WINTECHCON 2018

Engineering the Future

Time Sensitive Networking over WiFi

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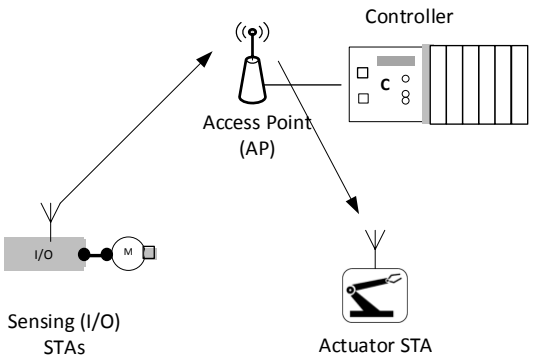
Motivation

- Time-critical applications require
  - time-synchronized computing and
  - deterministic communication between distributed components.
- Currently, typically these run over highly reliable and synchronous wired links (e.g., Deterministic Ethernet)
  - Present wireless standards do not guarantee low latencies (under 10 ms) and high reliability
- This submission focusses on a demo that aims at enabling reliable and deterministic low-latency wireless communication.
- Its adoption will lead to reduced wiring costs, greater deployment flexibility, and improved system mobility - attributing to flexible manufacturing (Industry 4.0), wireless autonomous systems, and tactile teleoperation.

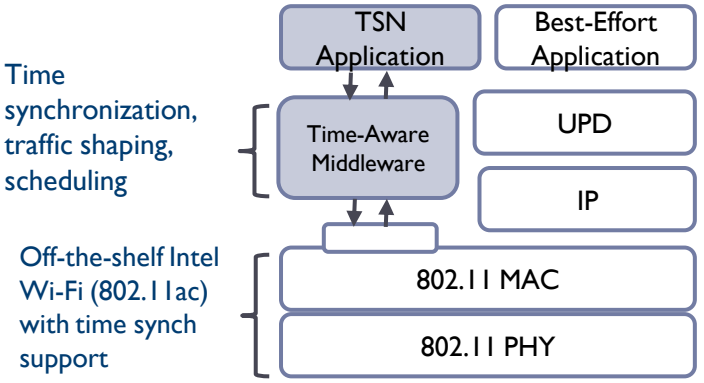
Problem Description

- Demo goals:
  - Leverage TSN concepts, such as, time synchronization capabilities and traffic awareness/shaping to reduce contention and limit randomness in Wi-Fi
  - Evaluate what latency bounds and Packet Error Rates (PER) can be achieved on Wi-Fi using existing 802.11 radios with SW/stack optimizations

Example Scenario



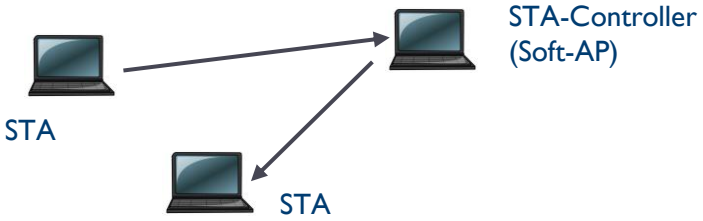
POC Protocol Stack

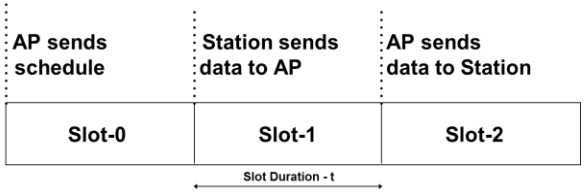


Time-Sensitive Wi-Fi Operation – Balancing Board Demo Setup

Time-Aware Layer: Enables time synchronized scheduled operation

- All stations (STAs) synchronize with a time sync master (STA-Controller) and align their data transmissions to a time slotted access pattern
- STA-Controller (AP) defines and distributes a schedule

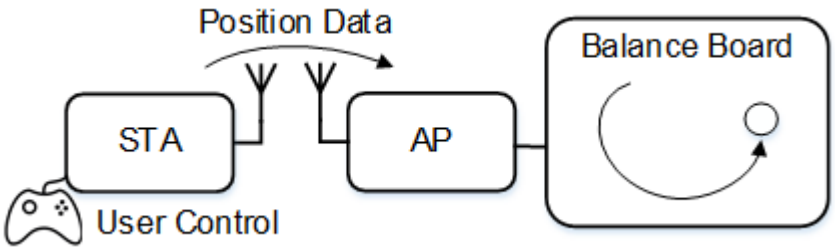




- Slot duration is configurable
- E2E application latency and PER are the main performance metrics

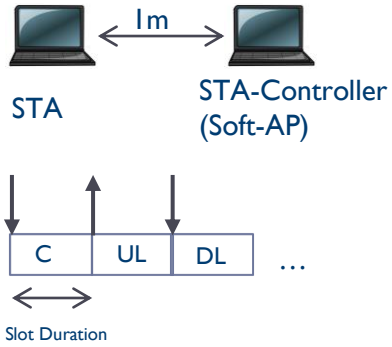
Slot Duration = Latency bound

Packet is considered lost if not delivered within the latency bound

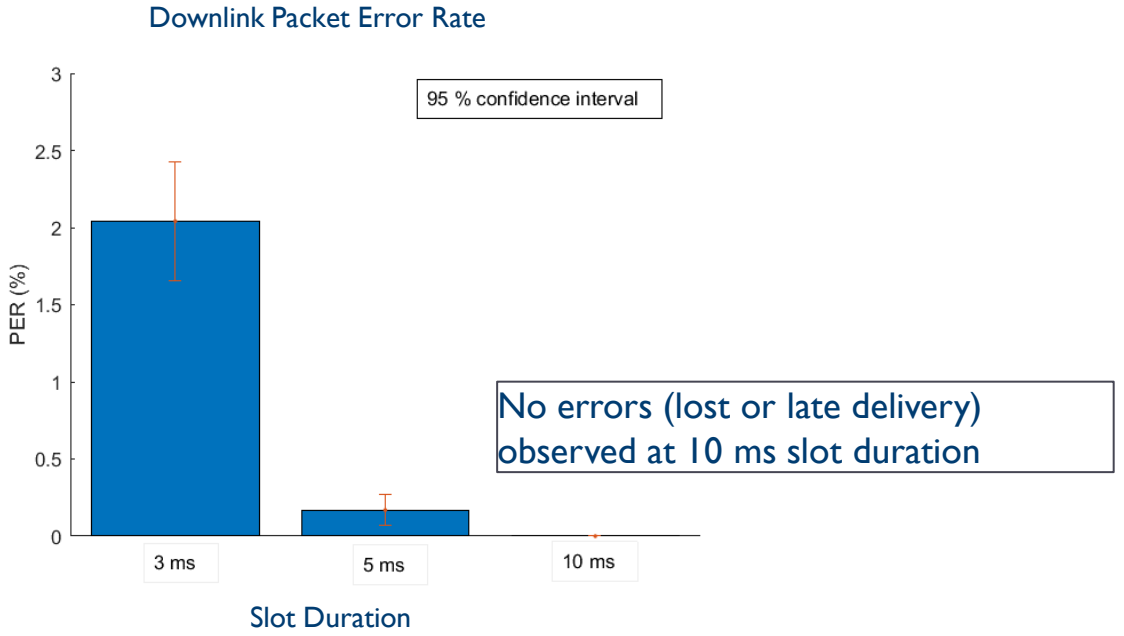


kinematic system comprises of a ball and a balancing board controlled by x and y position servo-motors

2.4GHz Short-range (1m) – PER vs Slot Duration/Latency



Application packet size = 100 Bytes



No errors (lost or late delivery) observed at 10 ms slot duration

Experiment duration: 300K slots (packet transmissions)

Conclusions and Future Work

- Preliminary results show latency vs PER tradeoffs in shared channels with other best effort applications (not ideal conditions)
  - Evaluations combine both stack (OS - Linux) and Wi-Fi (radio) latency
  - Time sync and scheduling help control latency, but additional optimizations in managed/private Wi-Fi networks can reduce latency and increase reliability
  - Deployment/coverage and channel planning (e.g. a dedicated channel for time sensitive STAs) are feasible industrial environments
- Future work:
  - Evaluate real work loads (control system model) and deployment conditions
  - Developing next gen WTSN POC platform to demo PHY and MAC capabilities that enable lower latency (1msec)

References

- S. Kim et al., "Demo/poster abstract: Enabling time-critical applications over next-generation 802.11 networks," IEEE INFOCOM 2018 - IEEE Conference on Computer Communications Workshops (INFOCOM WKSHPS), Honolulu, HI, USA, 2018, pp. 1-2.