From Wi-Fi 6 to 802.11be EHT
Test Challenges

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Wi-Fi 5 (802.11ac)  
High Throughput  
866 Mbps

Wi-Fi 6 (802.11ax)  
High Efficiency  
7Gbps

802.11be  
Extreme High Throughput  
>30 Gbps
802.11be Task Group Proposed Timeline

- First TG meeting: Q3 2020
- D0.1: Q2 2021
- D1.0 Letter Ballot: 2022
- D2.0 Letter Ballot
- D3.0 Letter Ballot
- Initial Sponsor Ballot (D4.0): 2023
- 802 EC approval: 2024
802.11be EHT - Frequency Allocation in 6 GHz Band*

- **5.925 GHz**: Standard-power AP with automatic frequency control
- **6.425 GHz**: Low-power indoor AP
- **6.525 GHz**: Standard-power AP with automatic frequency control
- **6.875 GHz**: Low-power indoor AP
- **7.125 GHz**: Fixed services (public safety)

*FCC Part 15
Wider Channels

- **80 MHz**
  - Wi-Fi 6 mandatory

- **160 MHz**
  - Wi-Fi 6 optional, 802.11be mandatory

- **320 MHz**
  - 802.11be optional
  - 802.11be possible contiguous aggregation

*National Instruments*
Non-Contiguous Spectrum Use

- Full Duplex (Tx and Rx) in the same band
- Full Duplex in different bands
- Data and control plane separation

STA

Carrier aggregation

160 MHz + 320 MHz

5 GHz Band

6 GHz Band
16 Spatial Streams for Double Spectral Efficiency

Implicit channel sounding with STA-transmitted pilots uses channel reciprocity

OFDM symbols with CSI uplink pilot tones
Multi-Access Point Coordination

Coordinated OFDMA

Coordinated null steering

Distributed MIMO

Spatial stream

Radiation null

High Speed Backhaul
Higher Order Modulation: 4096-QAM

- 12 bits per symbol
Incorrect EVM Measurement due to Symbol Errors

Ideal EVM decision area

Noise

symbol errors challenge the Tx EVM computation
Beamforming to Improve TX EVM – Simulation Results

Ref: https://mentor.ieee.org/802.11/dcn/19/11-19-0637-00-00be-feasibility-of-4096qam.pptx

No BF: SNR above 45 dB Not feasible
Beamforming is key 4096-QAM enabler
Rx EVM - Flat Channel Simulation Results

Need 35 dB Rx EVM to receive 4096 QAM

Additional Rx antennas to improve RX EVM

Ref: https://mentor.ieee.org/802.11/dcn/19/11-19-0637-00-00be-feasibility-of-4096qam.pptx
Test Challenges
Higher Device Complexity
802.11be EHT Test

Growing Test Complexity

Wi-Fi Implications

3 Bands

2X Carrier Bandwidth

Carrier Aggregation
Combinations

Higher QAM
Modulation

2X
MIMO Streams
OFDMA and Spectrum Sharing

Many more test scenarios

Exclusive vs. Shared spectrum use
5G Coexistence with Unlicensed Spectrum

Integration of Multi-technology Radios

Flexibility to Test for Coexistence of 5G and Wi-Fi
Real-Time Power, Timing, and Frequency Control

- RU allocations
- MCS indices
- Power boost factors
- # spatial streams

**AP**

**Step 1:** Send trigger frame to the DUT
**Step 2:** Measure frequency error relative to test instrument

Limit of ± 350 Hz of AP center frequency
- ± 0.07 ppm at 5 GHz
Complex Carrier Aggregation Test Cases

- 5 GHz Band
- 6 GHz Band
- 160 MHz
- 320 MHz
- Carrier aggregation

- 2.4 GHz
- 5 GHz Band
- 6 GHz Band
- 80 MHz
- 160 MHz
- 320 MHz
Block-level Testing of Wi-Fi 6 and EHT Devices

- **FlexRIO**
  - High-Speed Digital
- **PXie-5820**
  - Digital to Baseband
  - Baseband to/from RF
- **PXie-5840 + PXie-5830**
  - FEM + Duplexer

**Modem** to/from **ADC**

**Baseband to/from RF**

**Digital to Baseband**

**Digital**

- **RF Vector Signal Transceiver**
- **Baseband Vector Signal Transceiver**
- **Multi-Core Embedded PC**
- **18-Slot PXie Chassis**

**Vector Signal Analyzer**

- **System Source Measure Unit**
- **Precision Source Measure Unit**
- **High-Speed Digital Instrument**
- **High-Speed Scope**