

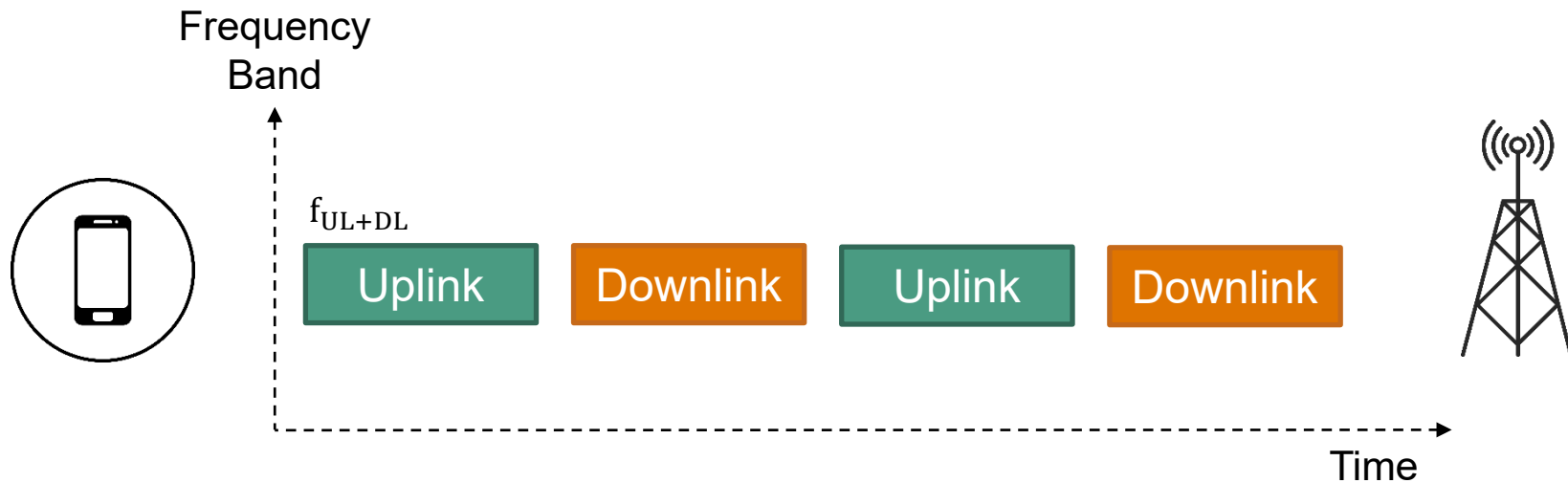
Precision Timing Measurements in 5G TDD Networks

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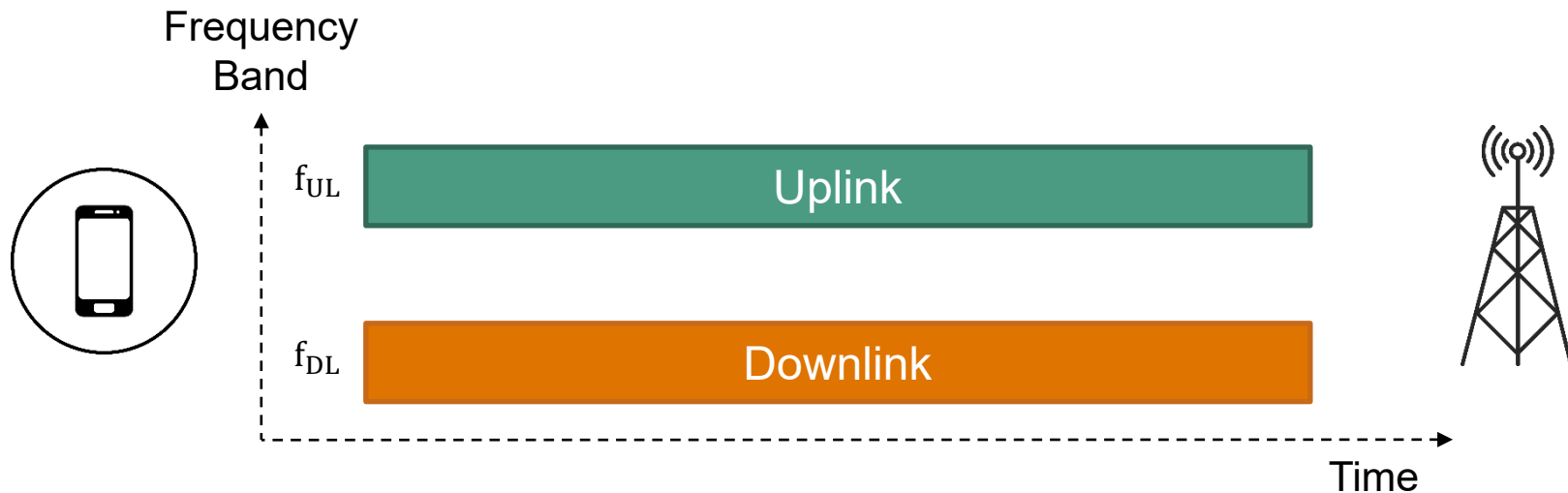
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Marketing Content Creator

- 5G TDD Networks Overview
 - TDD vs FDD
 - Importance of timing
- Essential RF Testing Metrics
 - Rise time, fall time, settling time
 - Propagation delay
 - Waveform anomalies
 - Crest factor
- Test Instrument Considerations
- Wrap Up

- Time Division Duplex (TDD)
 - Uplink/downlink transmissions share a frequency band
 - Time slots change rapidly
 - Guard band between uplink/downlink



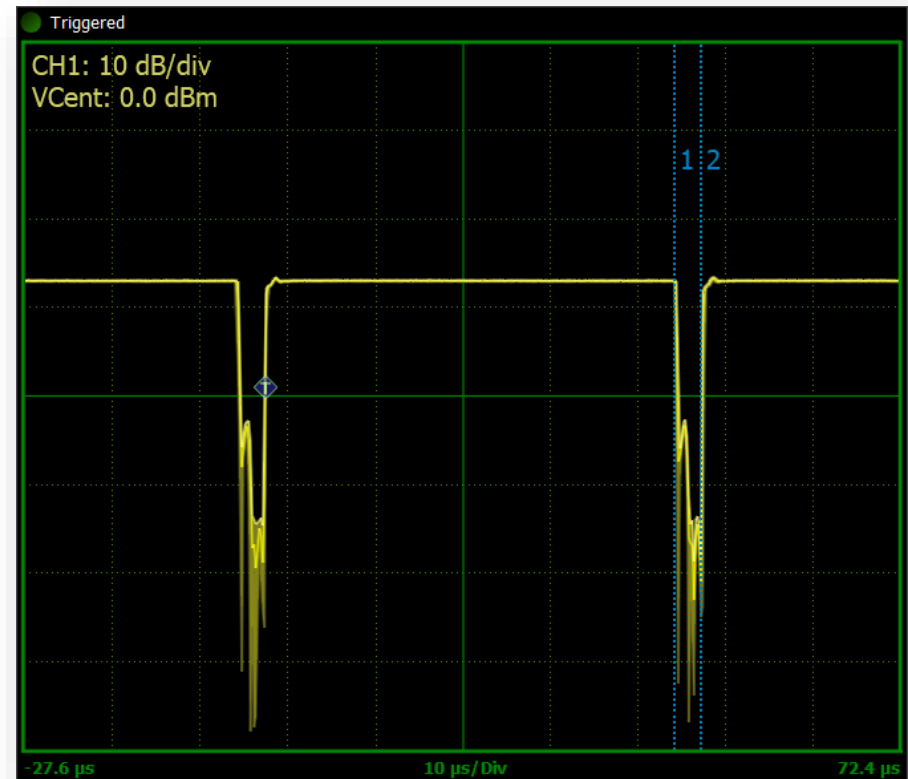
- Frequency Division Duplex (FDD)
 - Uplink/downlink on different channels
 - Needs frequency gap to avoid interference
 - Pre-determined uplink/downlink allocation



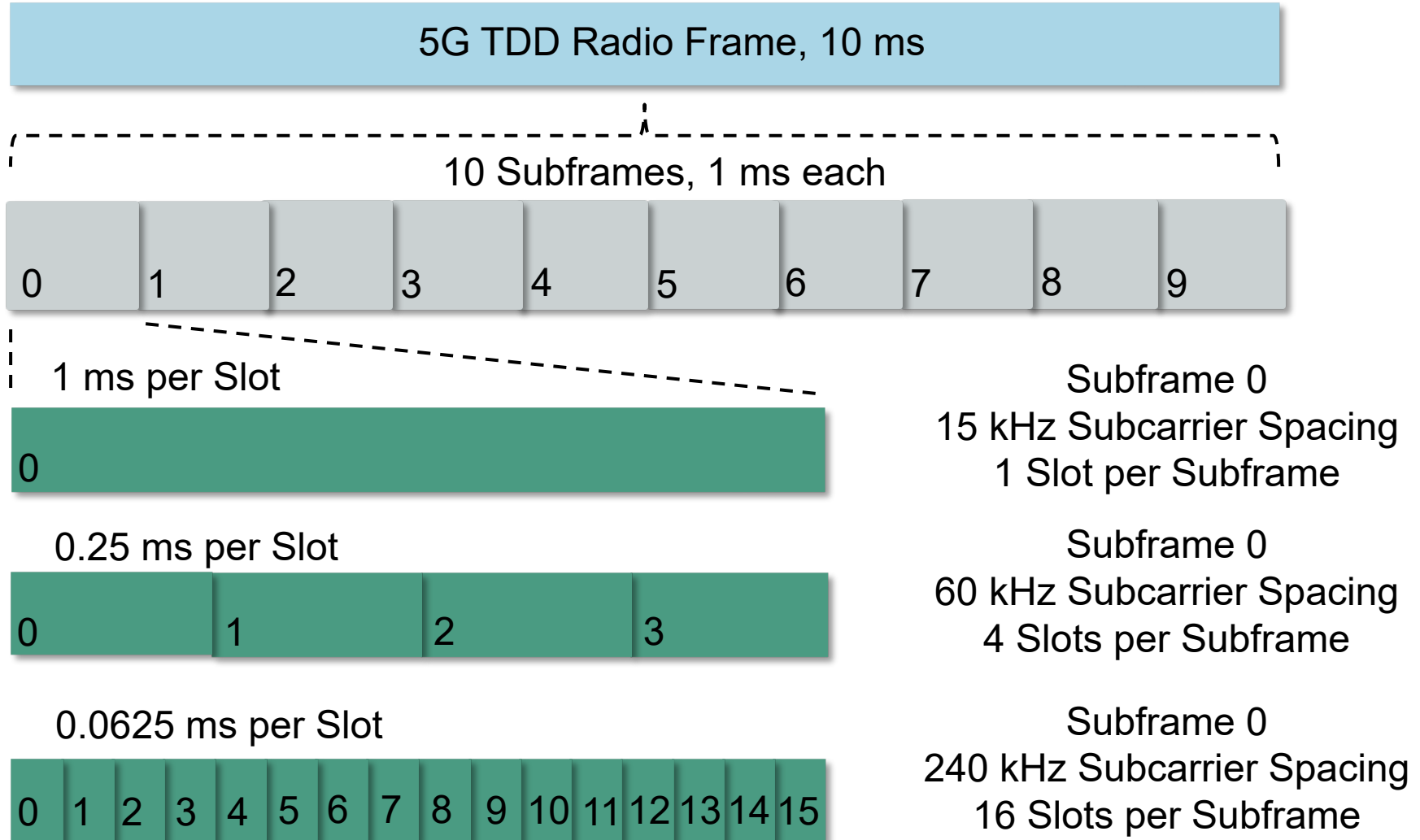
- TDD Benefits:
 - Efficient use of spectrum
 - Dynamic allocation of bandwidth for asymmetric traffic

- TDD Challenges:
 - Precision timing to avoid interference & delay
 - Timing compresses at higher frequencies

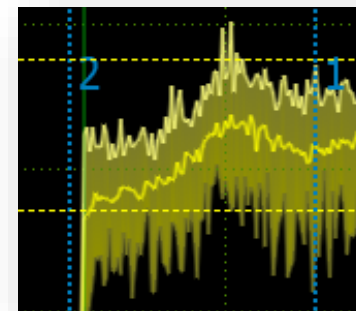
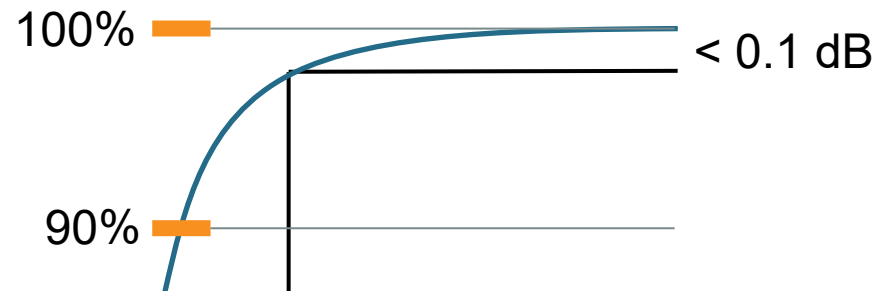
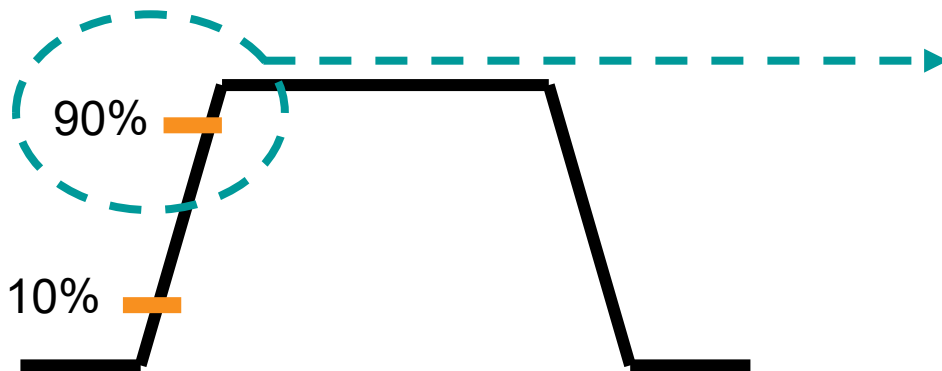
5G TDD Pulse
(without modulation)

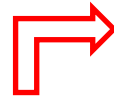


Pulse Width = 47 μ s
Gap = 3 μ s

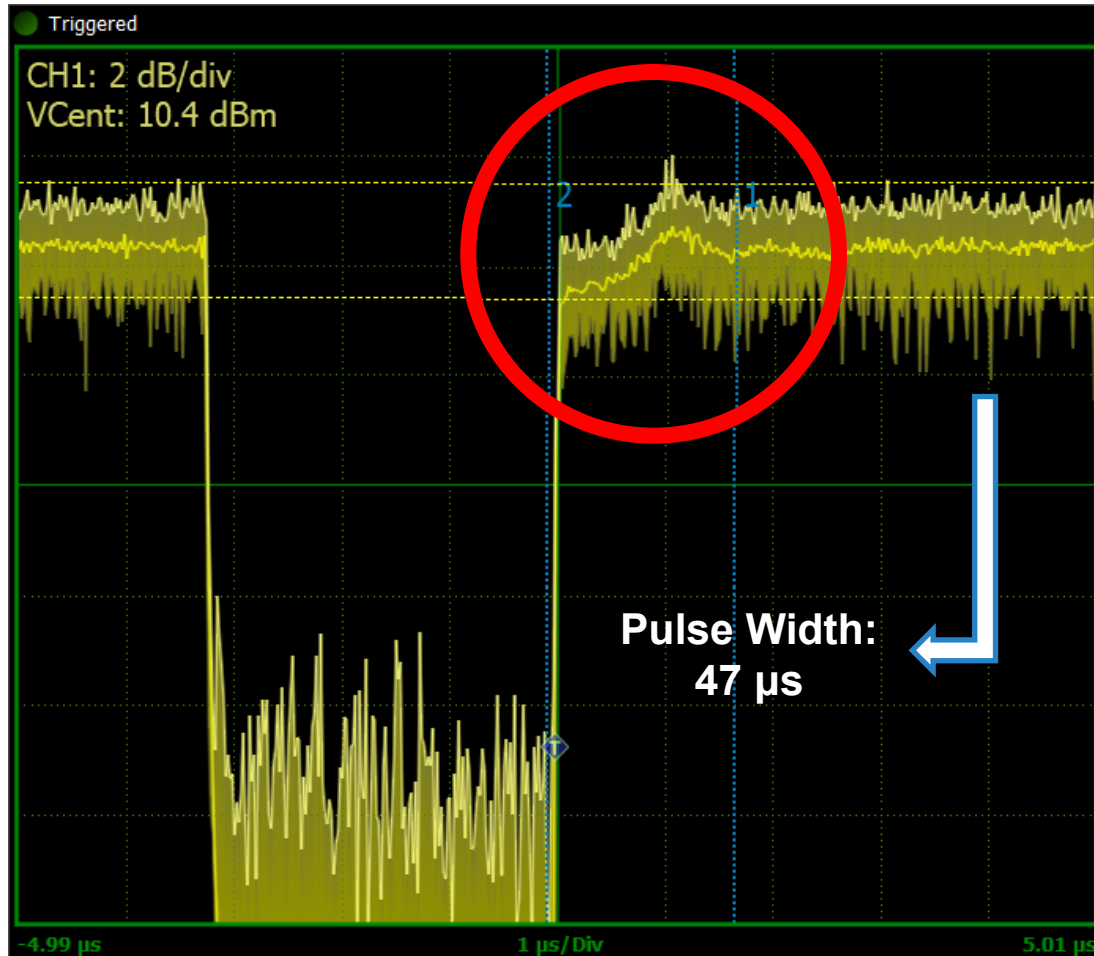


- **Rise Time:** Signal change from 10% to 90% of Its Magnitude
- **Fall Time:** Signal Changes from 90% to 10% of Its Magnitude
- **Settling Time:** Interval from 90% to Signal's Steady State Maximum Level
- All Key in Determining Switching Speed

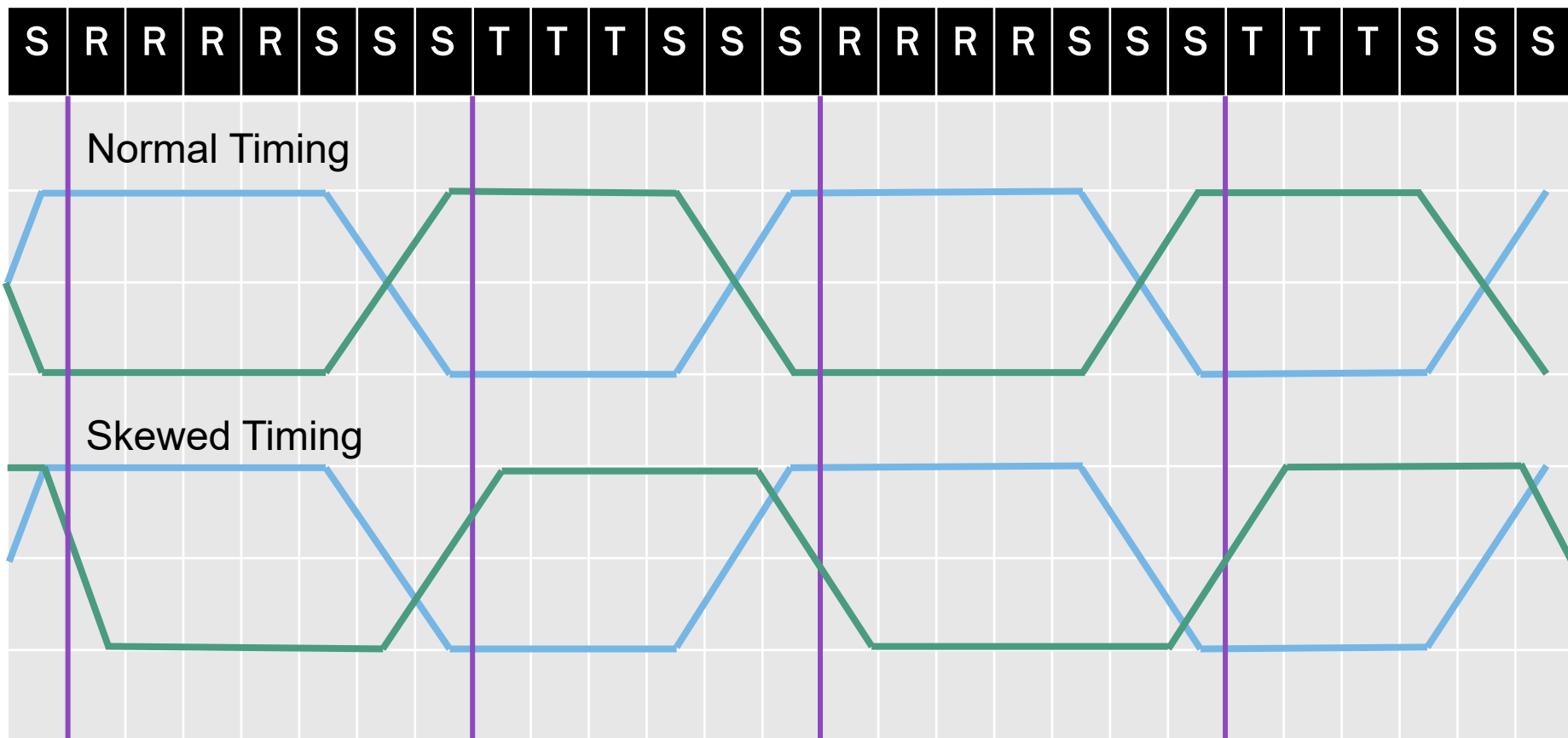




Settling Time:
1.7 μs

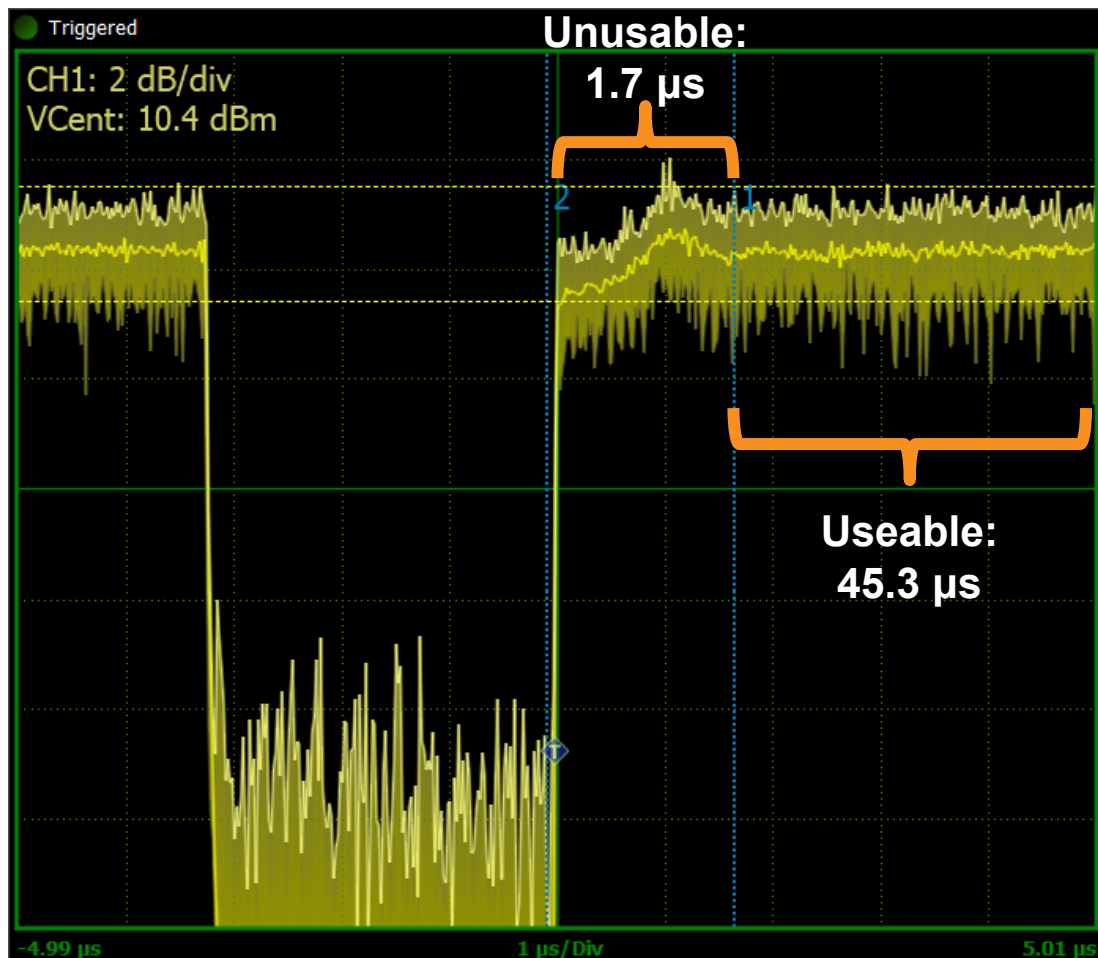


- **Settling Time: 90%** to Signal's Steady State Max Level
 - Dead time, region of unusable data
- Response Time = Rise Time + Settling Time



█ Transmit
 █ Receive
 █ Switch Time

Pulse width is 47 μs , but only 45.3 μs useable

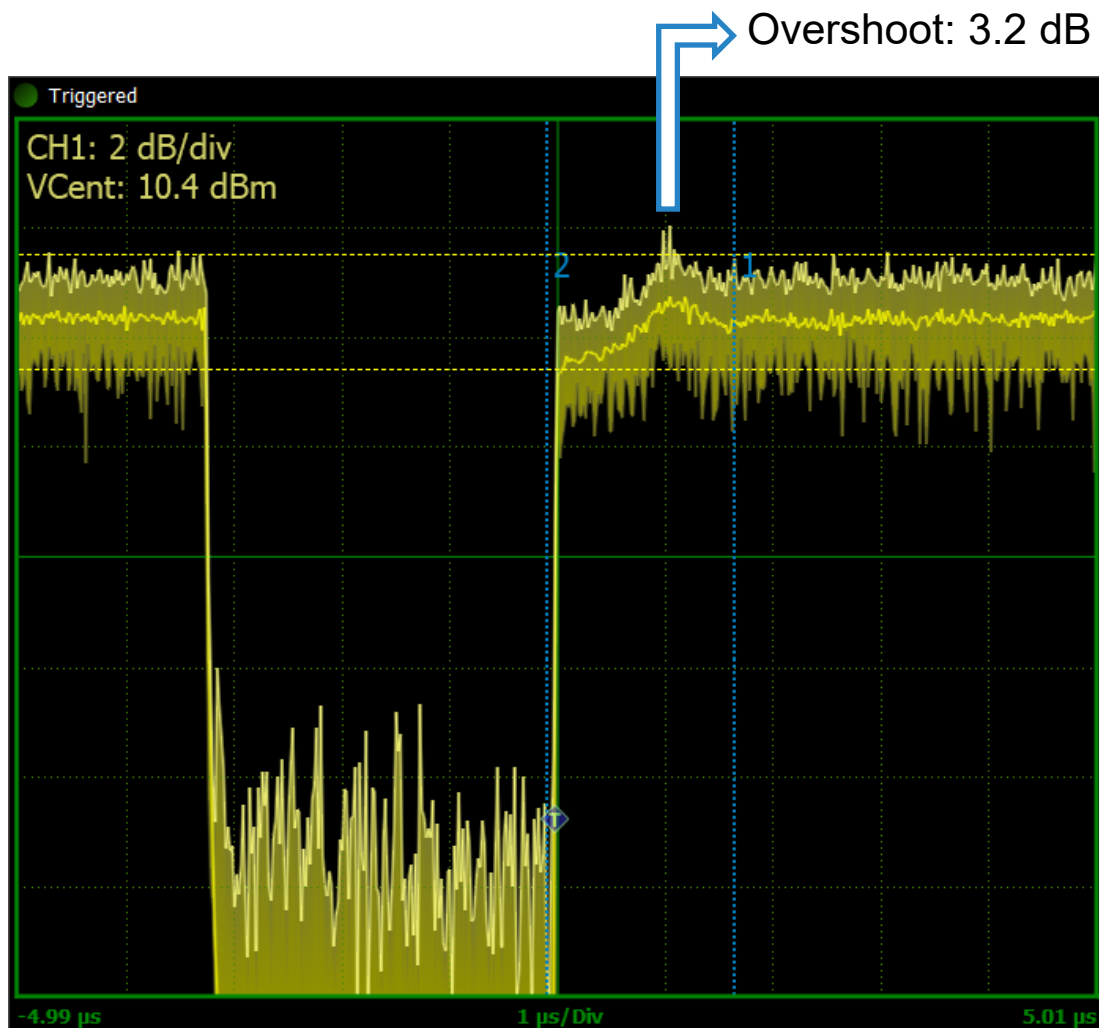


- **Propagation Delay:**

Round-trip Time Interval from the Sender to the Receiving Device

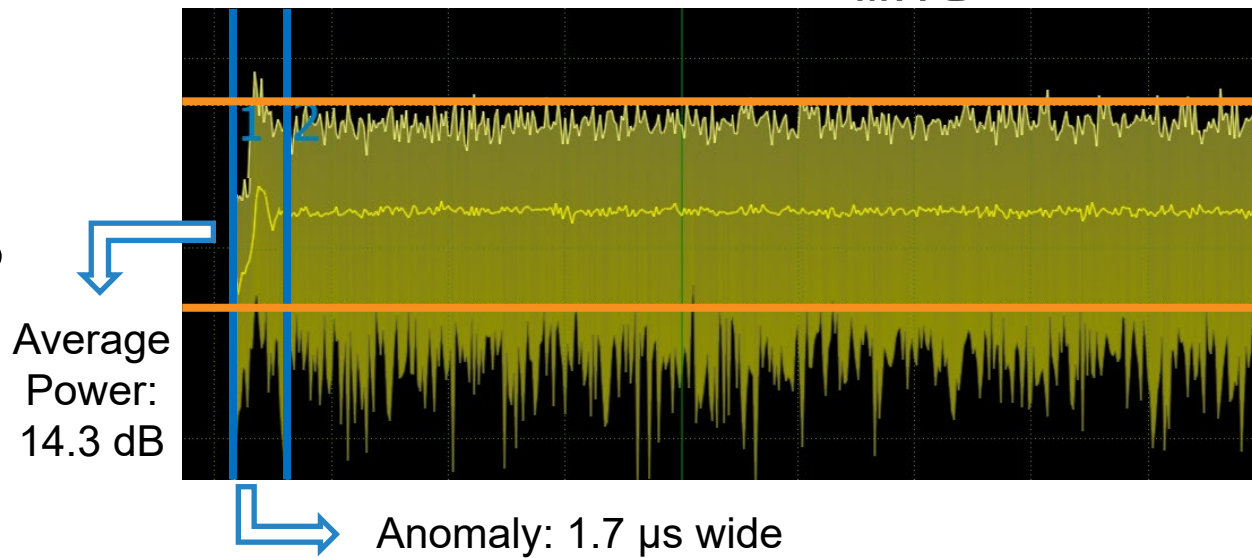
- **Leads to:**

- Uplink/downlink overlap
- Interference
- Performance degradation

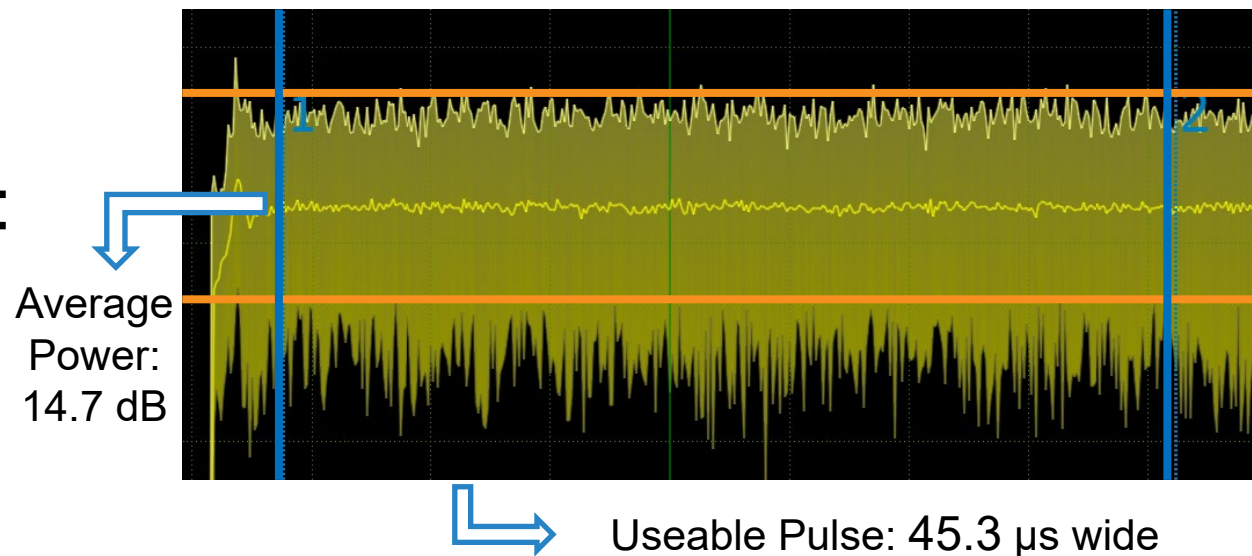


- **Overshoot:** Signal Exceeds Its Top Amplitude
 - Often followed by ringing
- Degrades Communications Integrity

- Crest Factor of Anomaly: 2.4 dB

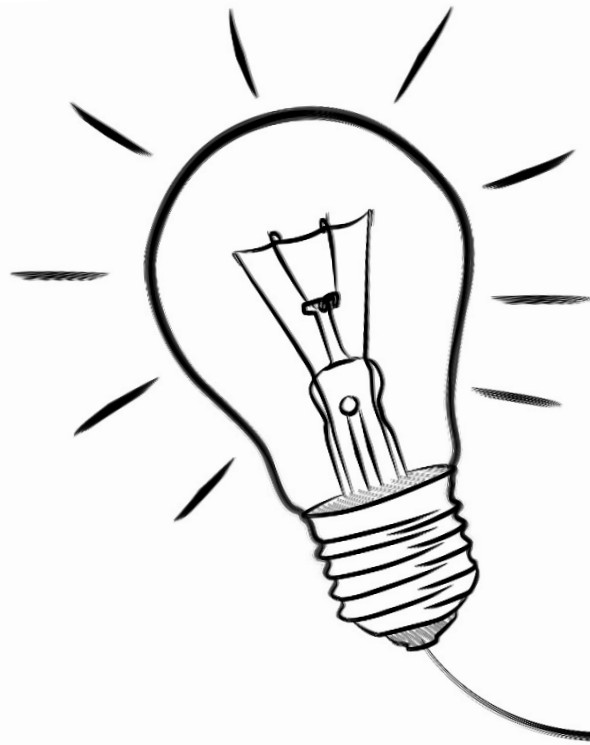


- Crest Factor of Remaining Pulse: 1.45 dB



— Vertical Markers — Horizontal Markers

What Test Instrument Can Capture the Critical Metrics for 5G TDD Networks?



Solution:
Broadband
Power Sensor

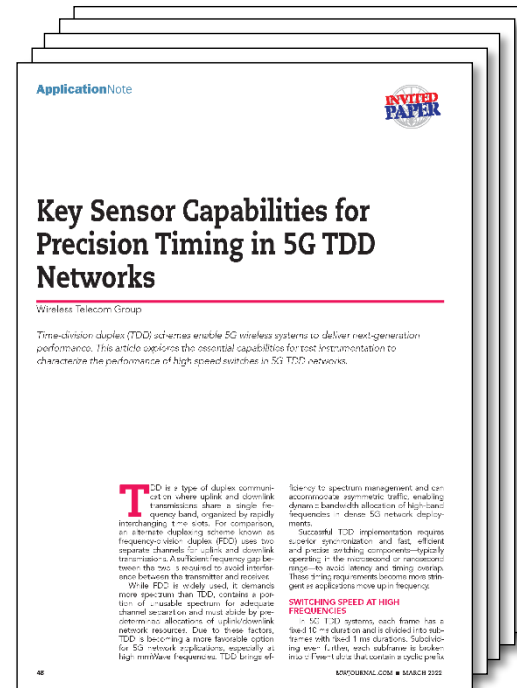


- Low-Cost Device
 - More economical compared to a VNA
- Fast Rise Times
 - Capture TDD signal's rising edge
 - Ideal: 3 ns
- Fast Measurement Speed
 - Validate switching performance and catch anomalies
 - Unique DSP enables gap-free acquisition
 - Ideal: 100,000 measurements per second

- Video Bandwidth
 - Accommodate 100-MHz 5G channel
 - Ideal: 195 MHz
- Cursor Resolution
 - Resolve timing difference between TDD switches
 - Ideal: 100 ps
- Test Setup Synchronization
 - Economical alternative to a VNA
 - Use client's actual signals

- 5G TDD Networks & Timing Requirements
- Critical Test Parameters
 - Rise time, fall time, settling time
 - Propagation delay & waveform anomalies
 - Crest factor
- Test Instrument Considerations
 - Cost & ease of use
 - Fast rise times & measurement speed
 - Video bandwidth & time resolution
 - Test setup synchronization

- MWJ March 2022 Issue: Test & Measurement
 - **Article:** “Key Sensor Capabilities for Precision Timing in 5G TDD Networks”



A large, 3D-style blue question mark with a glossy finish, positioned above the word "Questions".

Any Questions

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