Consideration on Positioning with 802.11bd

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Abstract

802.11mc contains Fine Timing Measurement (FTM) Protocol for round trip ranging and positioning.

802.11az proposes some improvements on FTM such as NDP SU/MU ranging, trigger based ranging, AOA/AOD measurements, …

What are the implications for 802.11bd positioning mode?

This is a discussion document so feedback highly welcome.

Introduction

- **PAR [1]:**
  - "This amendment defines at least one mode that achieves at least 2 times higher throughput" … "in high mobility channel environments at vehicle speeds up to 250 km/h (closing speeds up to 500 km/h);"
  - "this amendment defines procedures for at least one form of positioning in conjunction with V2X communications"
  - "This amendment shall provide interoperability, coexistence, backward compatibility, and fairness with deployed OCB (Outside the Context of a BSS) devices."
- **Use Case (UC) baseline document [2]:**
  - UC5 Vehicular Positioning & Location
  - UC8 Train-to-Train
  - UC9 Vehicle-to-Train

Current Situation V2X

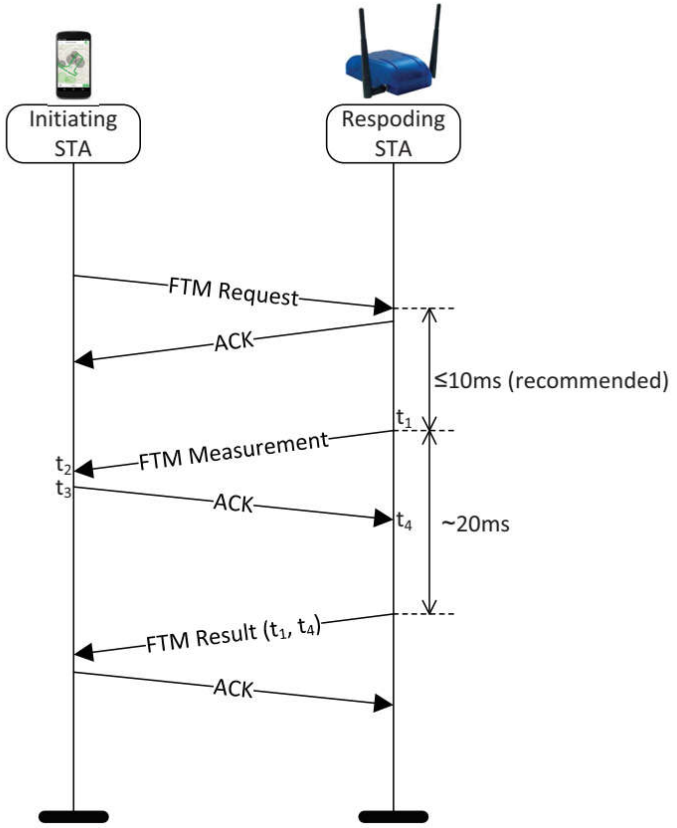
Proprietary solution [3] with road side units (RSUs) exists

- **RSUs generally broadcast their position information in either,**
  - Wave Service Announcements (WSA) (IEEE 1609)
  - Geonetworking messages (ETSI ITS)
- **Ranging measurements**
- **Enhanced signal processing algorithms to**
  - improve robustness with regard to multipath effects
  - achieve range accuracy in the order of nanoseconds Time-of-flight even in multipath channels
- **RSUs honor SIFS timing: IEEE 802.11 devices should respond to Unicast packets with a short ACK at a very specific period of time after receipt of Unicast packet.**
  ➔ 32µs@10 MHz

Fine Timing Measurement (FTM) Protocol

According to [4] FTM

- **Time to obtain range ~ 30 ms**
- **Position: 3 ranges needed**
  ➔ 100 – 120 ms
- **50 km/h=13.9 m/s**
  ➔ 0.4m moved while obtaining one range
  ➔1.4m - 1.7m moved while obtaining three ranges
- **ACK on FTM Measurement: aSIFSTime (32µs@10 MHz)**
  - Default accuracy ±1.3µs ➔ 390m error
  - 0.1% error (1/3 of sample) ➔10m error



Discussion

- **5.9 GHz mode:**
  - V2X (X=V,I,P,T) ranging?
  - Limits of round-trip ranging for high mobility?
  - One way ranging useful?
  - Multi-antenna approaches?
  - Bandwidth and aSIFSTime?
  - 802.11az features [5]?
  - Quality indicators for higher layer(data fusion: Channel impulse response, clock parameters, etc.?
  - Can we reuse existing messages or do we need dedicated 11bd ranging message?
  - Simulation and channel models [6]?
- **60 GHz mode: ranging mode (**large bandwidth ➔ high ranging accuracy**)?**

References

[1] TGbd, "Project Authorization Request (PAR)", IEEE 802.11-18/0861r9

[2] NGV SG, "Use Case Baseline Document Approved By SG", IEEE 802.11-18/1323r2

[3] Cohda Wireless, "V2X-Locate Positioning Whitepaper", https://cohdawireless.com/wp-content/uploads/2018/08/Whitepaper_V2X-Locate.pdf

[4] L. Banin, et al., "High-Accuracy Indoor Geolocation using Collaborative Time of Arrival (CToA) - Whitepaper", IEEE 802.11-17/1387r0

[5] L. Chu, et al., "NGV Ranging Discussion", IEEE 802.11-18/1250r0

[6] P. Unterhuber, et al., "Considerations on Vehicular Channel Models", IEEE 802.11-19/0034r1