PAW

Time-Sensitive applications support in 802.11ax and 802.11be (EHT)

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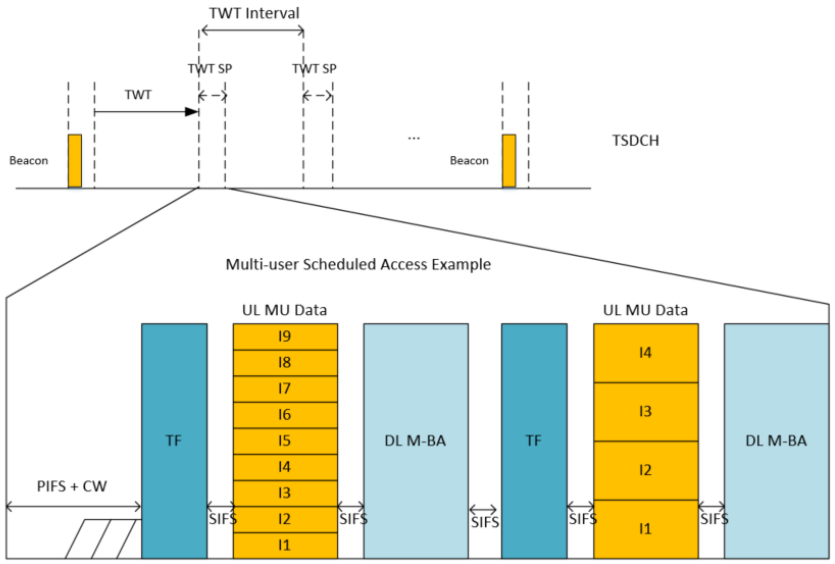
Abstract

- Traditionally, 802.11 has focused on improving peak throughput, capacity, and efficiency
- Emerging applications require accurate time synchronization and predictable (low) latency with high reliability
  - Average latency in 802.11 can be very low, but worst case latency, jitter and reliability can vary, mainly due to congestion
- This presentation describes recent advances in 802.11 standards to address time-sensitive networking (TSN) and real-time applications (RTA)
  - Latency and reliability enhancements in 802.11ax
  - Support for TSN/RTA in next generation 802.11be (EHT – Extreme High Throughput)

New capabilities to control latency in 802.11ax

- Trigger based Multi-User (MU) OFMDA access enables centralized scheduling for DL/UL

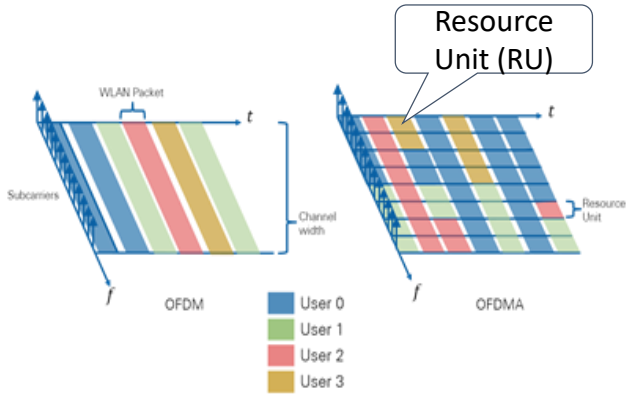


Centralized scheduling

- STAs wait for the trigger frame (avoiding EDCA access)
- Prevent intra-BSS collisions
- Increase network capacity in dense environments

OFDMA

- Reduced PHY overhead
- Flexible RU allocations
- Increase efficiency

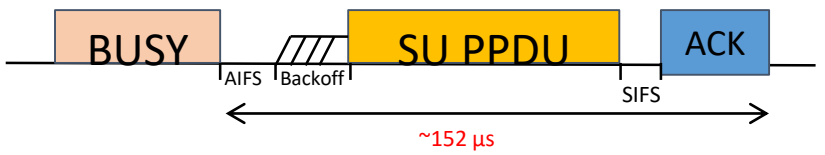


- TWT (Target Wait Time) mechanism enables scheduling of TXOPs (TWT SPs) at periodic intervals for groups of STAs

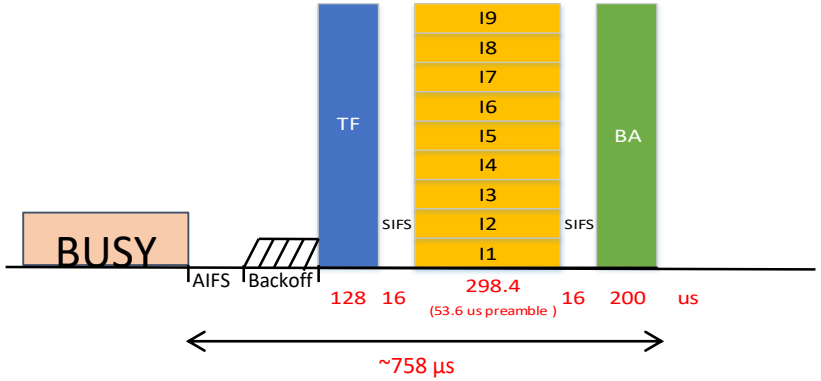
Latency enhancements with 802.11ax

- Example latency with single user transmission
  - Assuming: 802.11ac, 20 MHz BW, AC_VO (default parameters), average backoff (31µs), A-MPDU size (256 bytes), MCS 8 with SISO transmission
  - Single User transmissions from 9 STAs will take ~ 1.3 ms.
- With 802.11ax trigger-based Multi User UL transmissions, the same amount of data will take approximately 758 µs.
- Reliability can be improved by selecting lower MCSs
  - Smart scheduling can also help assign RUs to improve reliability
  - Depending on BW and channel conditions, impact on PPDU tx time can be small (but need to be taken into account for larger packets)

Single User transmission



Trigger-based MU OFDMA UL transmission in 802.11ax



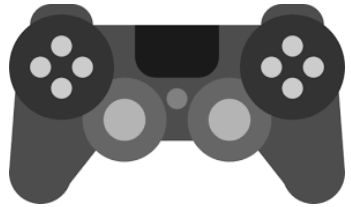
Next generation 802.11be

In the 802.11 Mar 2019 Plenary, the 802.11 working group approved a new PAR for the next generation MAC/PHY amendment to be developed by a new Task Group (TGbe)

The new project was developed by the EHT (Extremely High Throughput) Study Group and it includes throughput, worst case latency and jitter enhancements for time-sensitive applications

- Real-time mobile gaming
- Console gaming
- Industrial automation
- Real-time video
- AR/VR
- Drone control
- Cloud Gaming



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Application Requirements for 802.11be

Use cases		Intra BSS latency/ms	Jitter variance/ms [4]	Packet loss	Data rate/ Mbps
Real-time gaming [2]		< 5	< 2	< 0.1 %	< 1
Cloud gaming [15]		< 10	< 2	Near-lossless	<0.1 (Reverse link) >5Mbps (Forward link)
Real-time video [3]		< 3 ~ 10	< 1~ 2.5	Near-lossless	100 ~ 28,000
Robotics and industrial automation [1]	Equipment control	< 1 ~ 10	< 0.2~2	Near-lossless	< 1
	Human safety	< 1~ 10	< 0.2 ~ 2	Near-lossless	< 1
	Haptic technology	<1~5	<0.2~2	Lossless	<1
	Drone control	<100	<10	Lossless	<1 >100 with video

The 802.11 RTA (Real-Time Applications) Interest Group developed the use cases, requirements and solution directions, which will be considered as part of the 802.11be work.

Potential topics for 802.11be

- Extension of new TSN capabilities (Time-aware shaping, redundancy, pre-emption, …) to 802.11
- Predictable and efficient medium access
- Reduced PHY overhead and support for time-sensitive small packet transmissions
- Improved management and time-sensitive data coexistence
- Coordination between APs/BSSs to reduce impact of OBSS on latency/reliability

Conclusions

- 802.11ax provides new capabilities to control latency and improve reliability, which can support time-sensitive applications in managed network scenarios

- 802.11be will continue the work to improve throughput, reduce worst latency/jitter to better support time-sensitive applications in 802.11
  - Predictable channel access is one of the key areas for enhancement in 802.11be