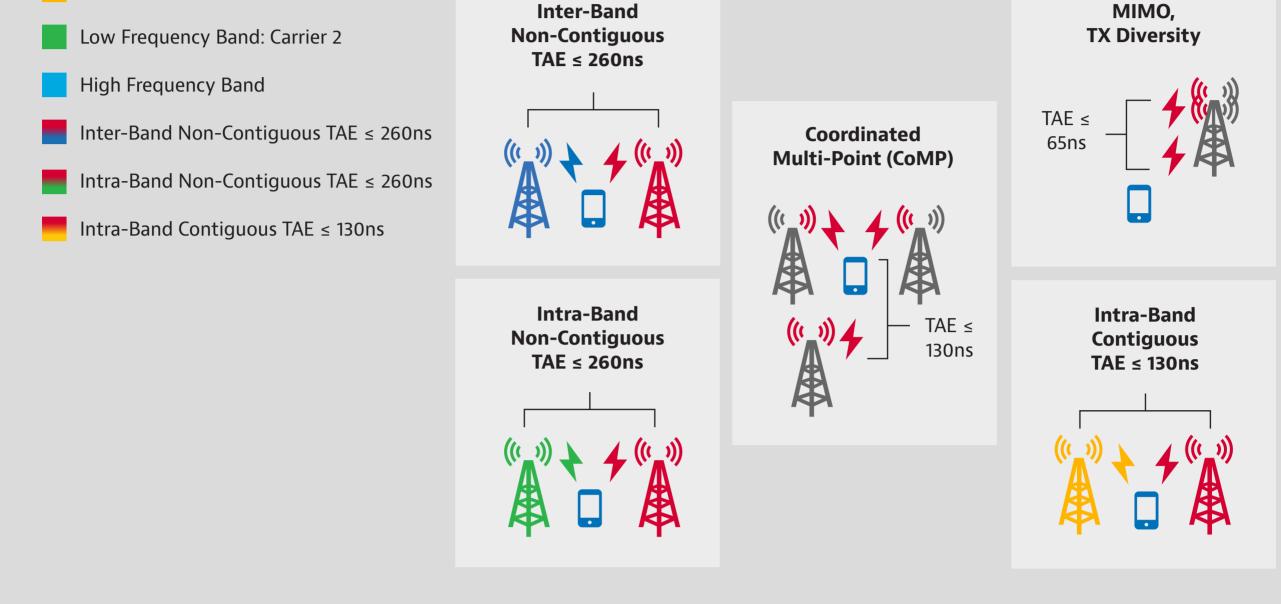
CPRI is not very efficient in terms of statistical multiplexing and cannot scale to the demands of 5G, especially for massive MIMO and larger bandwidth increments. The required bandwidth and antennas in a 5G scenario would push the CPRI bandwidth above 100Gbps. That is why using Ethernet for fronthaul and midhaul is very practical.



## THE POTENTIAL ERRORS

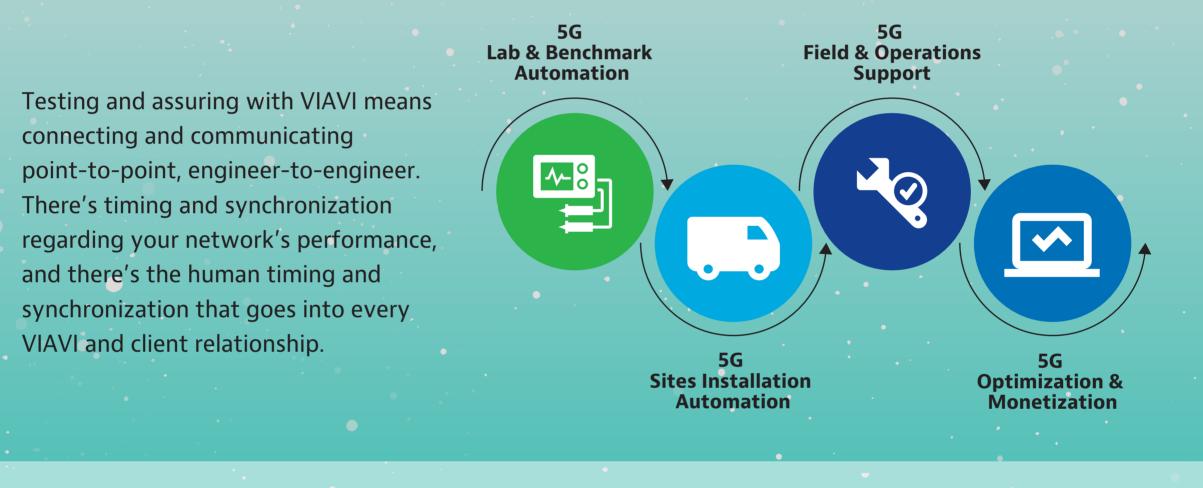
#### **Time and Time Alignment Errors**





#### THE ROLE OF TEST AND MEASUREMENT

#### From Lab to Field to Assurance, Testing is Essential Through Every Stage of the 5G Lifecycle



As a leader in test and measurement, VIAVI offers the most comprehensive Timing & Synchronization validation solutions and is currently the only provider offering such testing for 5G TDD deployment.

## THE SOLUTIONS

The VIAVI T-BERD<sup>®</sup>/MTS-5800-100G along with CellAdvisor<sup>®</sup> 5G (CA5G) can perform all required timing and synchronization tests for all types of 5G networks. They measure throughput, delay, packet jitter, timing, and frame synchronization to ensure backhaul, midhaul, fronthaul, and air interface meet designed network specifications.

#### Applications include:

**GPS Signal/Satellite Coverage Test** It is important to check GPS signal stability and suitability for the GPS antenna location at the time of installation, and periodically after installation as conditions around the site may change. The VIAVI T-BERD/ MTS-5800 tests GPS signals using an integrated GPS receiver and provides the number of visible satellites, signal strengths and satellite lines of sight.

#### PTP Timing Error Test

Using a VIAVI T-BERD/MTS, which works as a PTP slave, an engineer can check connectivity to the PTP grand-master and determine if timing error is within requirements by via a step-by-step guide.

#### **Frequency and Time Error Validation** Using a VIAVI CellAdvisor 5G, an RF

engineer or technician can quickly validate over-the-air frequency and time errors, ensuring synchronization conforms to the +/- 1.5µs vs UTC. This can be tested for the adjacent channel network as well.

#### **5G-NR Frame Format Validation** To prevent intercell interference between adjacent networks, validating an adjacent network's conformity to the agreed slot and frame formats is critical. Using a CellAdvisor 5G, service providers can easily validate frame format for multiple operators through over the air measurements.

**Synchronization Issue Resolution in the Field** Service providers experiencing RF

performance issues—handover failure, poor throughput, compromised QoS, and lower accessibility and retainability—can work with VIAVI engineers using the CellAdvisor 5G with NSA Signal Analysis to conduct over-the-air tests that quickly troubleshoot, pinpoint and resolve synchronization problems. T-BERD/MTS-5800-100G



**CellAdvisor 5G** 



Read the **Timing and Synchronization Handbook** and visit **VIAVI** online for more 5G insights on timing <u>and synchronization in TDD networks</u>.

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