IEEE 802.11 features towards RAW

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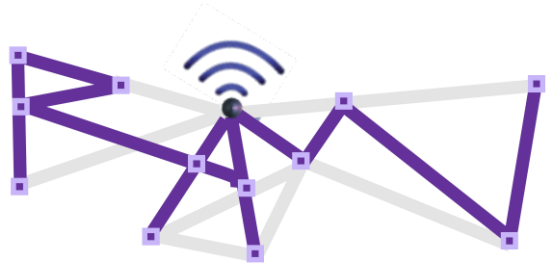
Outline



802.11 Scope

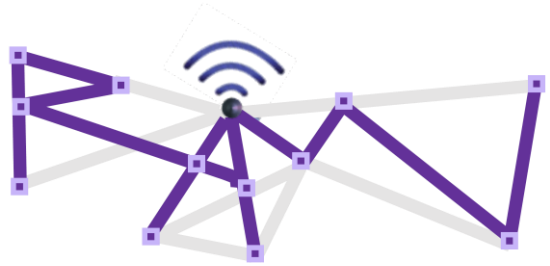
802.11 Extensions to support 802.1 TSN Capabilities

802.11ax Scheduled Operation

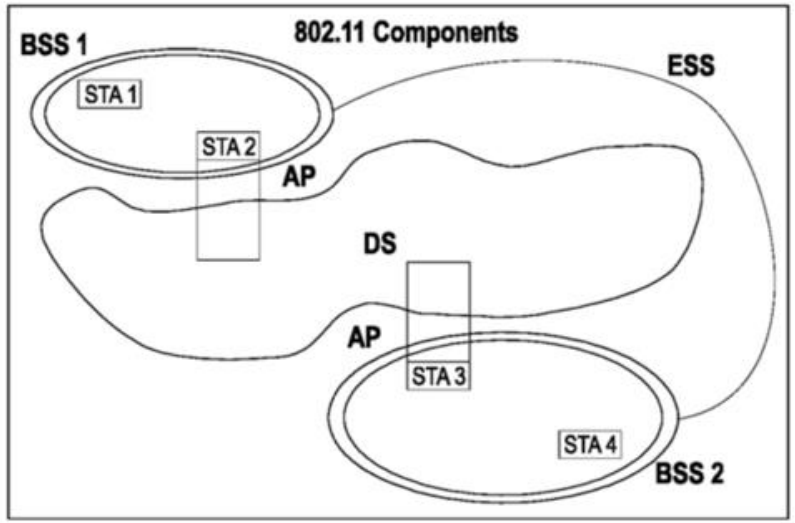
802.11be (EHT) enhancements

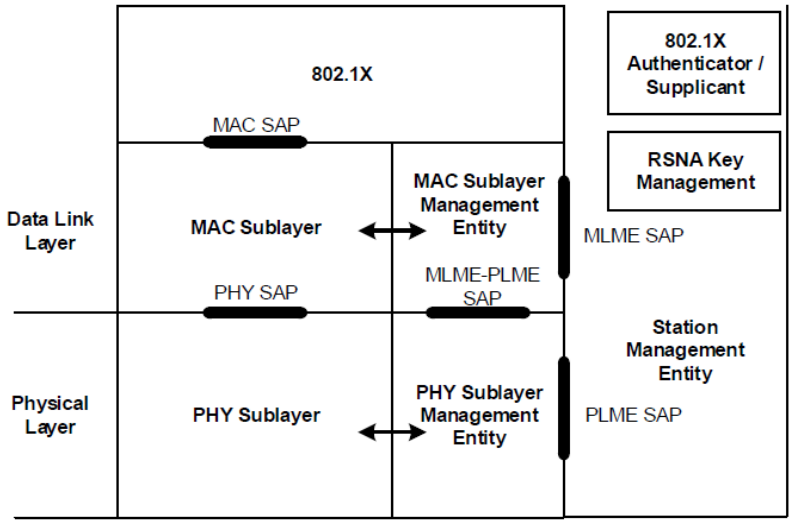
Conclusions

802.11 Wireless LAN - Scope



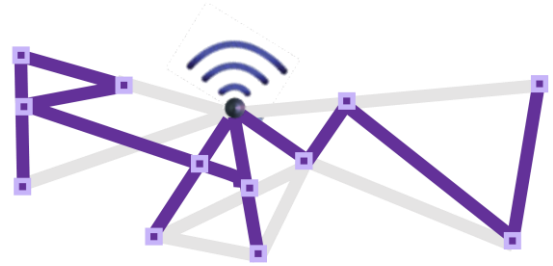
- The 802.11 MAC/PHY capabilities enable wireless communication within the BSS and ESS
- Integration with other IEEE 802 LAN and technologies is also defined



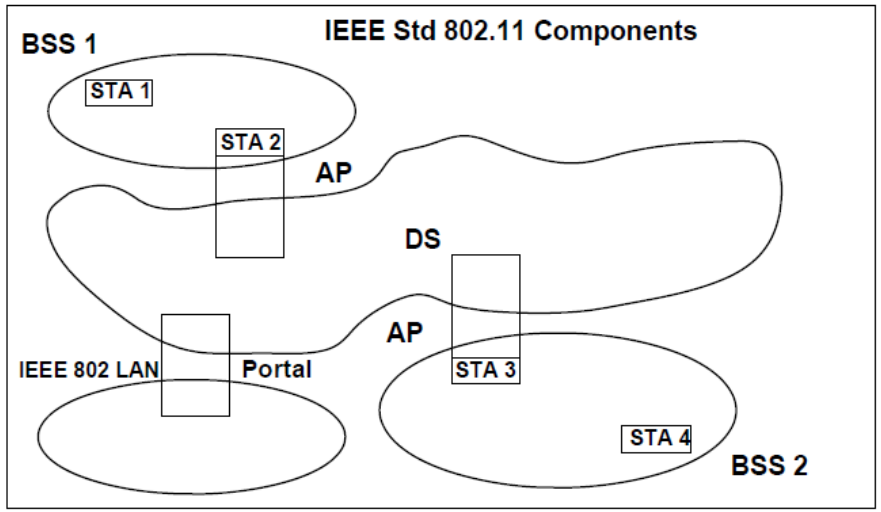


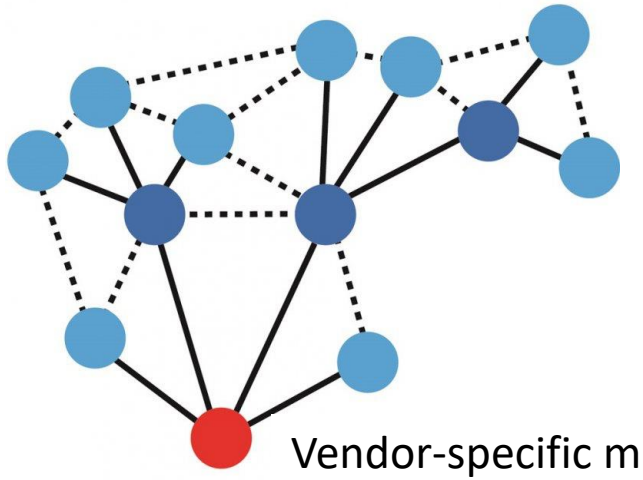
- 802.11 MAC/PHY capabilities and future enhancements to deliver data with bounded (low) latency and high reliability are available within the scope illustrated in the figure

802.11 Wireless Mesh



- 802.11 MAC/PHY is also defined for mesh, including multi-hop (mesh traversal) and path reconfiguration
- Integration with other IEEE 802 LAN is also defined (through the Portal)

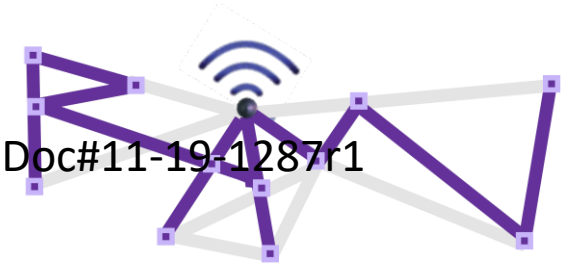




Vendor-specific mesh example
(bi-directional tree only)

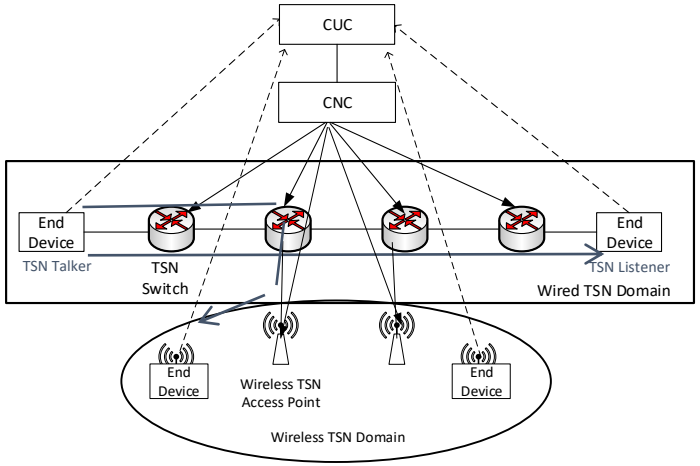
- Implementations often diverge from strict 802.11 mesh architectures

Extending 802.1 (Wired) TSN to Wireless



Ref: Doc#11-19-1287r1

- The IEEE 802.1 TSN Task Group develops standards to enable TSN features over IEEE 802 networks (e.g. Ethernet/802.3, Wi-Fi/802.11)



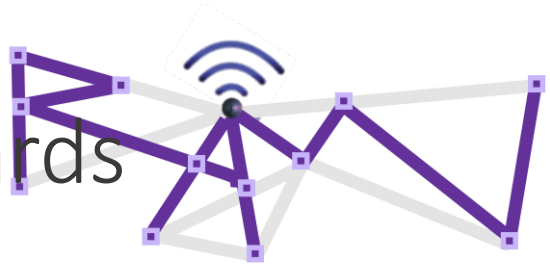
CUC: Central User Configuration
CNC: Central Network Configuration

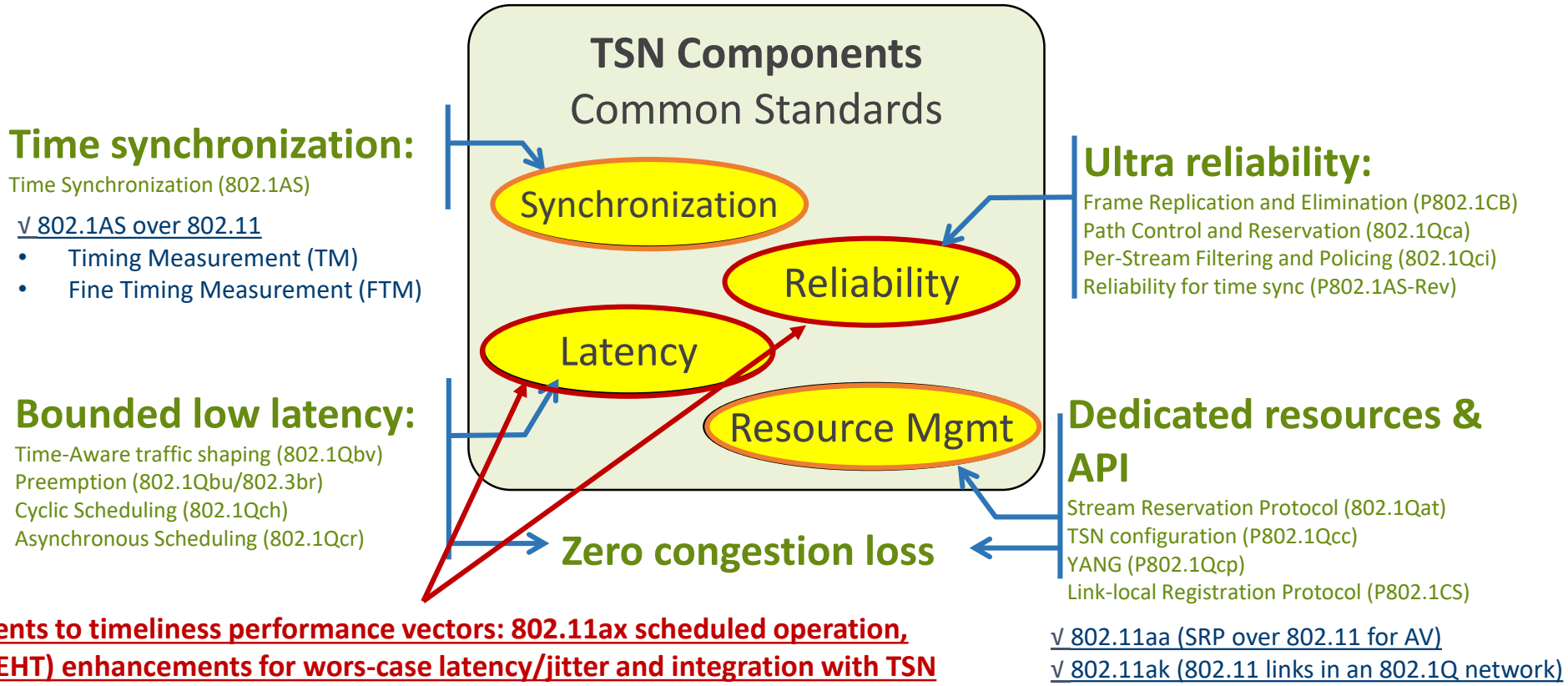
A **TSN Domain** (wired and wireless) is a **managed** (protected) domain

- **Admission control** is required
- The **network is provisioned** to serve end-to-end TSN streams
- The **CUC/CNC are responsible for user and network configuration** (e.g. as defined in 802.1Qcc)

- **Unique characteristics of wireless media**: link capacity is not constant and is subject to noise and interference (especially in unlicensed bands)

802.11 Extensions to support 802.1 TSN Standards

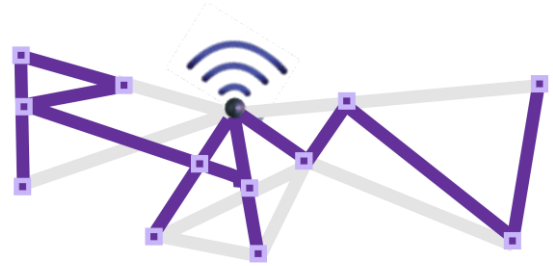




Credit: János Farkas, Ericsson

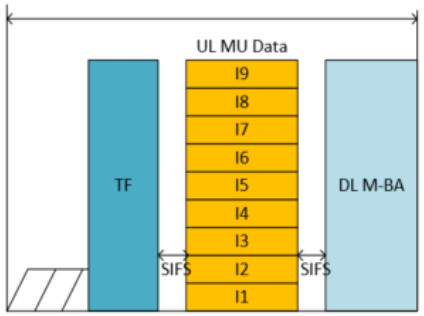
TSNA Conference 2017, http://www.tsnaconference.com/

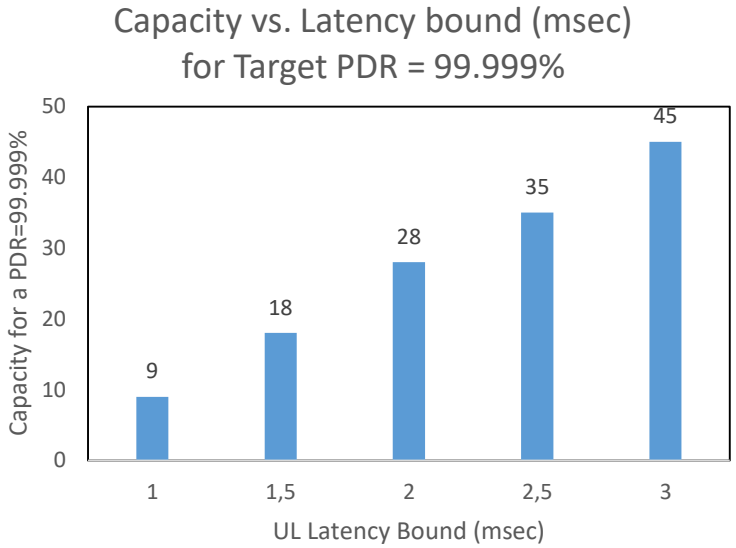
802.11ax (Wi-Fi6) Scheduled Operation



Latency bounds can be provided with high reliability with (1) Traffic identification and (2) Trigger-based access in a managed BSS scenario

Scheduled operation with 802.11ax Trigger-based OFDMA Mode





Channel access modes:

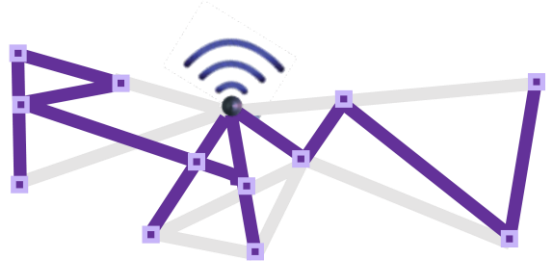
- 802.11ax Multi-user Trigger-based only with time-sensitive scheduling optimizations
- **Capacity** = number of STAs that can be supported with a given latency bound (1 – 3 msec) and 99.999% reliability

PDR: Packet Delivery Ratio (fraction of packets successfully delivered within the latency bound)

Assumptions:

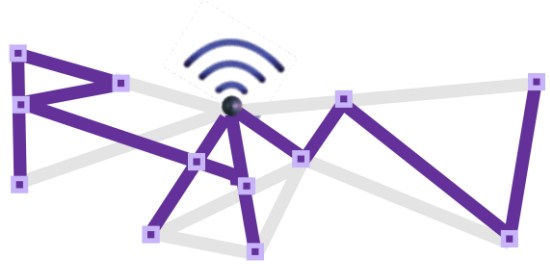
20 MHz channel, SISO, 100 Bytes packets, Channel model E, STAs randomly distributed in a 50 m radio, latency-optimized scheduling strategy.

802.11be (EHT) Enhancements



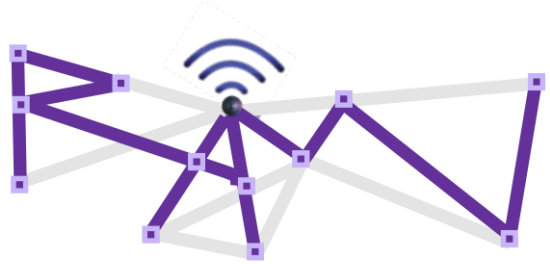
- TGbe/EHT has defined worst-case latency and jitter improvements are part of its scope to address TSN applications as well as integration with Ethernet TSN
- Some of the new capabilities in 802.11be include
  - Throughput enhancements (320 MHz, 16 ss)
  - Multi-link operation
  - Multi-AP coordination
  - HARQ
  - Channel access enhancements for low latency and time-aware operation
- 802.11be is expected to define enhancements to the 802.11ax scheduled operation to enable better control of the worst-case latency and jitter, especially under managed network operation

Conclusions



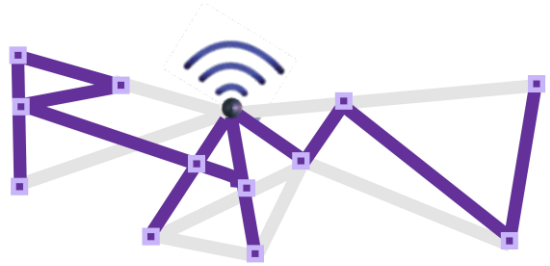
- 802.11ax provides new capabilities to control latency and improve reliability, which can support time-sensitive applications in managed network scenarios
- The new 6-7 GHz band will significantly increase the number of channels available (~ 1GHz of new spectrum), which is key for managed deployments that require latency/reliability guarantees
- 802.11be will continue to improve throughput, reduce worst latency/jitter to better support time-sensitive applications in 802.11 and integration with 802.1 TSN
  - Multi-link operation, predictable channel access and time-aware scheduling at the 802.11be MAC are some of the key areas for low latency and high reliability services
  - Multi-link and Multi-AP coordination capabilities in 802.11be can be leveraged to achieve redundancy and higher reliability with latency bounds
- RAW can provide a higher layer service across routed networks that leverages the low latency/high reliability capabilities in the 802.11 layer

Reliable and Available Wireless Technologies



- draft-thubert-raw-technologies provides an overview of recent and upcoming technologies that are capable of time synchronization and scheduling of transmission that can be used to support time-sensitive flows that required reliable delivery in bounded time.
  - 802.11ax and 802.11be
  - 5G URLLC
  - 802.15.4/TSCH
  - L-band Digital Aeronautical Communications System
- The above technologies are provided as examples and can be used to guide the development of RAW solutions

References



- Doc # 11-19-0373r0
- Doc# 11-19-1287r1
- Doc# 11-19-1983r0