IEEE 802.11be — Extremely High Throughput: The Next Generation of Wi-Fi Technology Beyond 802.11ax
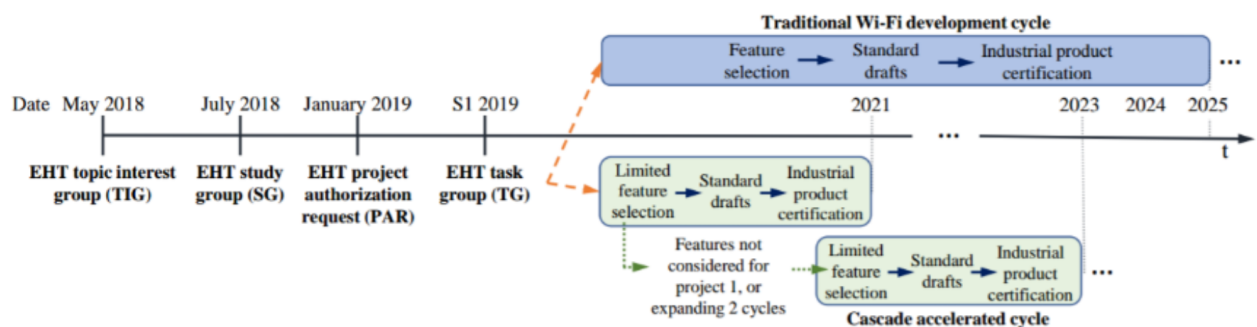
Key features

- Support 6G band
- 320MHz maximum BW
- Coordinated Communication
- 16 Spatial stream
- implicit CSI sounding
- Hybrid ARQ
- Full duplex communication
- data aggregation

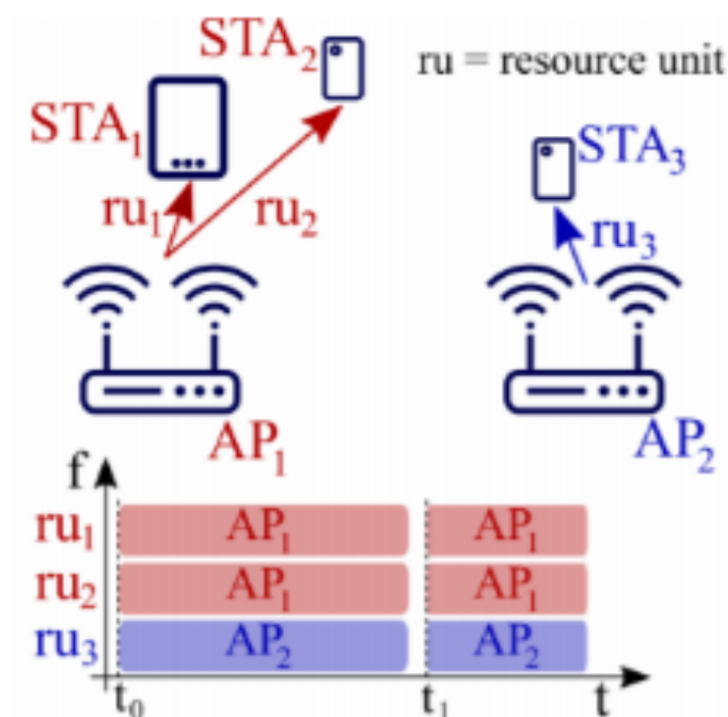## Objective and Standard development time frame

Objectvie

- Enabling new MAC and PHY to maximum throughput(at least) **30Gbps**
- 4x data service access wrt 802.11ax
- Using frequencies between 1 to 7.125 GHz
- backward support 11g/n/ac/ax in 2.4,5 and 6GHz

Time-frame

Figure 1: Illustration of the different standardization cycles considered by 802.11 stakeholders.
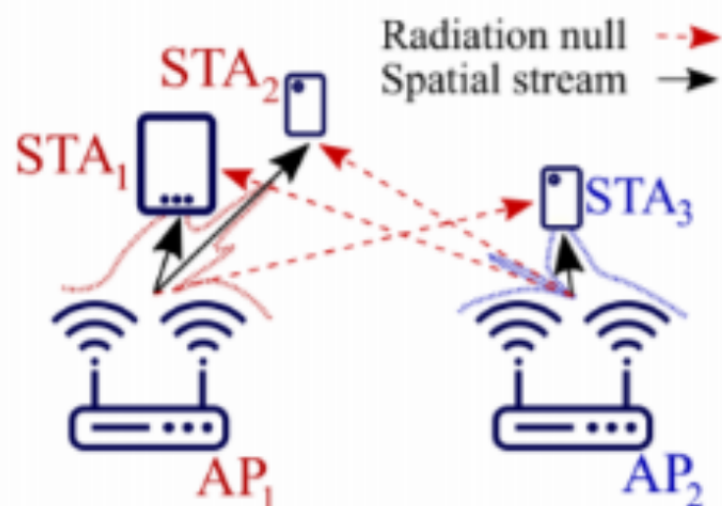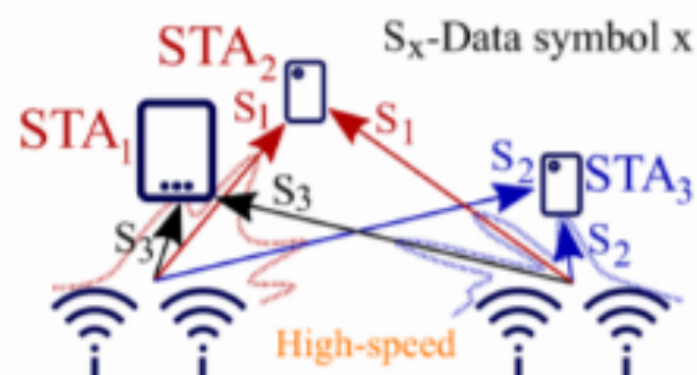
Candidate Technical Features

- 320MHz BW and more efficiently of non-contiguous spectrum
  - adoption of **160** MHz and **320** MHz communication bandwidth per AP in the 6 GHz band as mandatory and optional features
  - Moreover, a **minimum channel size** of **40** or even **80** MHz in the 6 GHz band.
  - Always schedule uplink transmissions in the 6 GHz band
- Multi-channel/multi-band aggregation and operation
  - Multi-band data aggregation: aggregation of 5G and 6G band data transmission
    - require device sync start of TXOP in different band
  - Simultaneous transmission and reception in different bands
    - multi-band full duplex
    - reducing latency and enhancing the throughput by enabling an asynchronous and simultaneous up-link/downlink operation in separate bands
  - Simultaneous transmission and reception in the same band
    - in-band full duplex operation for Wi-Fi
  - Data and control plane separation
    - unprecedented opportunity of separating the data and management planes
    - immediate status feedback is possible in data and control plane separation.
    - reliable feedback channel on control plan is possible.
  - 16 spatial streams and multiple-input multiple-output (MIMO) protocol enhancements
    - possible high speed back-haul provided by fiber-to-the-home (FTTH) solutions and the rich scattering in the indoor environments
    - implicit sounding procedure to solve hugh channel sounding feedback data rate
  - Multi-access point coordination Communication

ru = resource unit

(a) Coordinated OFDMA

Radiation null - - ->
Spatial stream ---->

(b) Coordinated null steering

S_x-Data symbol x

High-speed

(c) Distributed MIMO (D-MIMO)

- Coordinated OFDMA
- Coordinated Null Steering
  - APs can also leverage their antennas to place spatial radiation nulls from and towards non-associated devices in their neighbor-hoods
- Distributed MIMO (D-MIMO)
  - multiple non-collocated APs perform a joint data transmission and/or reception from multiple STAs
    - Enhanced link adaptation and retransmission protocol
      - hybrid ARQ (HARQ) capabilities

System performance comparison to 11ac

- Benefit
  - More bandwidth
  - More antenna and spatial stream
  - implicit CSI acquisition

Table I: Detailed system-level parameters

Parameter	Description
Deployment	
Floor size	40 m × 40 m
AP positions	16 ceiling-mounted APs equally spaced ($d_x = d_y = 10$ m)
AP/STA heights	$h = 3/1$ meters
STA distribution	512 uniformly deployed STAs
AP-STA association criterion	Strongest average received signal
PHY & MAC	
Carrier frequency	5.18 GHz (.11ax) / 6.2 GHz (EHT)
System bandwidth	320 MHz (.11ax) / 640 MHz (EHT)
Channel size	80 MHz (.11ax) / 160 MHz (EHT)
AP/STA maximum TX power	$P_{\text{max}} = 24/15$ dBm
Number of antennas per AP	4×2 (.11ax) / 4×4 (EHT)
Number of antennas per STA	1
AP and STA antenna elements	Omnidirectional with 0 dBi
CCA energy detection threshold	$\gamma_{\text{LBT}} = -62$ dBm
Signal detection threshold	$\gamma_{\text{preamble}} = -82$ dBm with -0.8 dB of minimum SINR
MCS selection algorithm	Minstrel
AP/STA noise figure	$F_{\text{dB}} = 7/9$ dB
Maximum # of scheduled STAs	8 (.11ax) / 16 (EHT)
STA scheduling	Round Robin with semi-orthogonal user selection (SUS)
Downlink power allocation	Equal power assigned per STA
MPDU payload size	1500 bytes
Maximum TXOP length	4 ms
Channel model	
Path loss and LOS probability	3GPP 3D InH [14] for all links
Shadowing	Log-normal with $\sigma = 3/8$ dB (LOS/NLOS) [14]
Fast fading	Ricean with log-normal K factor
Thermal noise	-174 dBm/Hz spectral density

Traffic model	
Traffic model	FTP model 3 with a packet size of 0.5 MBytes
Traffic generated per STA	75 Mbits/s
DL/UL traffic ratio	0.5/0.5

- Throughput enhance:
  - 3.2x enhance in 50% CDF,
  - 4.6x enhance in worst 5% CDF
- Throughput Comparison