Emerging Wireless Standards and Test Solutions - 802.11ax,802.11ay,802.11be

Brian Su	2019.10.2
Sr. Project Manager/Keysight	

KEYSIGHT TECHNOLOGIES

Today’s WLAN Market

Wi-Fi

$6B

MARKET SIZE
in 2017

CAGR

21.2%

Compound Annual Growth Rate through 2022

Devices

30B

Devices shipped since 1999

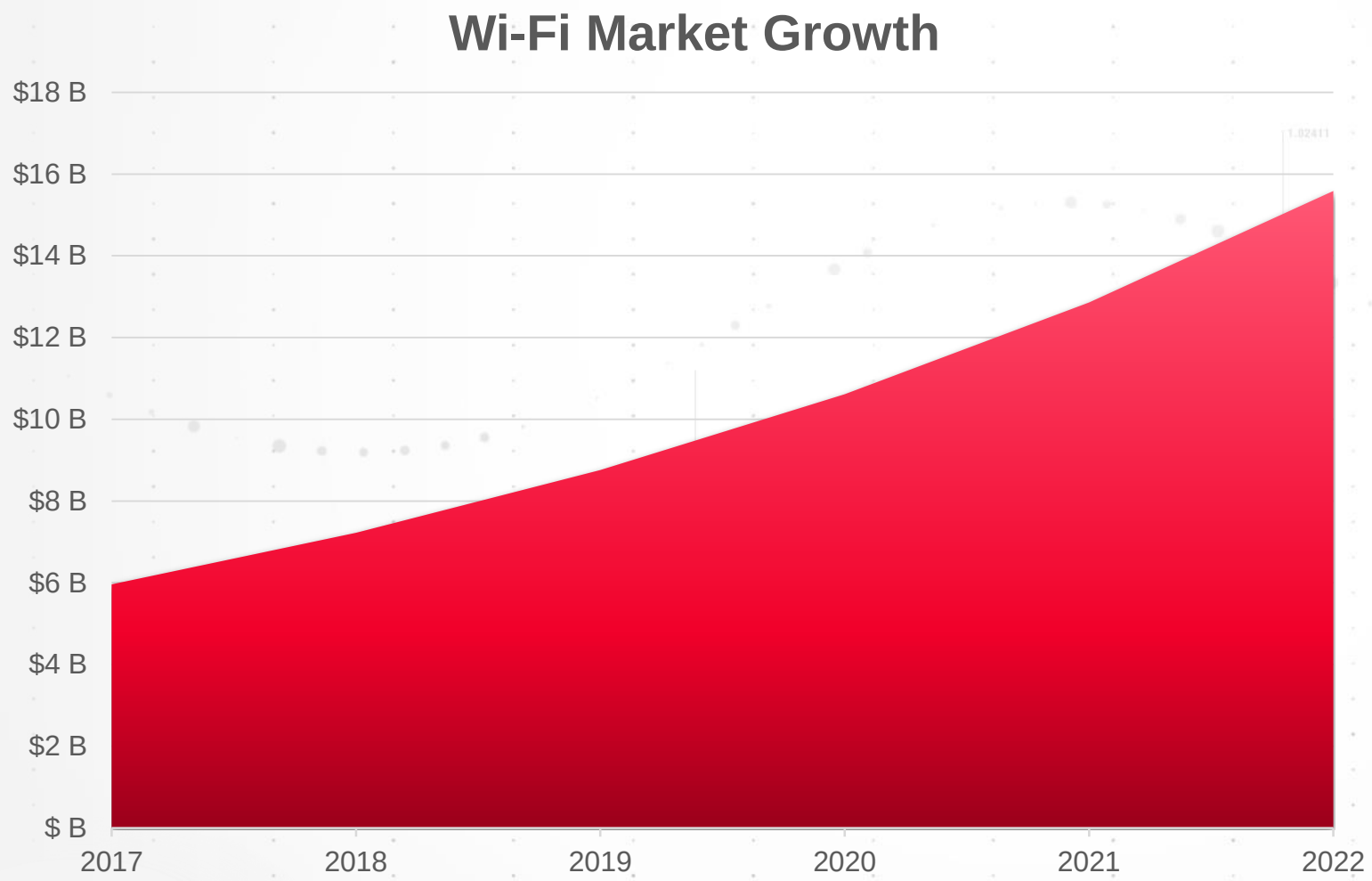
Device Usage

13B

Devices in use
in 2018

Wi-Fi Market Share

21% CAGR

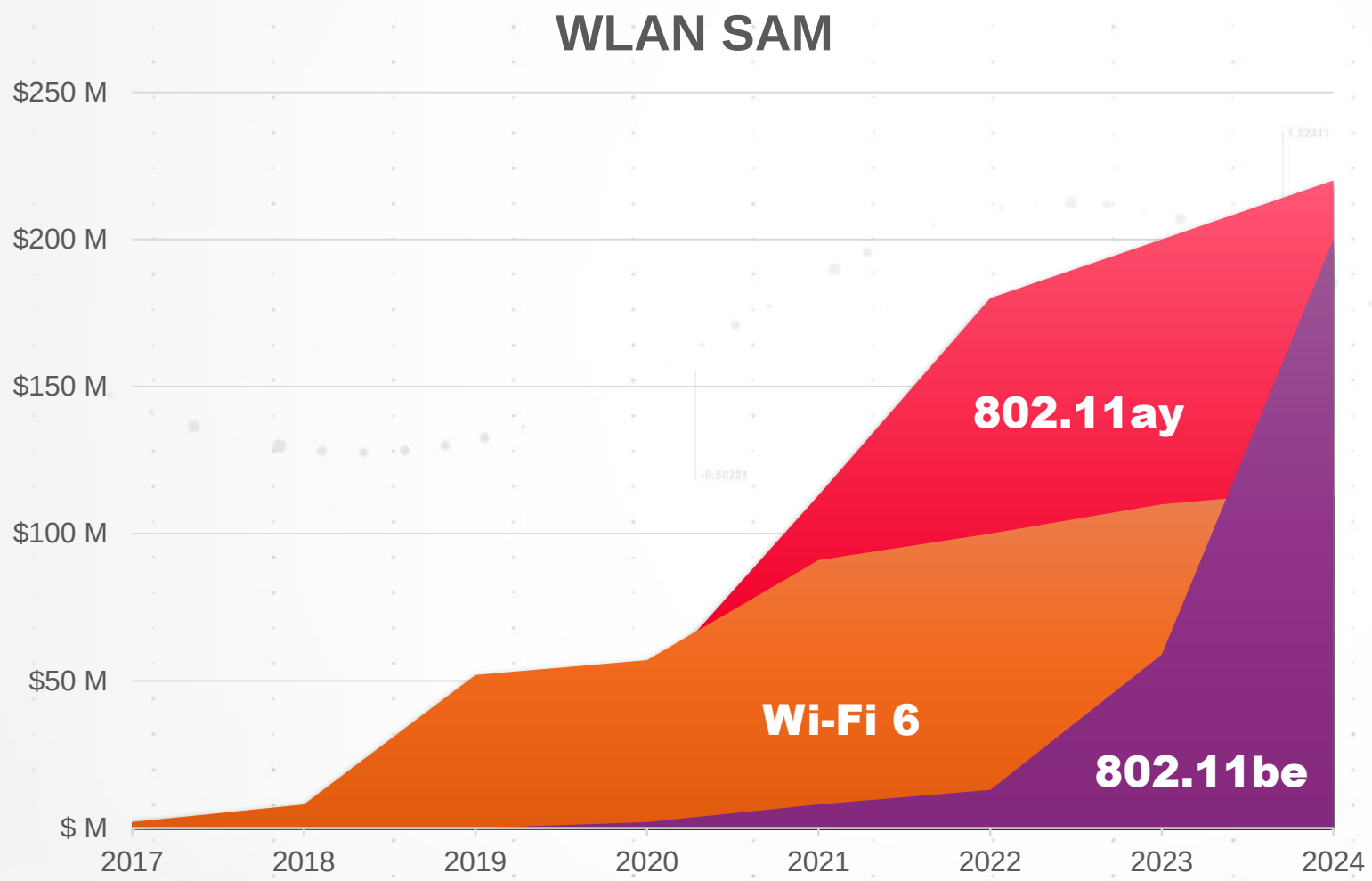


Wi-Fi Growth

- 2017
  - $5.96B
  - 4 Billion devices shipped
- 2022
  - $15.60B

KEYSIGHT TECHNOLOGIES

WLAN Serviceable Available Market



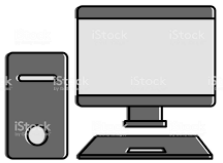
WLAN Test Opportunity

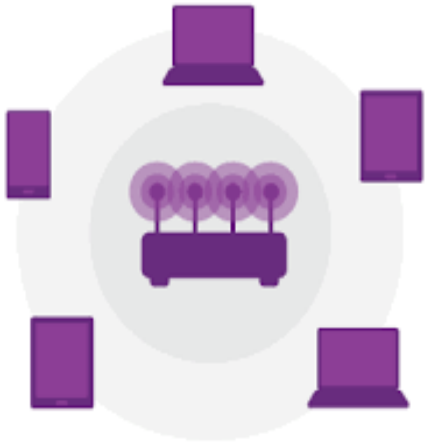
- Wi-Fi 6
  - Smaller T&M equipment upgrades
- 802.11ay
  - Requires new wide band T&M equipment
- 802.11be
  - Requires wider BW than ax

What applications are driving change?

Evolution of WLAN Technologies

Data Throughput Requirement (keep up with 5G)





802.11b 1999

802.11a/g 2003

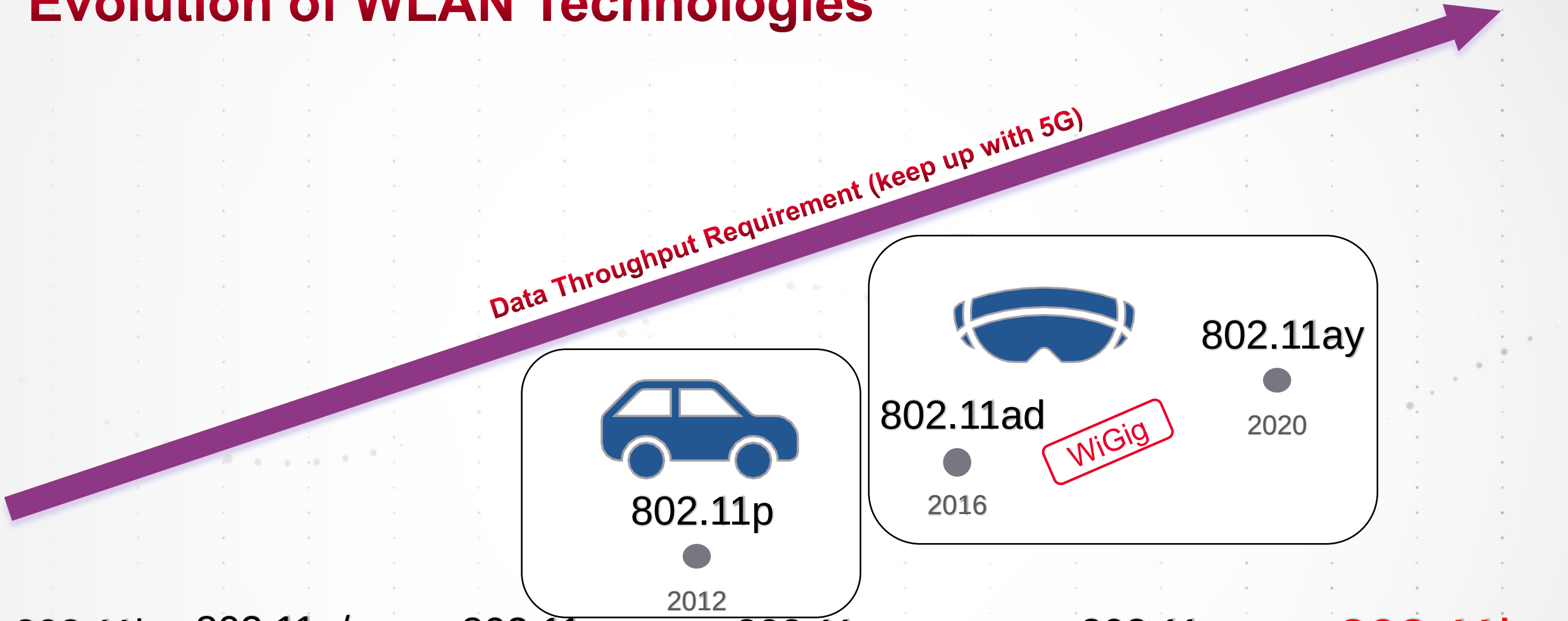
802.11n Wi-Fi 4 2009

802.11ac Wi-Fi 5 2013

802.11ax Wi-Fi 6 2019

802.11be 2023

Evolution of WLAN Technologies



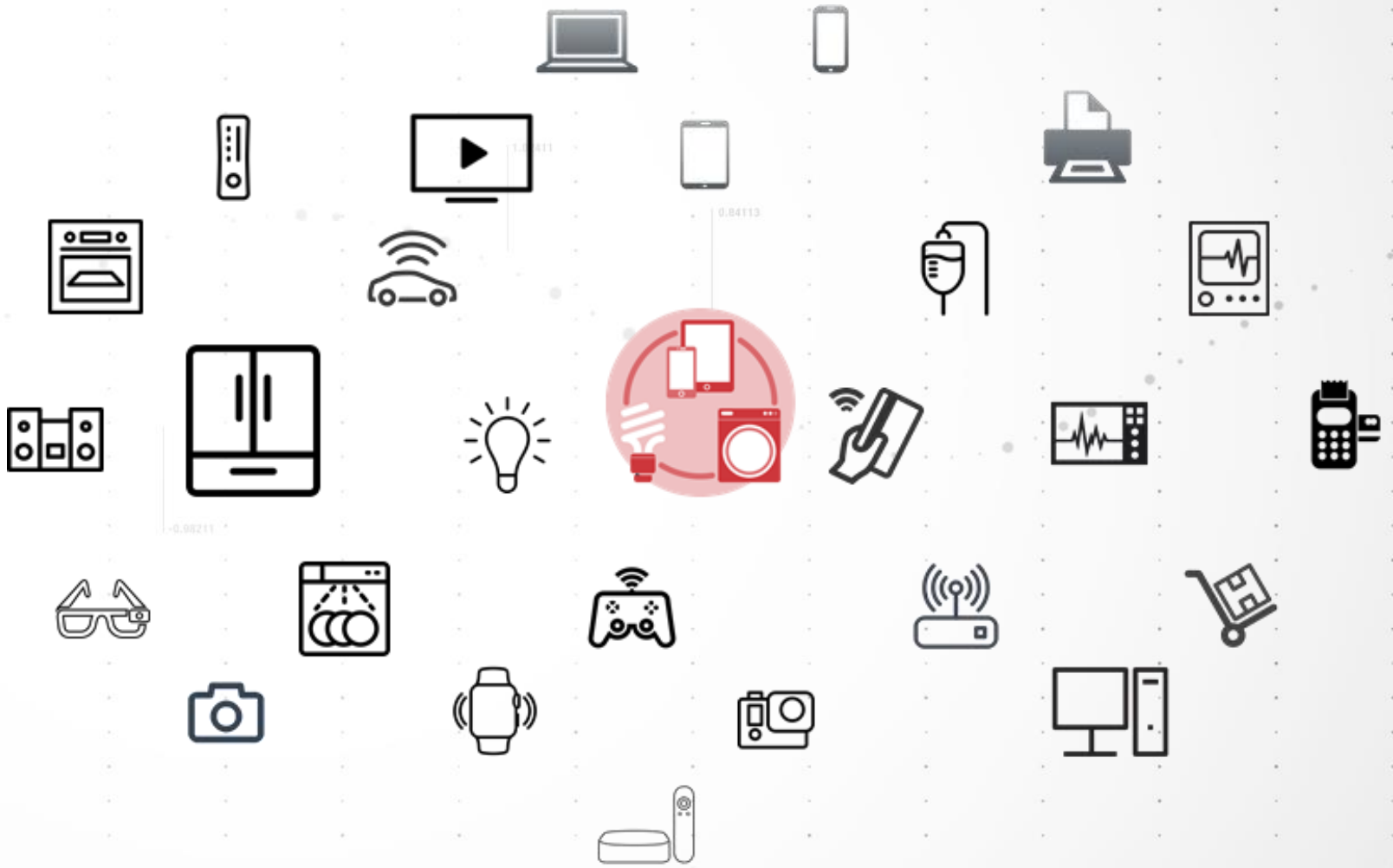
Wi-Fi 6 Applications

Wi-Fi 6 Applications

WHY ARE WE EXCITED?

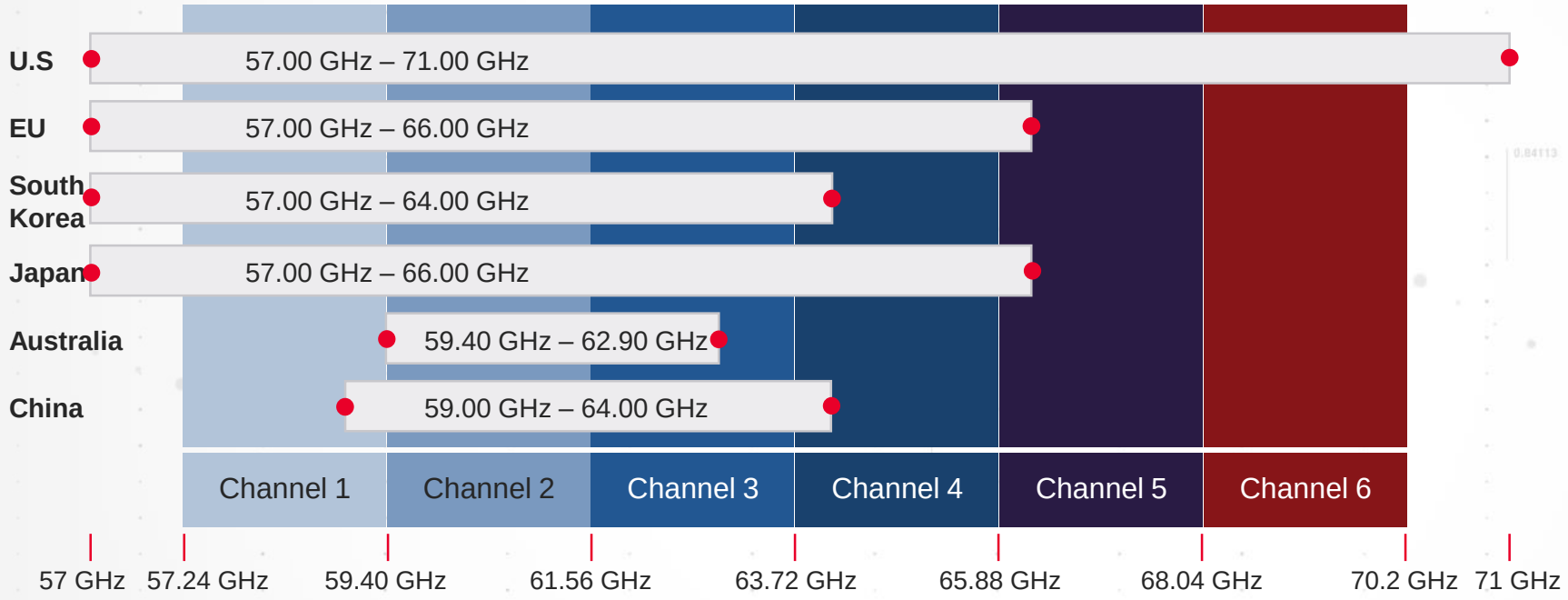
High-density environments

- IoT
- High usage homes
- High BW applications
  - video conferencing
  - 4K, 8K video
  - AR, VR



WiGig 802.11ad/ay Frequency Bands

REGIONAL ALLOCATIONS



Ref: WFA, Wi-Fi CERTIFIED WiGig Messaging Architecture v1.0

Directional transmission with large arrays provides necessary gain

WiGig 60 GHz Band

- Advantages
  - Large spectrum
  - Small antenna size
  - Directional antennas for spatial reuse
  - Low interference
  - Increased security

802.11ay Applications

WHY ARE WE EXCITED?

Higher bandwidth and low-latency applications

- Augmented Reality

https://phys.org/news/2018-11-augmented-reality.html

802.11ay Applications

WHY ARE WE EXCITED?

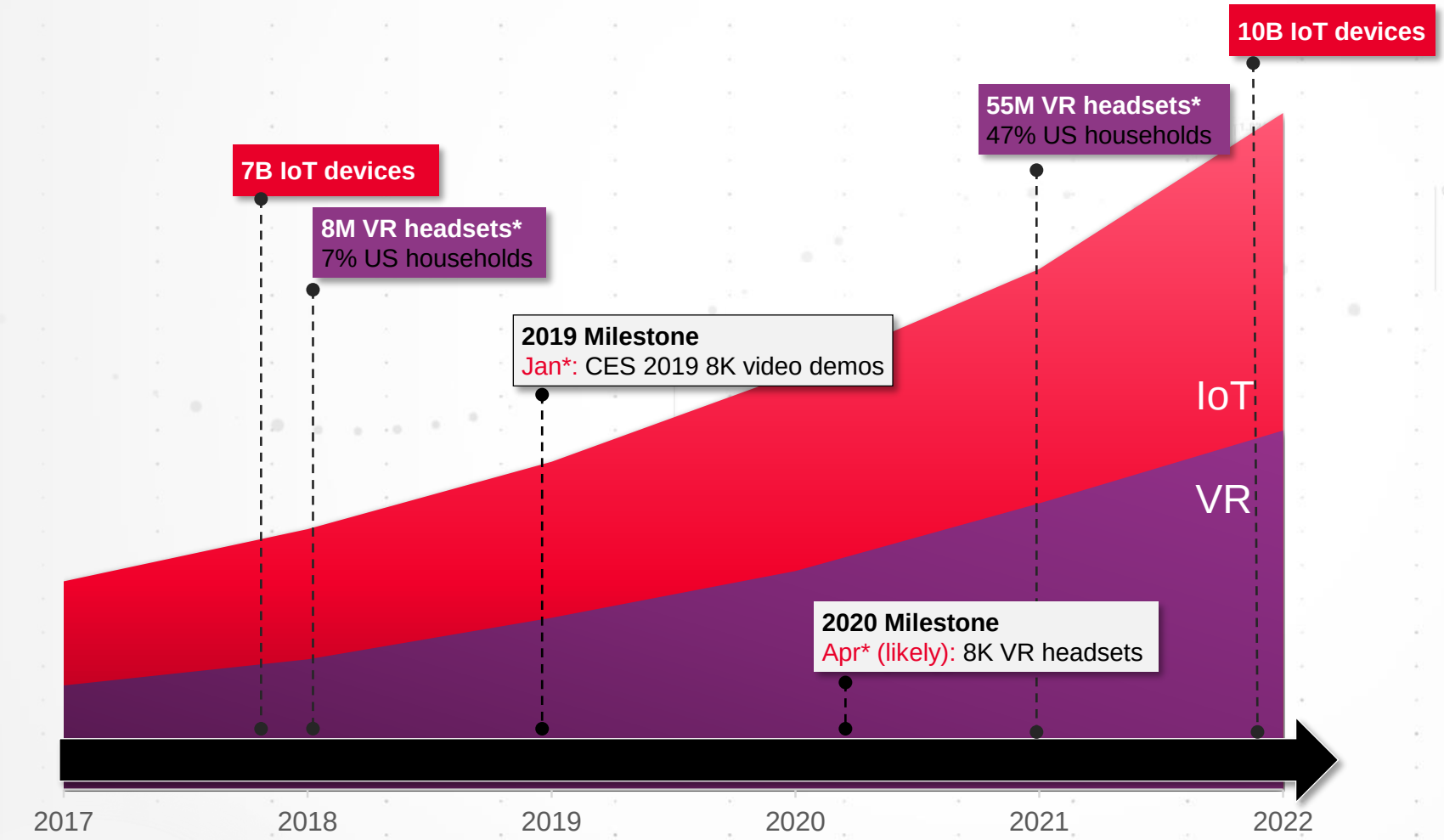
Higher bandwidth and low-latency applications

- Augmented Reality
- Virtual Reality
- Outdoor Backhaul
- Short-Range communications
- Faster throughput for existing applications

https://softwaredevelopersindia.com/virtual-reality.html

WLAN applications

VR AND IOT



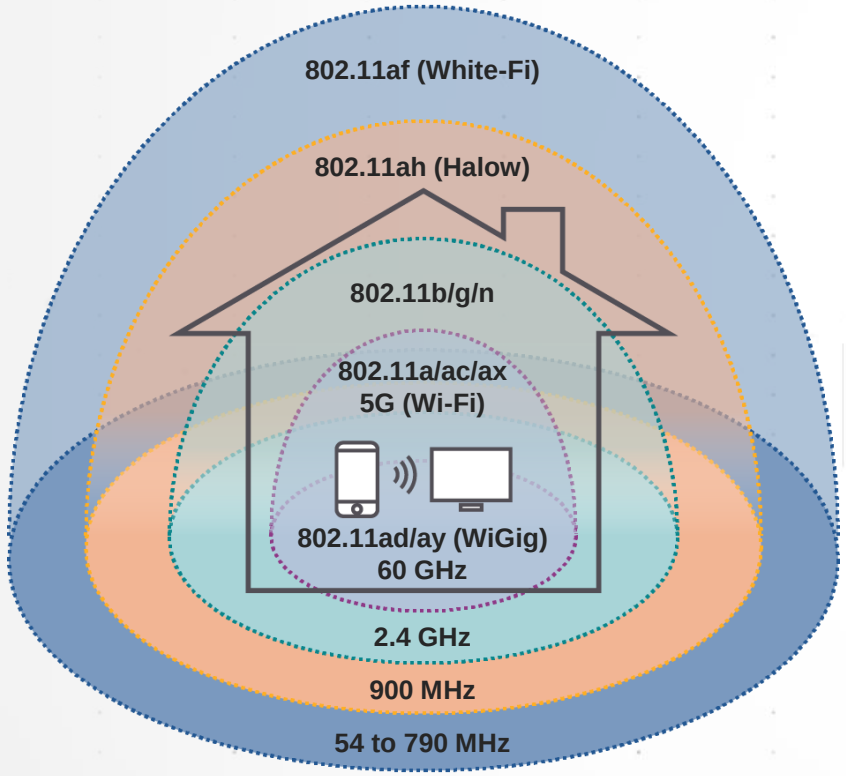
WLAN Application Growth

- IoT
  - $151B in 2018
  - 20% CAGR
- AR/VR
  - 73.3% CAGR
  - Largest growth in Non-Immersive Applications

KEYSIGHT TECHNOLOGIES

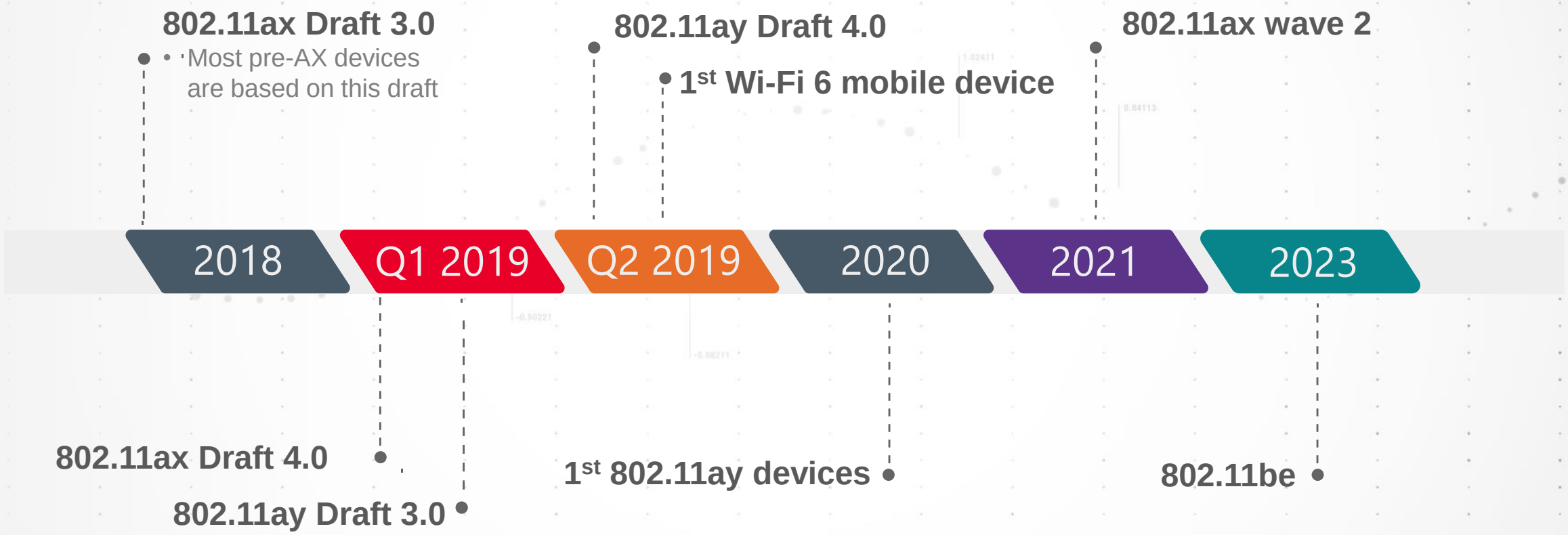
What changes can we expect and when?

Evolution of WLAN Standards



Standard	Frequency (GHz)	Bandwidth (MHz)	Modulation	Max Data Rate
802.11b	2.4	22	DSSS	11 Mbps
802.11a	5	20	OFDM	54 Mbps
802.11g	2.4	20	OFDM	54 Mbps
802.11n (WiFi 4)	2.4, 5	20, 40	MIMO-OFDM	600 Mbps
802.11ac (WiFi 5)	5	20,40,80,160	MIMO-OFDM	7 Gbps
802.11ax (Wi-Fi 6)	**2.4, 5, 6**	**20,40,80,160**	**MU-MIMO OFDMA**	**10 Gbps**
802.11be (EHT)	**2.4, 5, 6**	**20,40,80,160, 320**	**MU-MIMO OFDMA**	**30 Gbps**
802.11ad	60	2160	SC/QAM	~8 Gbps
802.11ay	**60**	**(2160) x2, x3, x4**	**SC/QAM, MIMO-OFDM**	**>20 Gbps**

WLAN Timeline



Wi-Fi 6 and EHT Key Technologies

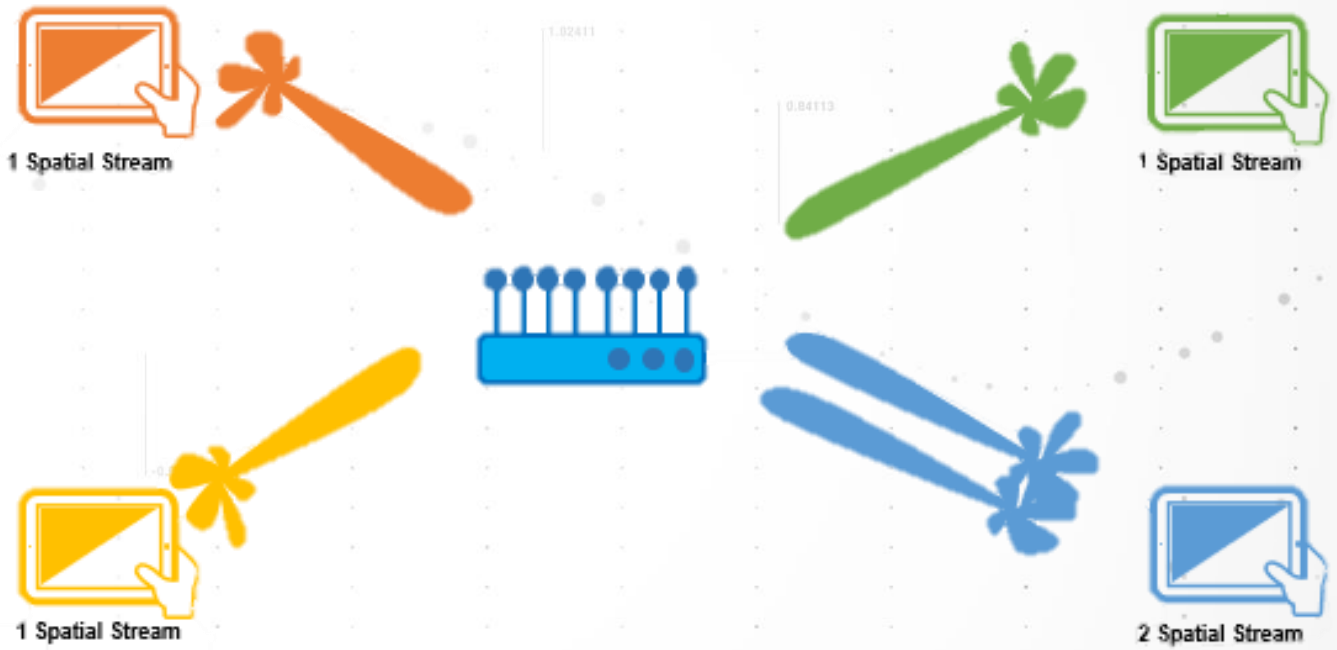
HIGH CAPACITY, HIGH THROUGHPUT

Wi-Fi 6 (802.11ax)

- OFDMA
- 8 Spatial Streams
- MU MIMO on both DL and UL
- 1024QAM

EHT (802.11be)

- 16 Spatial Streams
- 320 MHz BW
- 6 GHz operation

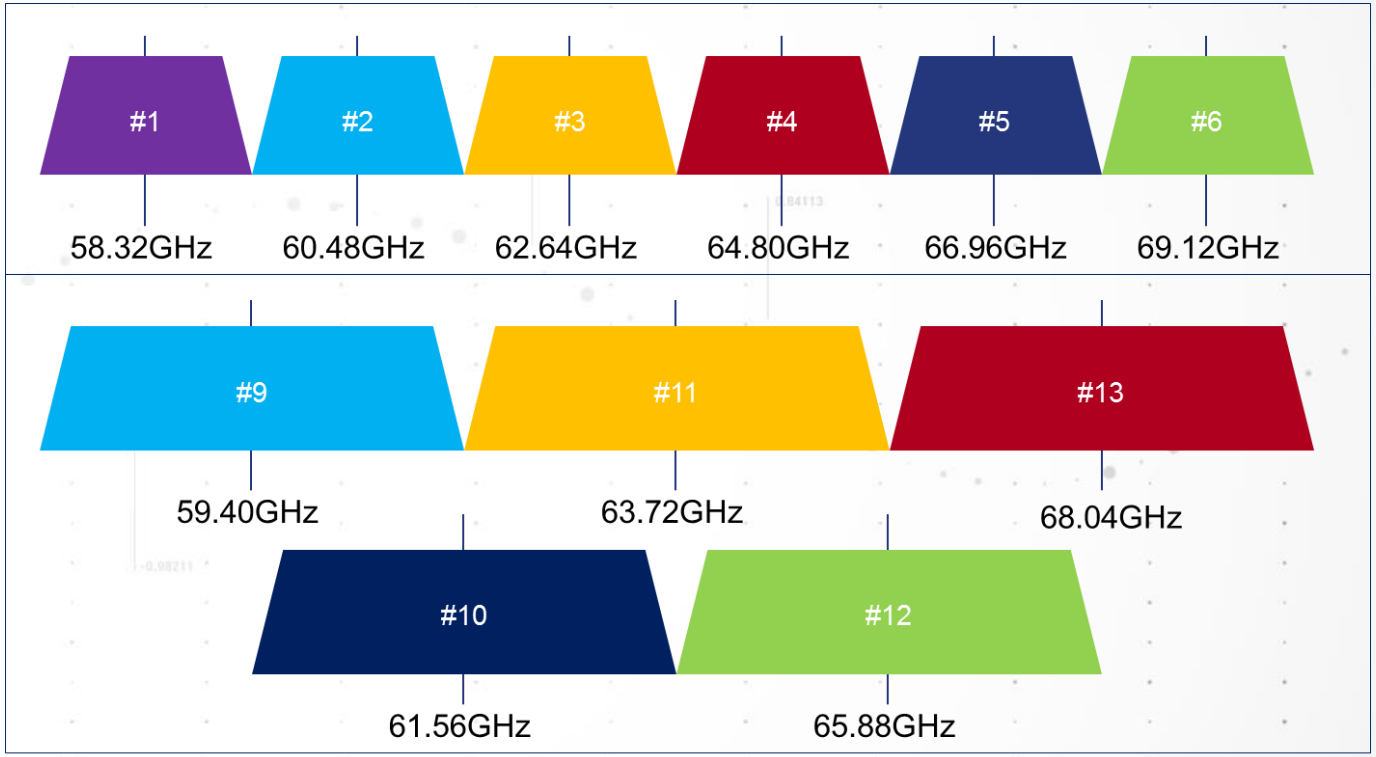


802.11ay Key Technologies

HIGH SPEED, LOW LATENCY

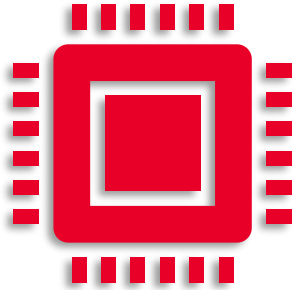
WiGig (802.11ay)

- 60 GHz band
- Channel bonding and aggregation
  - Up to four channels
  - Two 2.16 GHz Mandatory
- 20 Gbps

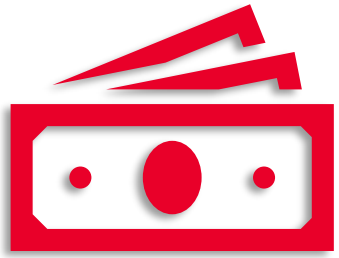


WLAN Challenges

Time to Market



Complexity



Cost of Test

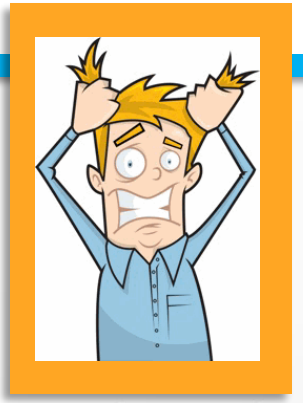
Challenge: Test a Very Wideband Device

802.11AY WITH 4.32 GHZ BANDWIDTH

Design → Test → Ship

2GHz → Tested → Ready

4GHz → Failed →



802.11ay Solution Overview

NEW WIDEBAND R&D TESTBED FOR 5G NR, 802.11AY APPLICATIONS

Available now!

Generate & Analyze Wideband mmWave Signals

- Multi-band, multi-channel
- Scalable: multiple frequency bands
- Support 802.11ay and 5G NR measurements
- Up to 8 GHz bandwidth
- More detail in Insight 5G_2 class

Target Customers:

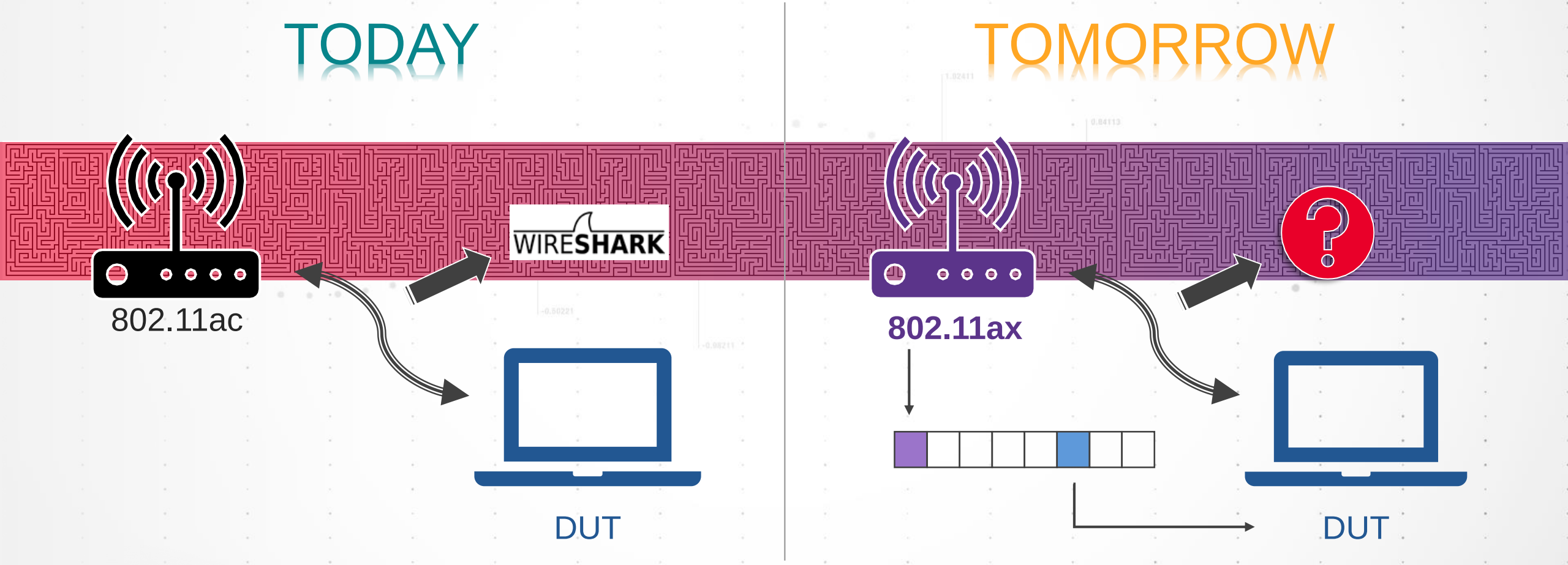
Design and Development

Chipsets, Modules and Devices

Demo video: http://videos.microwavejournal.com/watch/mmwave-testbed-for-emerging-applications-mw8ayo

Challenge: Capture and Analyze 802.11ax Traffic

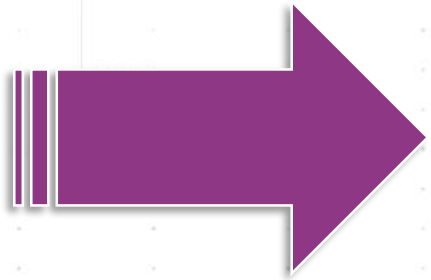
NEW: OFDMA AND TRIGGER FRAME ALIGNMENT



Challenge: Keep Cost of Test Low with 802.11be

WIDER BANDWIDTH OF 320 MHZ

This Photo by Unknown Author is licensed under CC BY-NC



This Photo by Unknown Author is licensed under CC BY-NC

M9410A VXT Wideband Transceiver

OPTIMIZED SOLUTION FOR WLAN

Available now!

Test Up to 8x8 MIMO with Wideband Transceiver

- Up to 8 transceivers in one PXIe chassis
- 380 MHz to 6 GHz with up to **1.2 GHz bandwidth**
- Excellent performance
  - SSB phase noise **< -131 dBc/Hz** at 1 GHz, 10 kHz offset
  - **< 0.6%** EVM for 160 MHz bandwidth 802.11ax signal at 5.8 GHz

Target Customers:

Design Verification (DVT) and Manufacturing Test

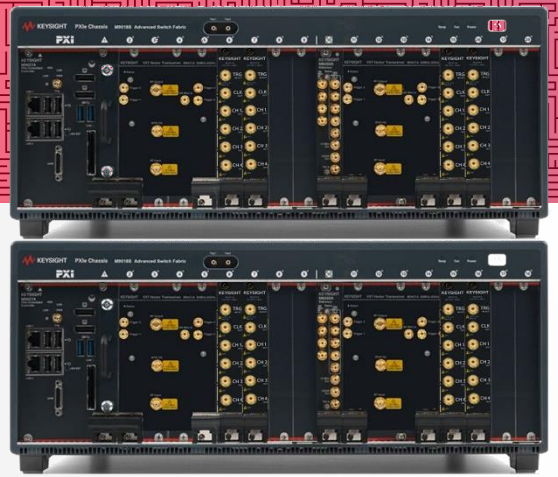
Chipsets, Modules and Devices

KEYSIGHT TECHNOLOGIES

Challenge: Keep Cost of Test Low with Wi-Fi 6

802.11AX FREQUENCY EXTENSION TO 7.125 GHZ

TODAY



8x8 MIMO test solution for WLAN
up to 6 GHz

Insert roadrunner here

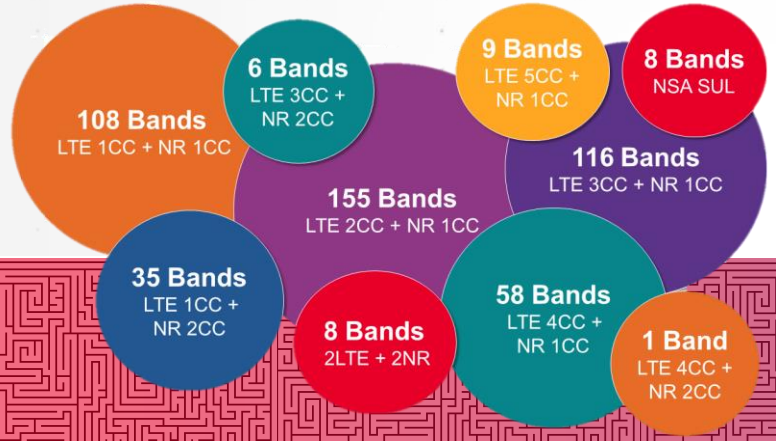
TOMORROW

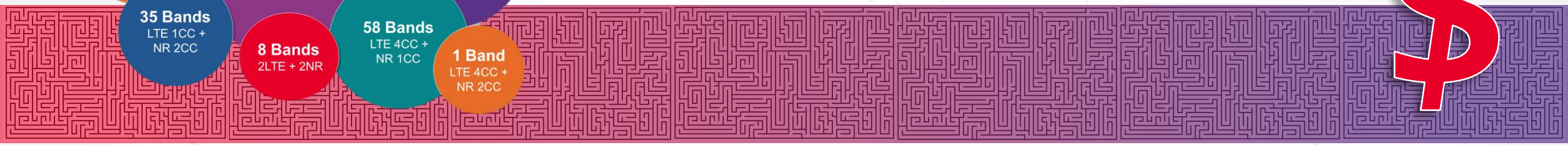
Wi-Fi 6
7.125 GHz

Insert coyote here

Challenge: Keep Cost of Test Low

MORE BANDS, MORE FORMATS, MORE TESTING





+

802.11ac,ax...

5G 3G BT 4G 2G

E6640A EXM Wireless Test Set

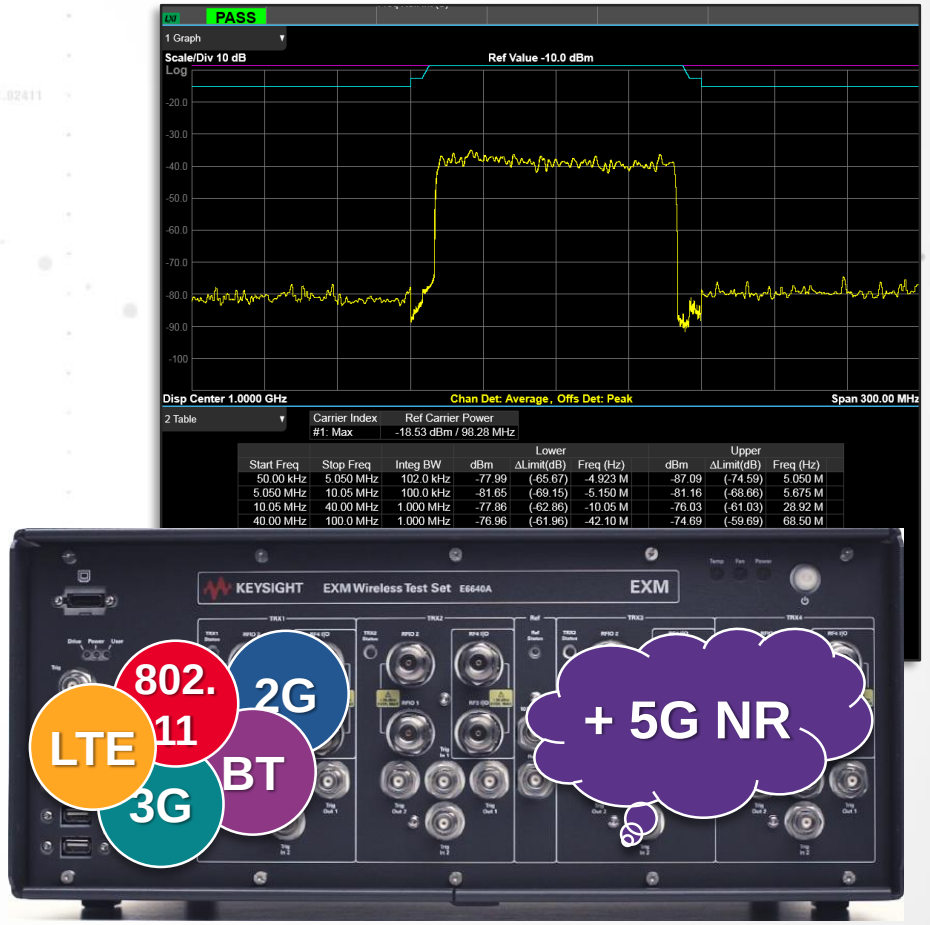
INDUSTRY-PROVEN PLATFORM

Available now!

Improve cost of test

- Develop test plans quickly on an industry-proven platform
- Test up to 4 DUTs simultaneously
- Verify multi-format 5G, cellular, WLAN and Bluetooth® devices with a single solution
- Test confidently with a solution approved by chipset vendors (e.g., QDART)

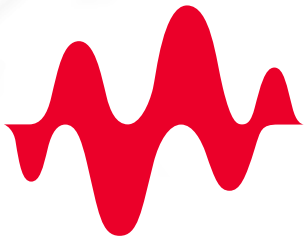
Spectrum emission mask



Target Customers:

Manufacturing Test

Chipsets and Devices



KEYSIGHT
TECHNOLOGIES