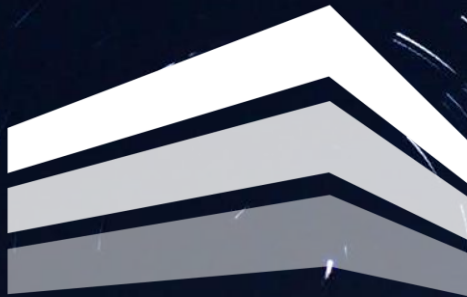


IEEE 802.11be Multi-link Operation in ns-3



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Workshop on ns-3 June 18, 2020

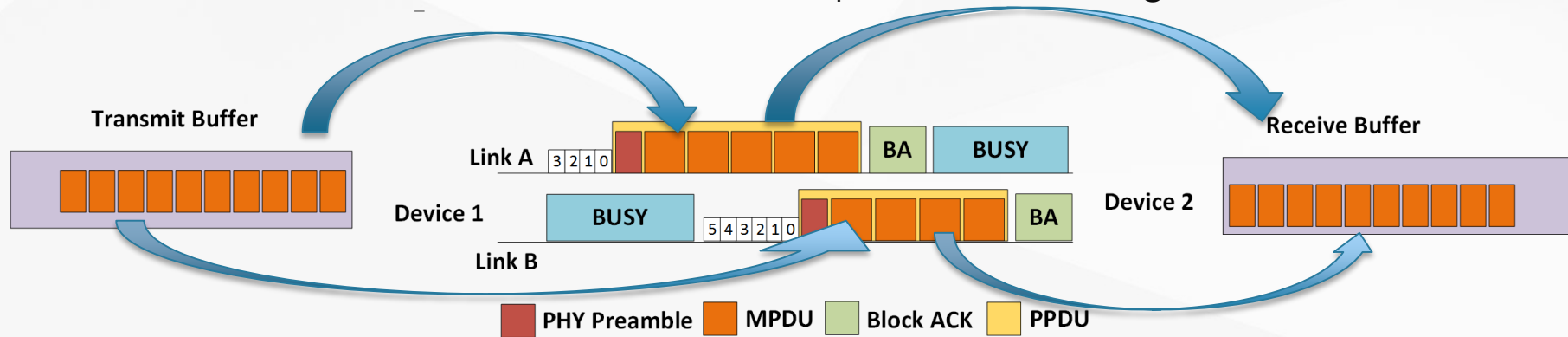


COLLABORATE. INNOVATE. GROW.

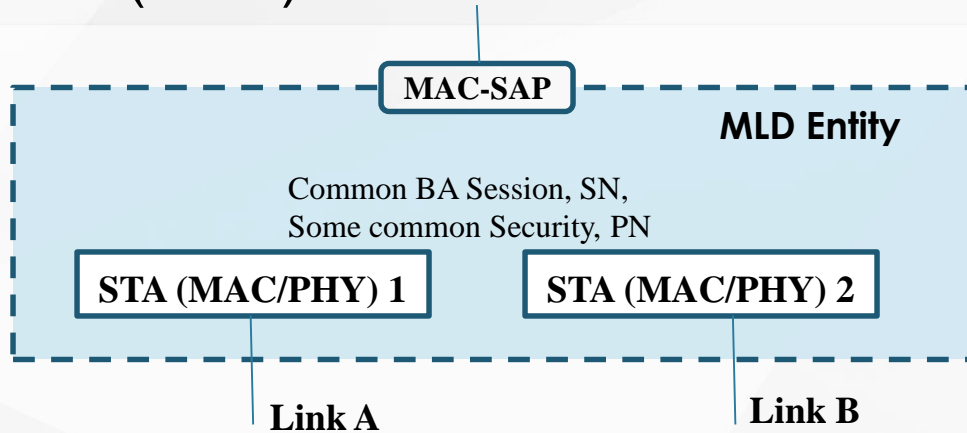
SAMSUNG

802.11be Multi-link Operation

- IEEE 802.11be
 - Next-generation IEEE 802.11 standard project after IEEE 802.11ax
- Multi-Radio Devices
 - Emergence of dual-radio end user devices and tri-band Access Points (APs)
 - 2.4 GHz, 5 GHz and 6 GHz
- Multi-link Operation
 - Framework to enable packet-based aggregation at the MAC layer
 - Data from same traffic session over multiple channels using first available channel



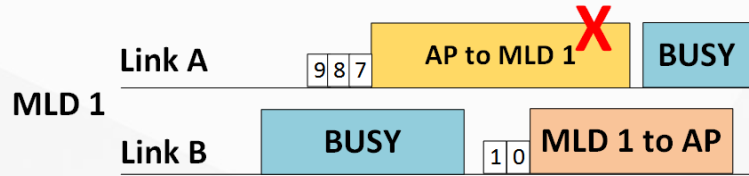
Multi-link Device (MLD) Architecture



- One MAC SAP to LLC, which includes one MAC data service
- Authentication and association (setup) at MLD level
- MAC address at MLD level and for each STA
 - RA/TA fields would have the STA MAC addresses
- MLD-level Block ACK agreement and common Sequence Number per TID
- Traffic on a TID can be dynamically mapped to a subset of setup links
- Unified queueing to take advantage of medium access (Implementation)

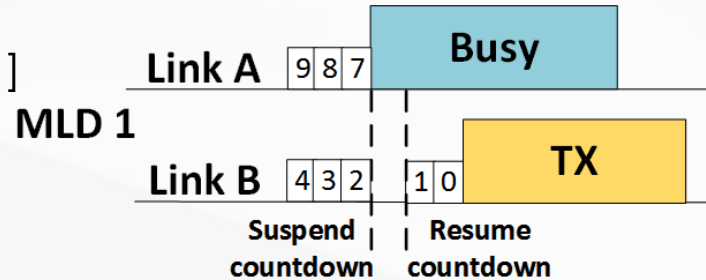
Medium Access in Multi-link Operation

- Default: Asynchronous operation with independent medium access per link
 - Does not need any medium status sharing between STAs within MLD
- STR (simultaneous transmission and reception) capability
 - Ability to receive on one link while simultaneously transmitting on other link
 - An MLD may lack STR capability due to insufficient frequency separation



MLD 1 lacks STR capability

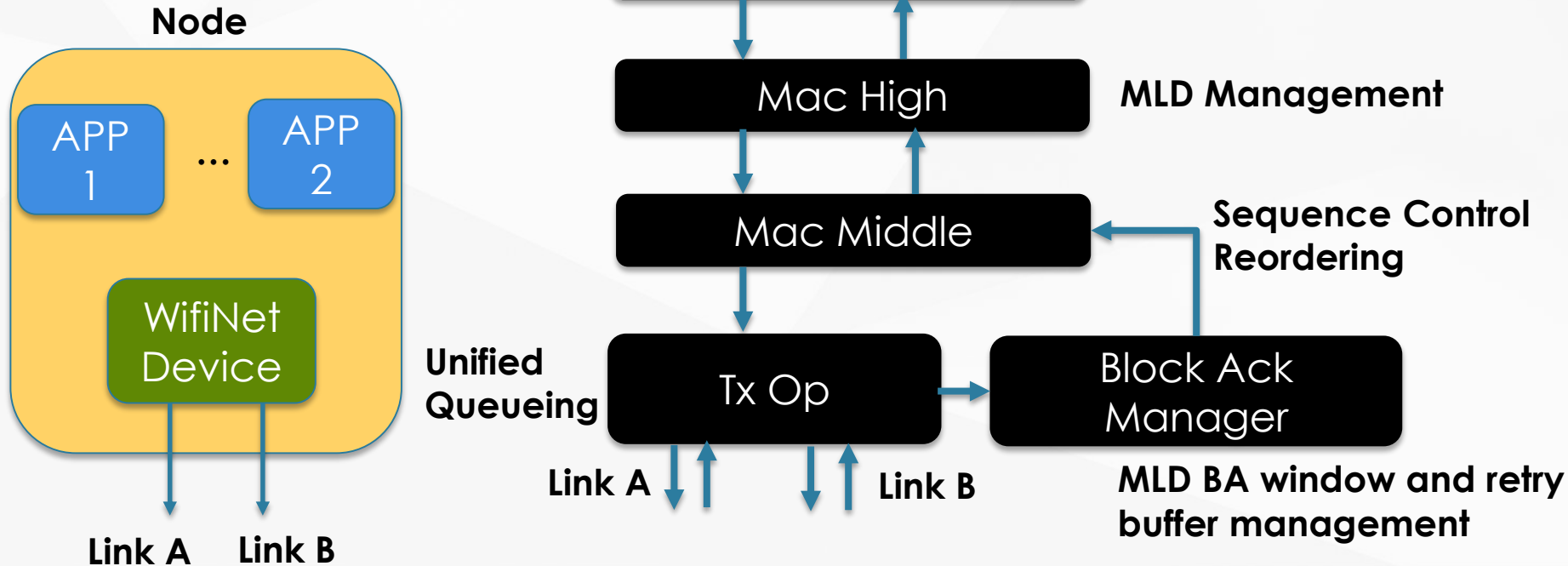
- Coordination between STAs at lower MAC/PHY may be required to avoid data reception failure
 - Opportunistic backoff countdown resumption[1]



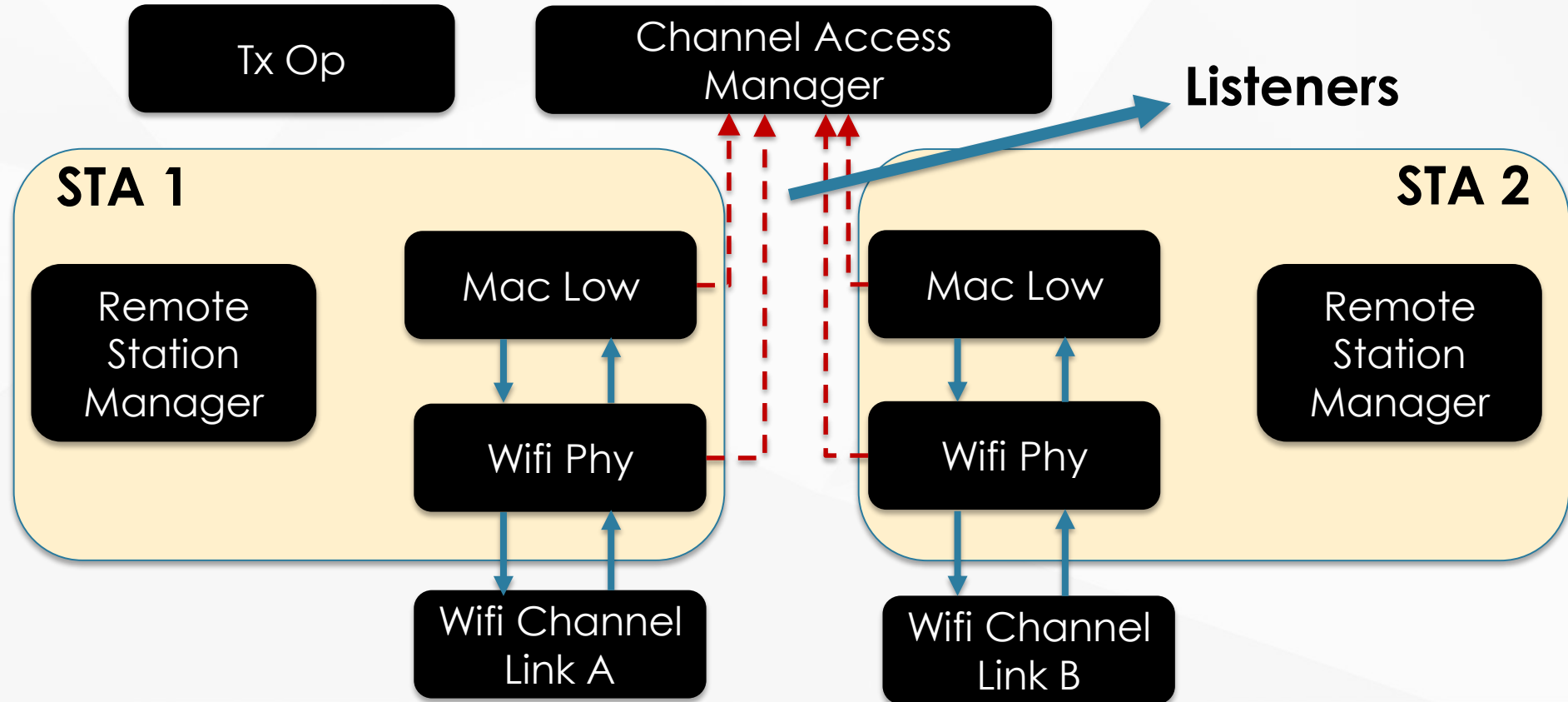
[1] S. Naribole et al., "Simultaneous Transmit-Receive Multi-Channel Operation in Next-Generation WLANs," *IEEE WCNC*, 2020

Multi-link Device Architecture in ns-3: MLD Level

- ns-3 Wi-Fi extension involves functional distribution
 - Operations at MLD level
 - Operations at STA level



Multi-link Device Architecture in ns-3: STA Level



Conclusion

- IEEE 802.11be
 - Next-generation IEEE 802.11 standard project after IEEE 802.11ax
- Multi-link Operation
 - Framework to enable packet-level aggregation at the MAC layer
- Giant leap in architecture, protocol and modeling

