



LITEPOINT

A Teradyne Company

Wireless Communication is
More Important than Ever





2020 was a very
weird year



We learned a new
way of working



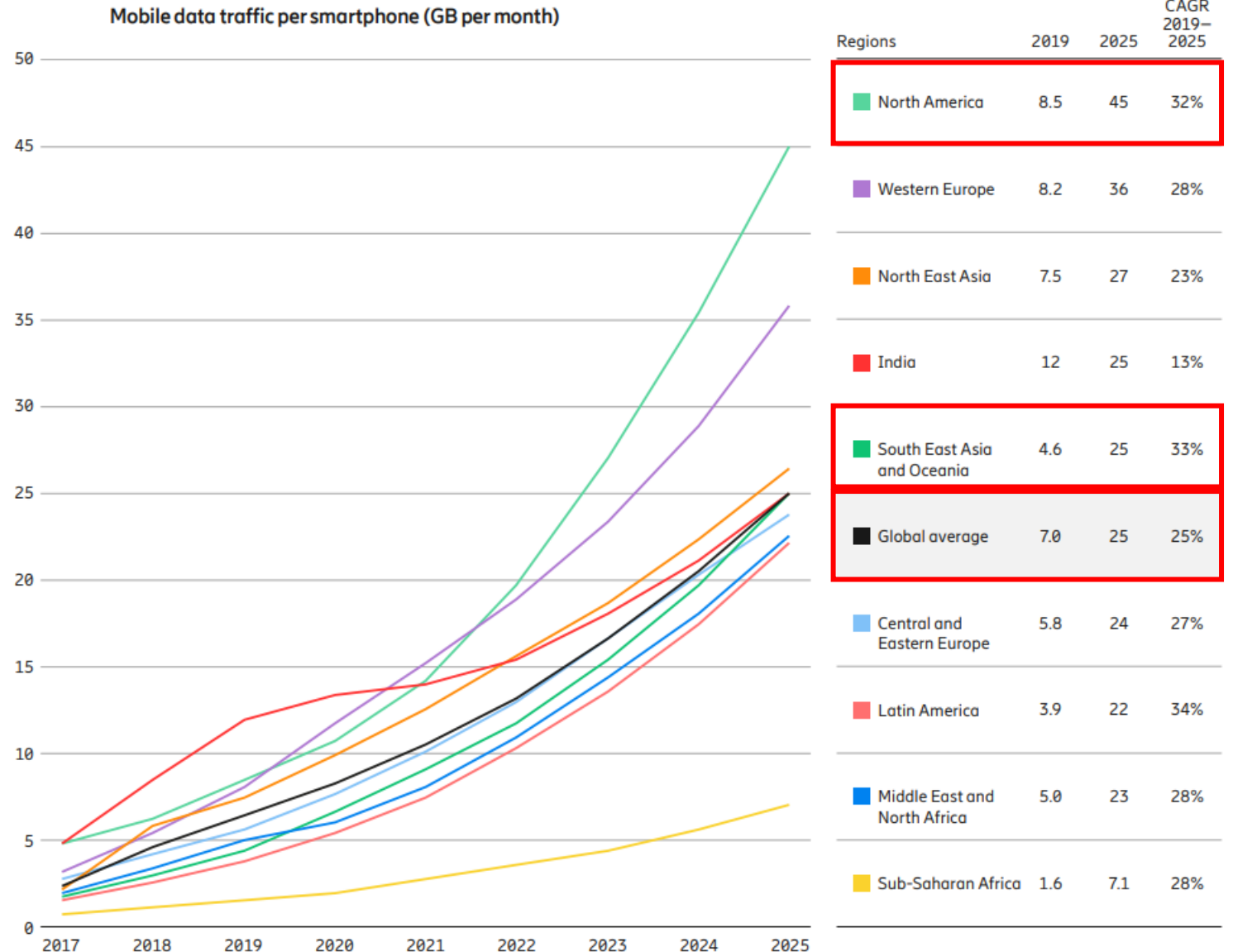
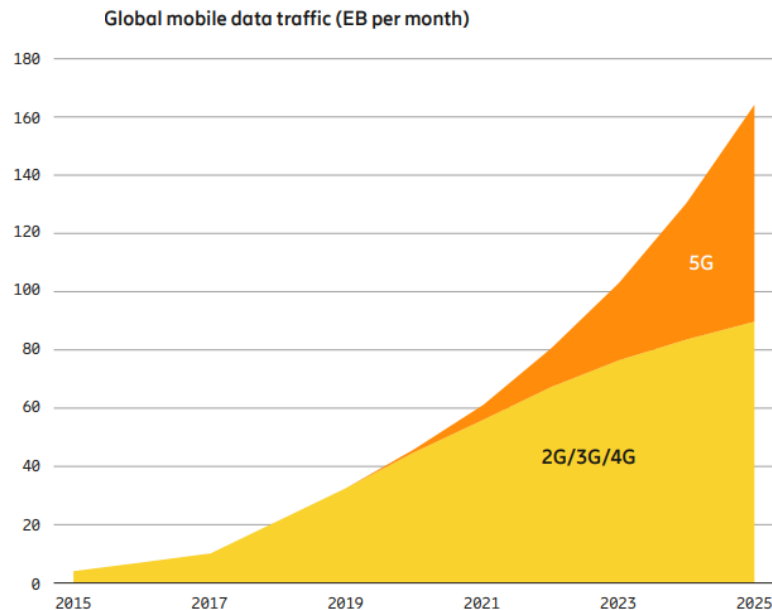
We learned a new
way of learning



Wireless connectivity
proved to be an
essential part of life

Data Consumption Growth Can Strain Network Capacity

South East Asia: 33% CAGR
 North America: 32% CAGR
 Global average: 25% CAGR



Source: Ericsson Mobility Report June 2020

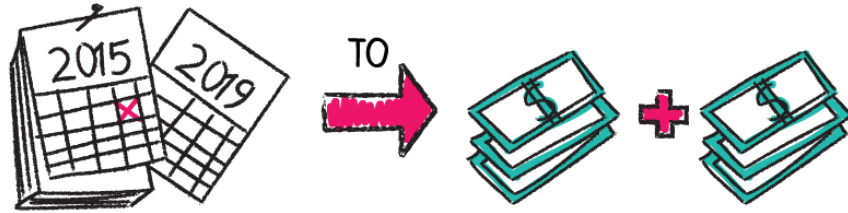


RULE OF 72

WHAT

HOW MUCH TIME

DOUBLE YOUR \$



FORMULA

JUST DIVIDE **72** BY THE INTEREST RATE

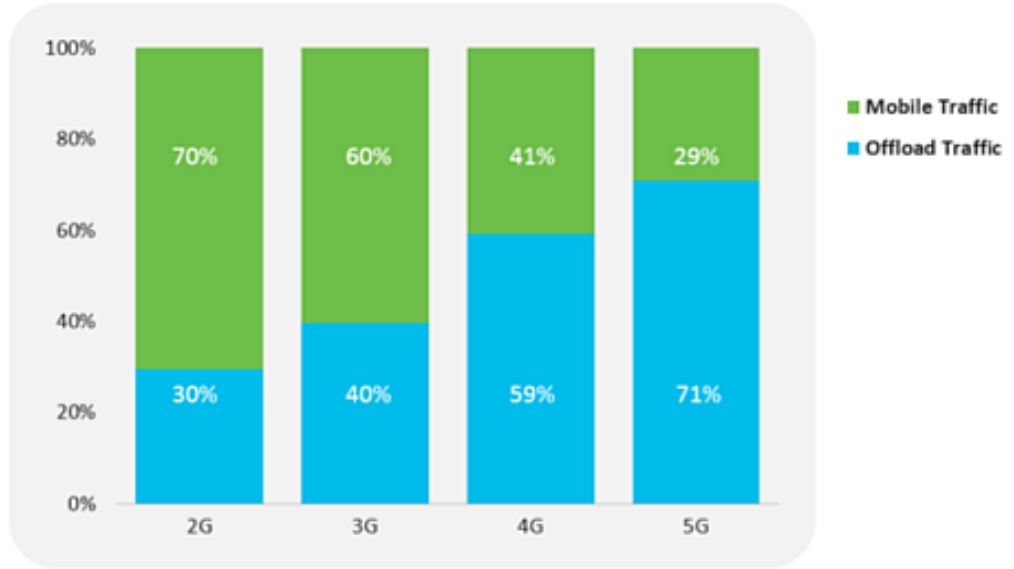
$$\frac{72}{\% \text{ RATE OF RETURN}} = \text{YEARS TO DOUBLE}$$

EXAMPLE: $72 / 6 = 12$ YEARS















Source: napkinfinance.com

A 25%-35% growth in data traffic requires 2x more network capacity every 2-3 years



Source: Cisco VNI Global Mobile Data Traffic Forecast, 2017-2022

Global Spectrum Allocations and Network Deployments


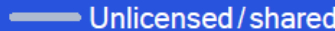
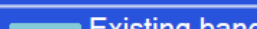
	<1GHz	3GHz	4GHz	5GHz	6GHz	24-30GHz	37-50GHz	64-71GHz	>95GHz
	600MHz (2x35MHz) 900MHz (2x3MHz) 2.5/2.6GHz (B41/n41)	3.1-3.45GHz 3.45-3.55GHz 3.55-3.7GHz	3.7-3.98GHz 4.99GHz	4.94-5.9-7.1GHz		24.25-24.45GHz 24.75-25.25GHz 27.5-28.35GHz	37-37.6GHz 37.6-40GHz 47.2-48.2GHz	57-64GHz 64-71GHz	>95GHz
	600MHz (2x35MHz)	3.475-3.65 GHz 3.65-4.0GHz				26.5-27.5GHz 27.5-28.35GHz	37-37.6GHz 37.6-40GHz	57-64GHz 64-71GHz	
	700MHz (2x30 MHz)	3.4-3.8GHz		5.9-6.4GHz		24.5-27.5GHz		57-66GHz	
	700MHz (2x30 MHz)	3.4-3.8GHz				26GHz		57-66GHz	
	700MHz (2x30 MHz)	3.4-3.8GHz				26GHz		57-66GHz	
	700MHz (2x30 MHz)	3.46-3.8GHz				26GHz		57-66GHz	
	700MHz (2x30 MHz)	3.6-3.8GHz				26.5-27.5GHz		57-66GHz	
	700MHz 2.5/2.6GHz (B41/n41)	3.3-3.6GHz		4.8-5GHz		24.75-27.5GHz		40.5-43.5GHz	
	700/800MHz 2.3-2.39GHz	3.4-3.42-3.7-3.7GHz 3.42GHz 3.7GHz 4.0GHz			5.9-7.1GHz	25.7-26.5GHz 26.5-28.9GHz 28.9-29.5GHz	37GHz	57-66GHz	
		3.6-4.1GHz		4.5-4.9GHz		26.6-27GHz 27-29.5GHz	39-43.5GHz	57-66GHz	
	700MHz	3.3-3.6GHz				24.25-27.5GHz 27.5-29.5GHz	37-43.5GHz		
		3.4-3.7GHz				24.25-29.5GHz	39GHz	57-66GHz	

Global snapshot of allocated/targeted 5G spectrum

5G is being designed for diverse spectrum types/bands

Source: Qualcomm, Global update on spectrum for 4G & 5G, Dec 2020

New 5G band

-  Licensed
-  Unlicensed / shared
-  Existing band

Mid-Band, The Goldilocks 5G Spectrum?



- Low Band (<50 MHz)
- Mid Band (200 MHz)
- High Band (~1 GHz)

Outstanding Bandwidth
Very Limited Coverage

Outstanding Coverage
Very Limited Bandwidth

Better Coverage than High Band
More Bandwidth than Low Band

English Fairy Tales and Stories
34K subscribers

The Mid-Band Goldrush

2021: 3.7 GHz – 3.98 GHz auction

\$81 Billion!!

280 MHz

(almost \$300M per MHz!)

Verizon:	\$45B
AT&T:	\$23B
T-Mobile:	\$9B

...3.45 – 3.55 GHz auction coming later in 2021...

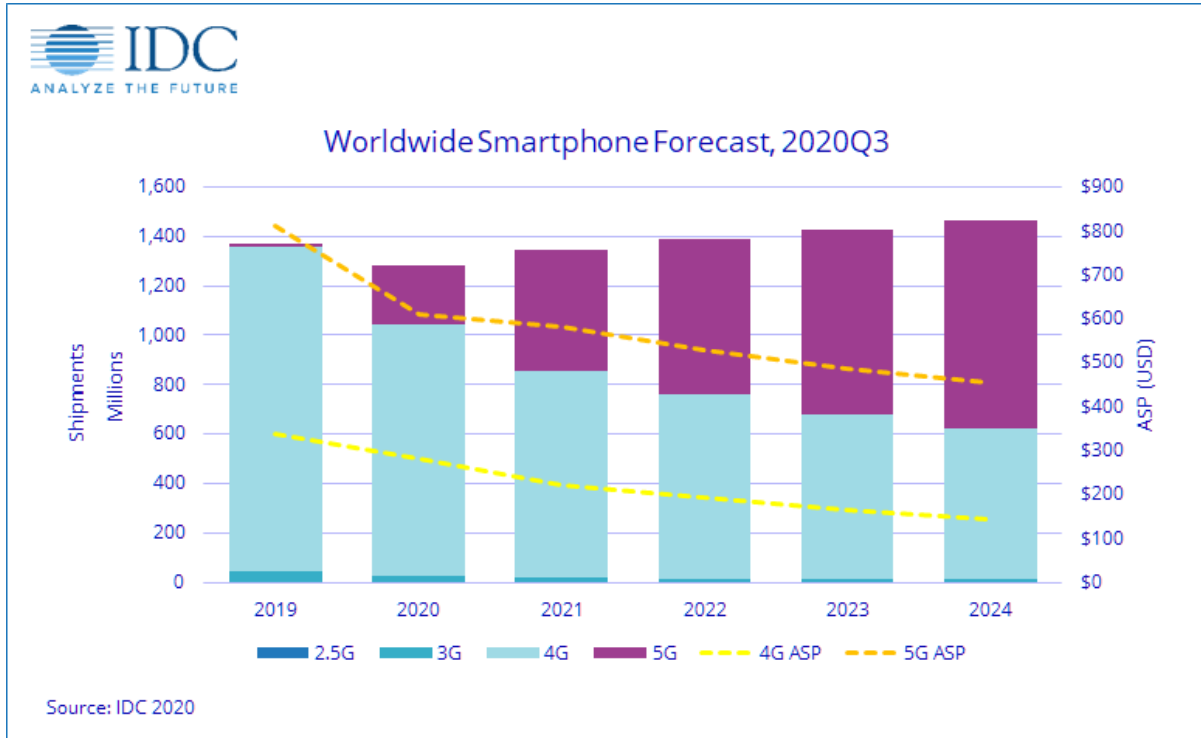




Trends we are watching in 2021

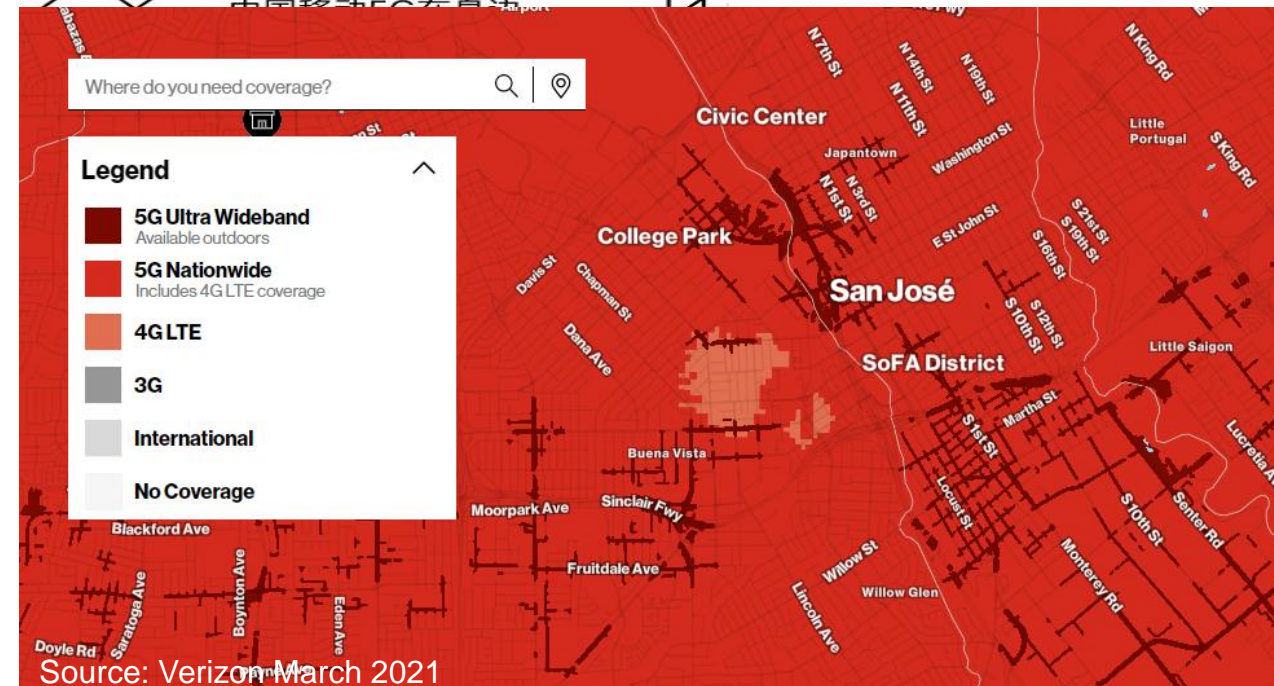
5G Becoming Mainstream

> 30% of all Smartphones sold in 2021 will be 5G enabled



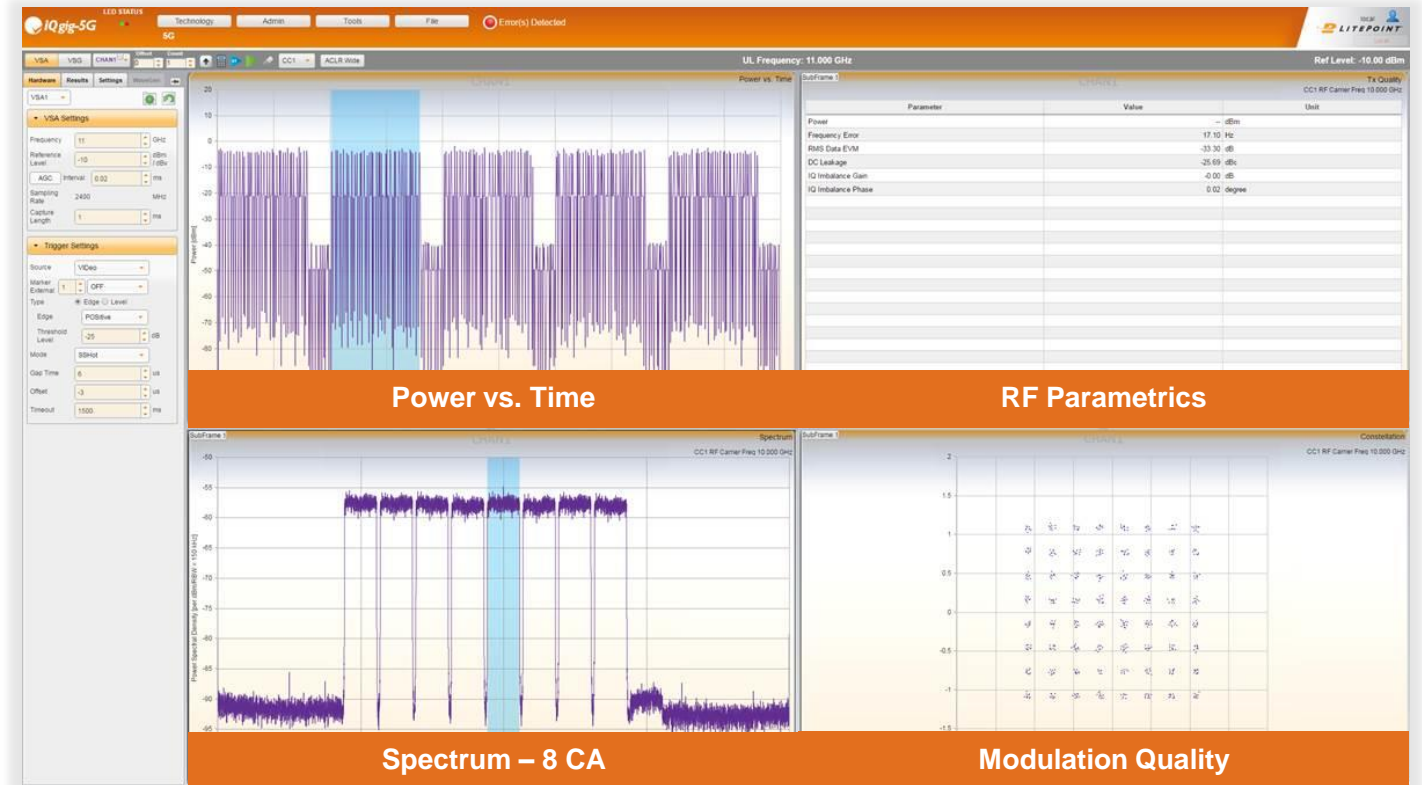
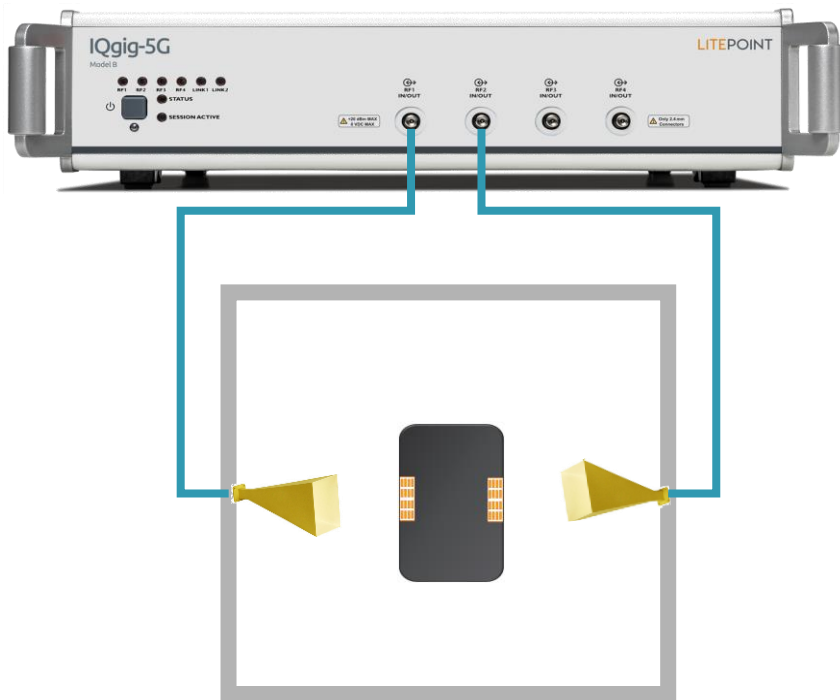
- 2019: 20M 5G Smartphones
- 2020: 200M 5G Smartphones
- 2021: 450M+ 5G Smartphones

- 5G deployments are still predominantly FR1 low band and mid-band



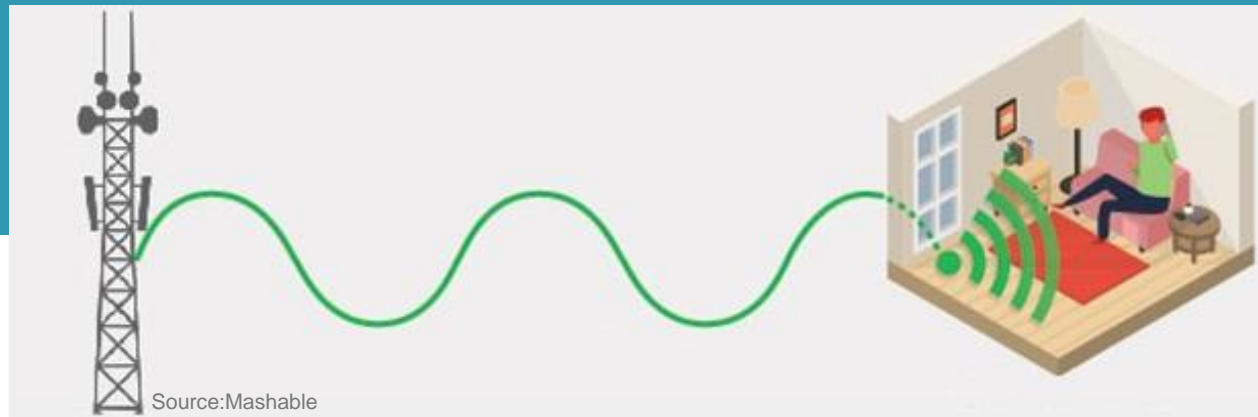
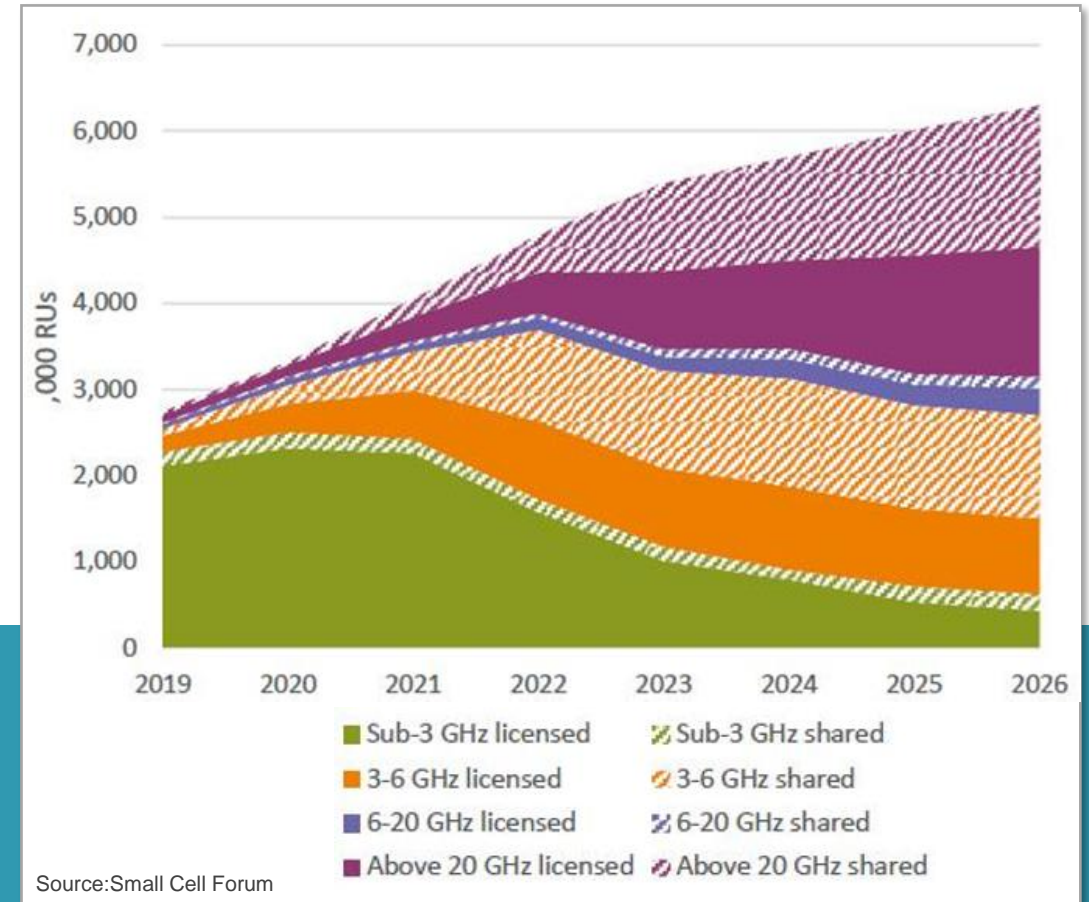
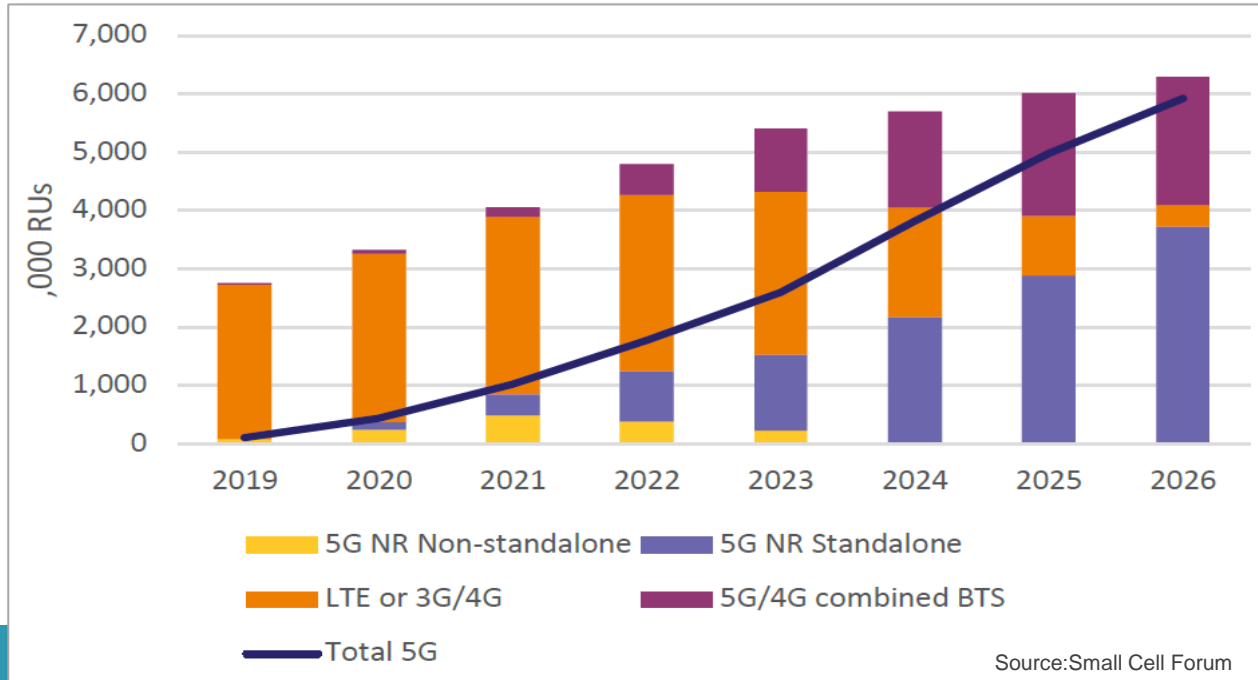
Carriers Deploying FR2 with Wide Transmission Bandwidth

- Wider bandwidth enables shorter transmission times
 - Better battery life
 - Frees up network capacity
- Must ensure that devices are validated in these conditions



Solving the “Indoor Problem”

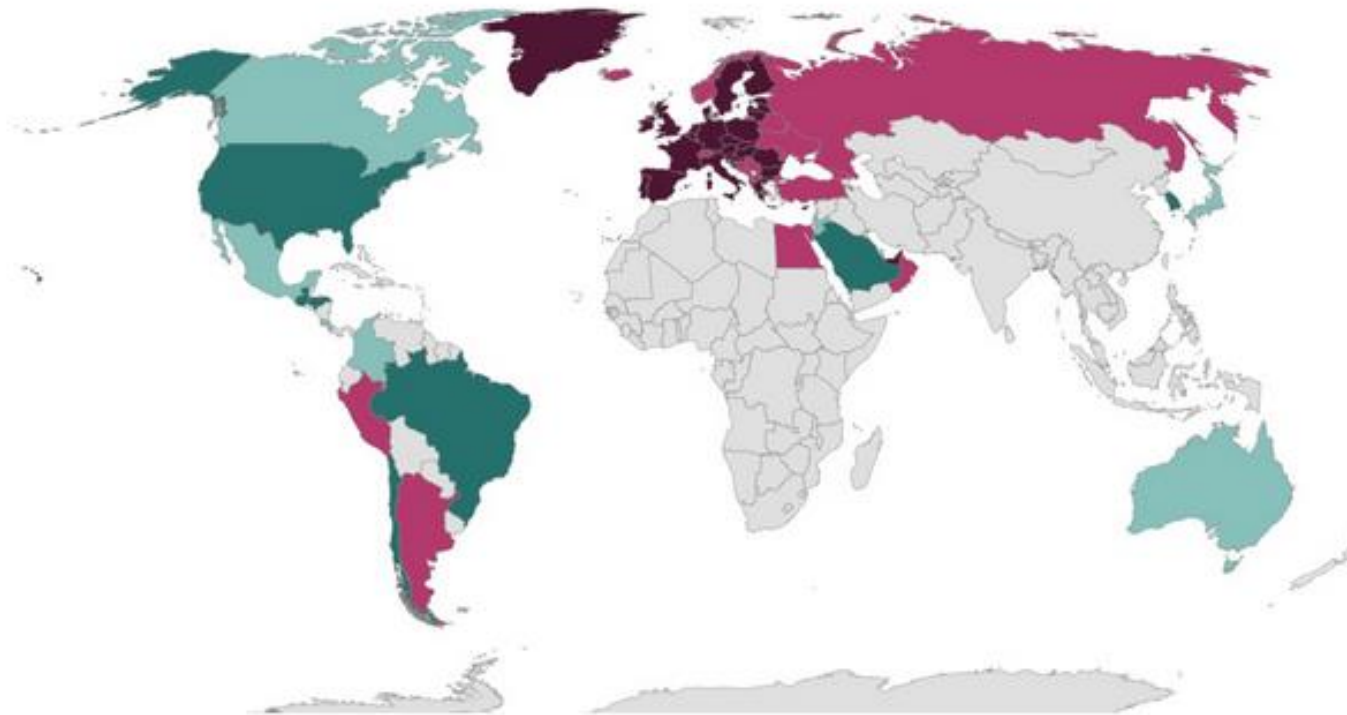
Small Cells and CPEs Play a Crucial Role in the 5G Build-Out



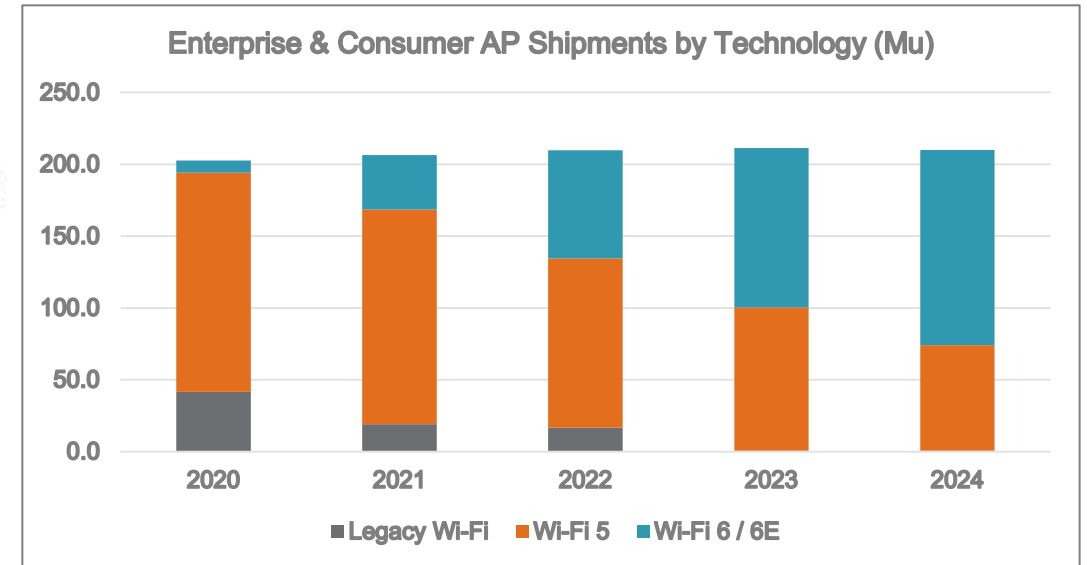
Focus is on mid-band and mmWave

Wi-Fi 6E Rolling Out and Gaining Momentum

- Adopted 5925-6425 MHz
- Adopted 5925-7125 MHz
- Considering 5925-6425 MHz
- Considering 5925-7125 MHz



Source: Wi-Fi Alliance, April 2021



Source: ABI Research Wi-Fi CPE Market 3Q 2020

“Wi-Fi 6E will see rapid adoption in 2021 with more than 338 million devices (Networking and Mobile) entering the market, and nearly 20 percent of all Wi-Fi 6 device shipments supporting 6 GHz by 2022”

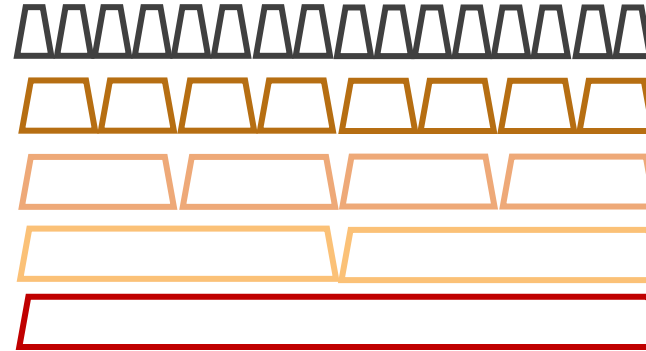
Phil Solis, research director at IDC.

Wi-Fi 6 is Barely Here, but Wi-Fi 7 is Already in the R&D Phase

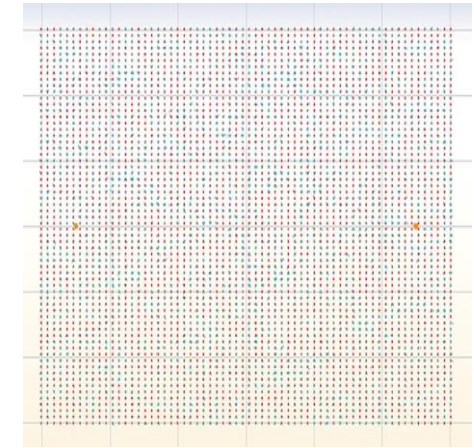
802.11be “Extremely High Throughput” (EHT)



- Target Performance
- Low Latency: **< 5 ms**
- High Throughput: **30 Gbps**



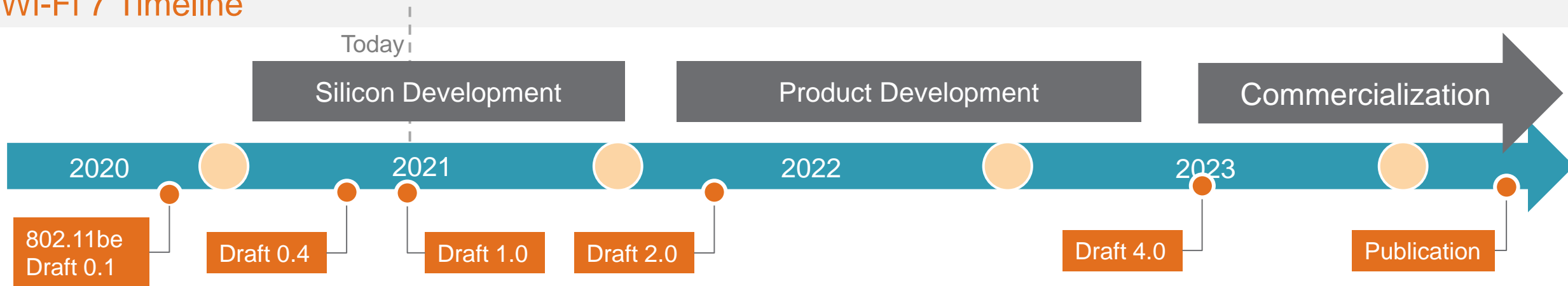
320 MHz Channels



4096 QAM

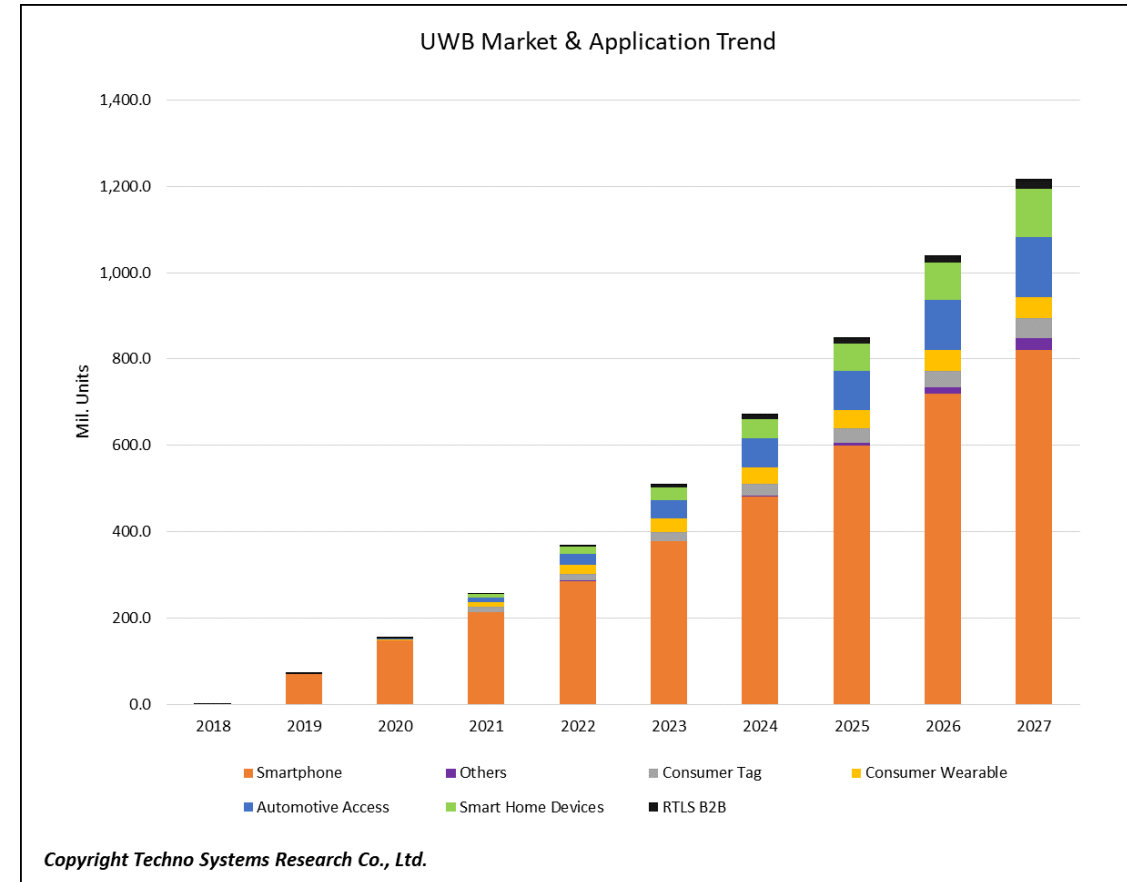
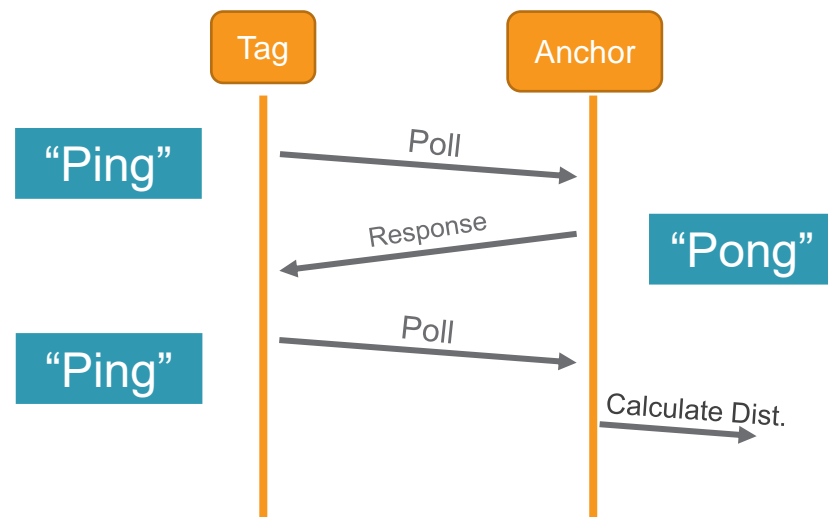
Additionally up to 16x16 MIMO, Multi-Link Operation, and many more features...

Wi-Fi 7 Timeline



UWB: Helping to Make the World More Secure

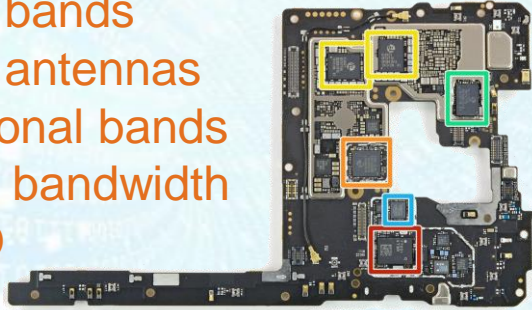
- A device can now understand its position, enabling a variety of new use-cases:
 - Smartphone, Automotive, Smart Home, IoT
- UWB uses Time of Flight to determine position, enabling “positional authentication, adding a new layer of security



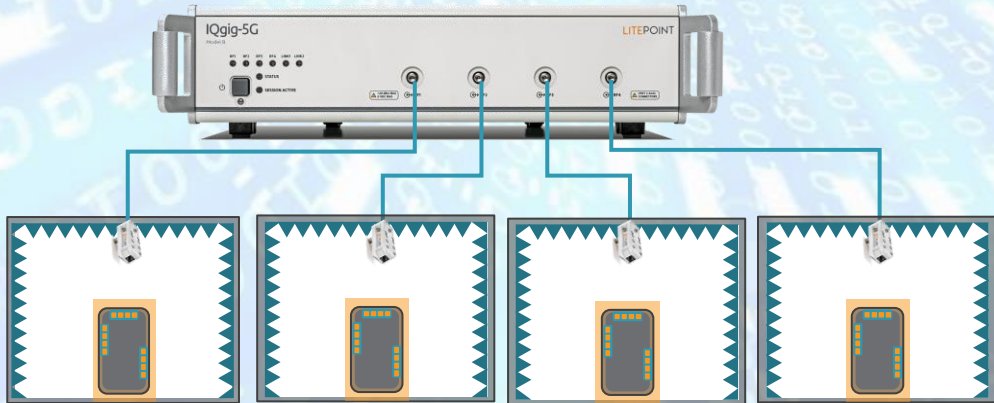
Ensuring 5G and Wi-Fi 6 & 6E Performance

5G

FR1: Many bands
Many antennas
Additional bands
Wider bandwidth
MIMO

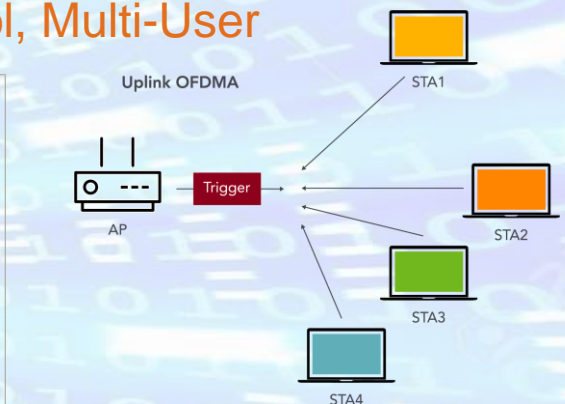
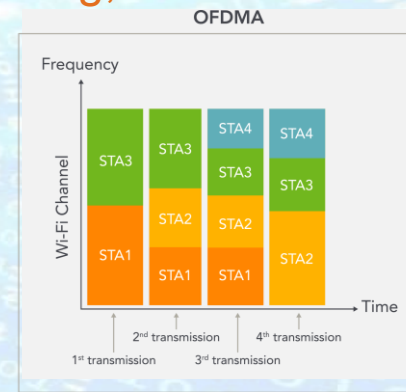


FR2: Increasing phone attach rate
Focus on production economics
Carriers deploying 8x 100 MHz

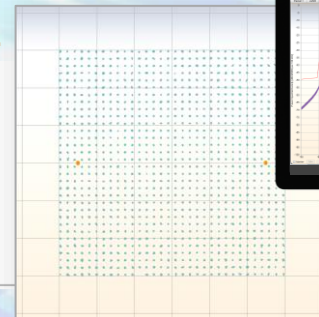
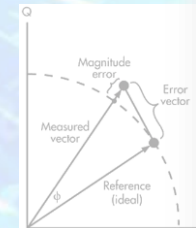


Wi-Fi 6E

Wi-Fi becoming “cellular-like”:
Timing, Power Control, Multi-User



Breaking the “6 GHz barrier”
EVM Performance pushing boundaries:
1024 QAM → 4096 QAM
160 MHz → 320 MHz



Wi-Fi & 5G: Why Choose?



- 5G & Wi-Fi will both play a significant role in the “5G Era”
- The application-specific use-case must consider its unique requirements:
 - Licensed vs. Unlicensed spectrum
 - QoS requirements, network predictability, security, user-authentication
 - Cost to deploy, flexibility, existing device interoperability
- Use-case convergence allows both technologies to shine
 - Solving the “indoor problem” with Small Cells and CPEs

