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**RTCA Special Committee 186, Working Group 5**
**ADS-B UAT MOPS**
**Meeting #10**

# Multi-Aircraft UAT Simulator Results for Various Scenarios

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SUMMARY

Model results from the Multi-Aircraft UAT Simulator are presented in response to Action Items 8-9, 9-5, 9-6, 9-7, 9-8, and 9-9

# MAUS Results

Presented to UAT MOPS WG

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# Outline of Results

- Core Europe and LA Basin (Air-Air and Air-Ground)
  - A1 sub-class added
  - Receivers less than 20 nmi away use probe data
- Co-located TACAN transmitter (100 W and 10 kW with cavity filter) for Ground Receivers in Europe 2015
- UAT equipage levels supported in current European scenario
- Receptions of ground vehicle broadcasts for victim at FL 20 (Probe in LA/CE)

# New MAUS Features

- New UAT self-interference bit-level model – James Higbie/APL bench testing
- New error-handling algorithm - produces BER from L16, DME, and UAT self-interference
- Probe simulations
  - Receptions of ground vehicle broadcasts
  - Close range Air-Air
- More realistic DME/TACAN pulse profile
- 15-us receive suppression after transmission
- A1 sub-class

# Victim Receivers

- Filter bandwidth by receiver type:
  - A3 uses 0.8 MHz filter
  - All other receiver types use 1.2 MHz filter
- Altitude
  - High (FL300 – 400) - aircraft with the most other aircraft in LOS
  - FL 150
  - Ground receiver
- Probe receivers used for ground vehicle reception

# Ground Receiver Assumptions

- -96 dB sensitivity
- 8 dB gain DME antenna
- 1.2 MHz filter

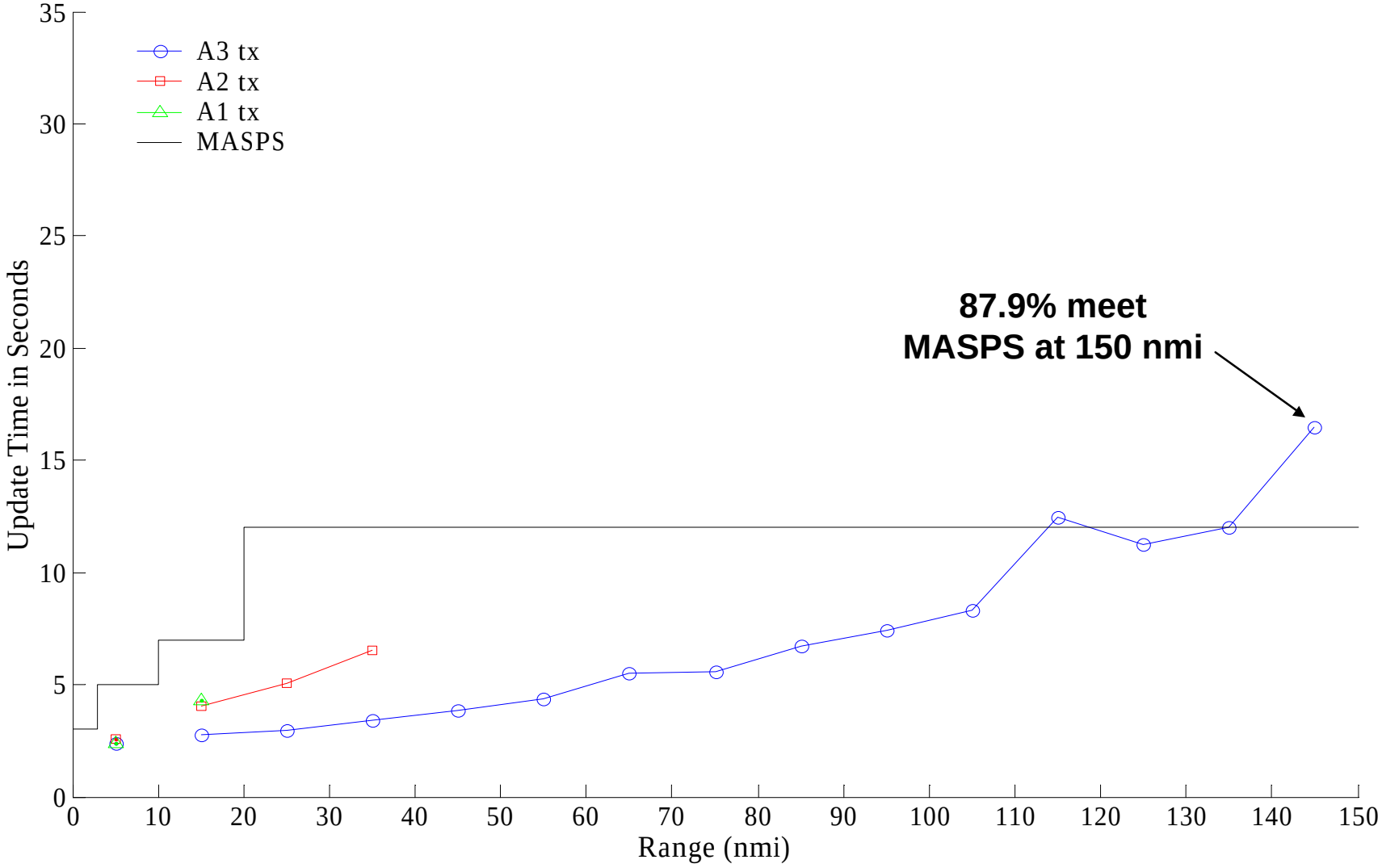
# LA Basin

# LA Basin Assumptions

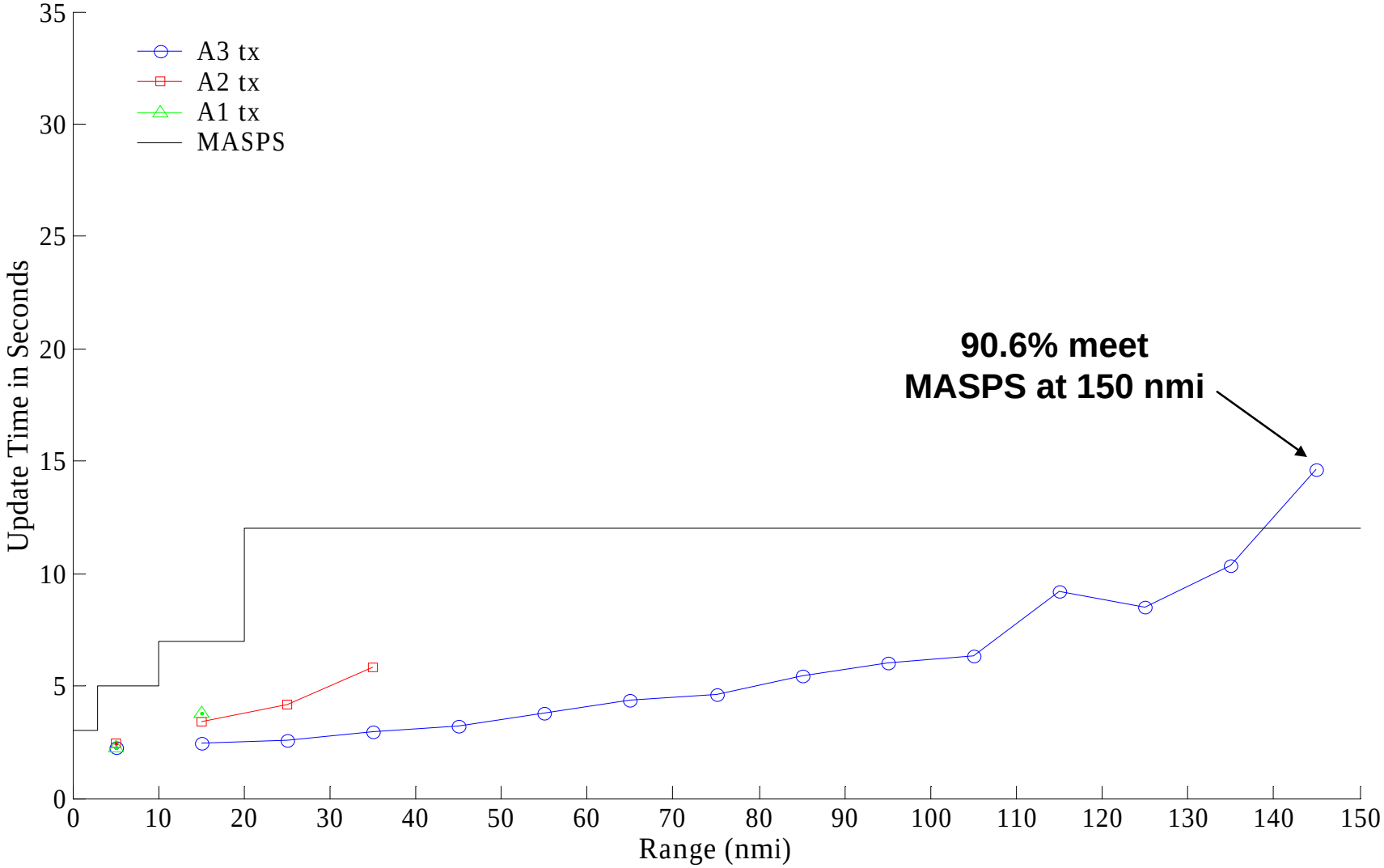
- Standard LA interference environment
  - Link 16 Baseline B
  - 2694 aircraft in 400 nmi radius + 100 ground vehicles at each of 3 airports = 2994 transmitters total
  - Co-site 1030, 1090, DME, UAT transmissions assumed to prevent reception during time of transmission + 15 us
  - No DMEs
- Transmit Powers
  - A0/A1*: 38.5-42.5 dB
  - A1/A2: 42-46 dB
  - A3: 50-54 dB

A1* - subclass of A1 aircraft consists of 84% of A1 aircraft below FL180

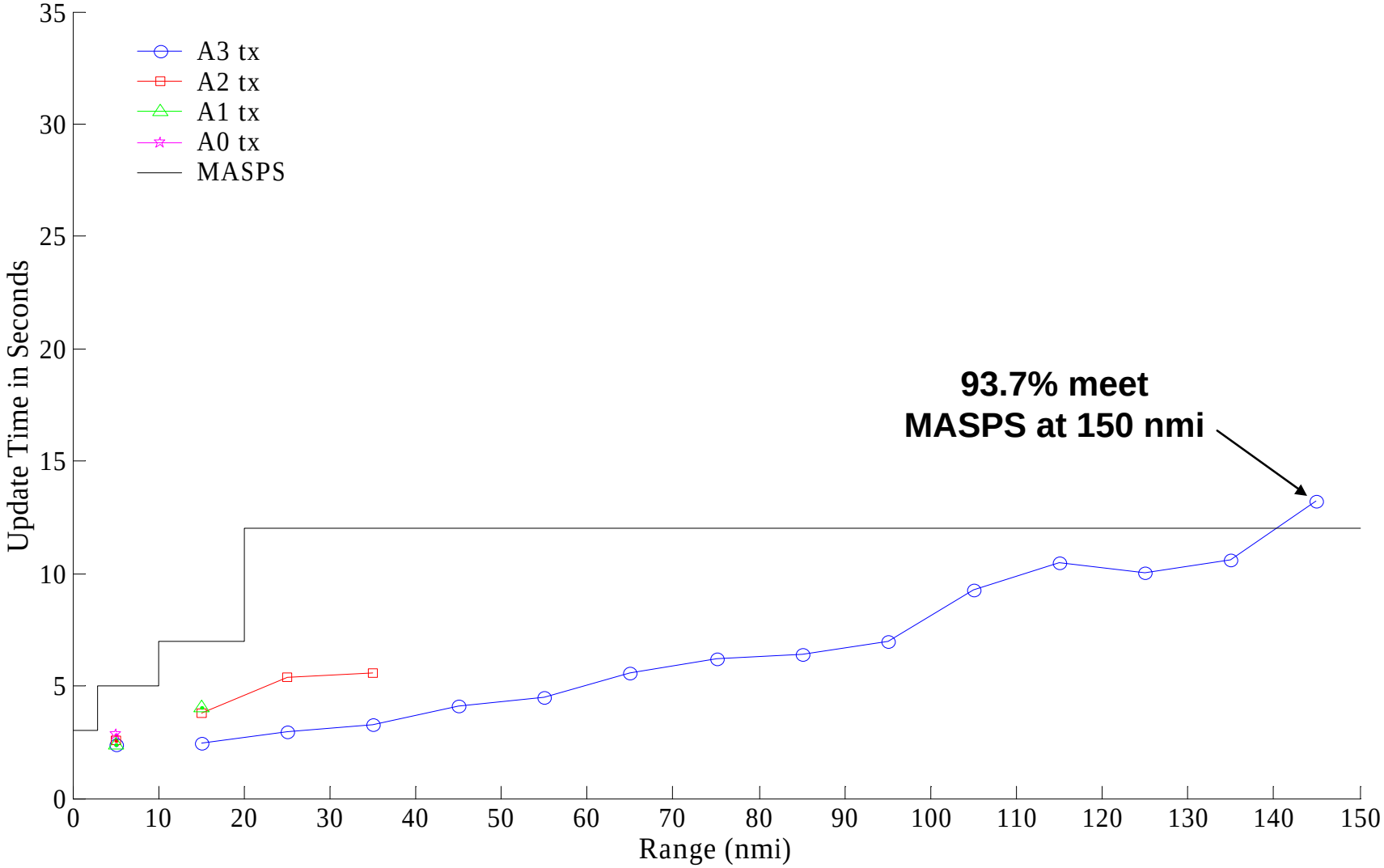
# A3 Receiver at High Altitude in LA



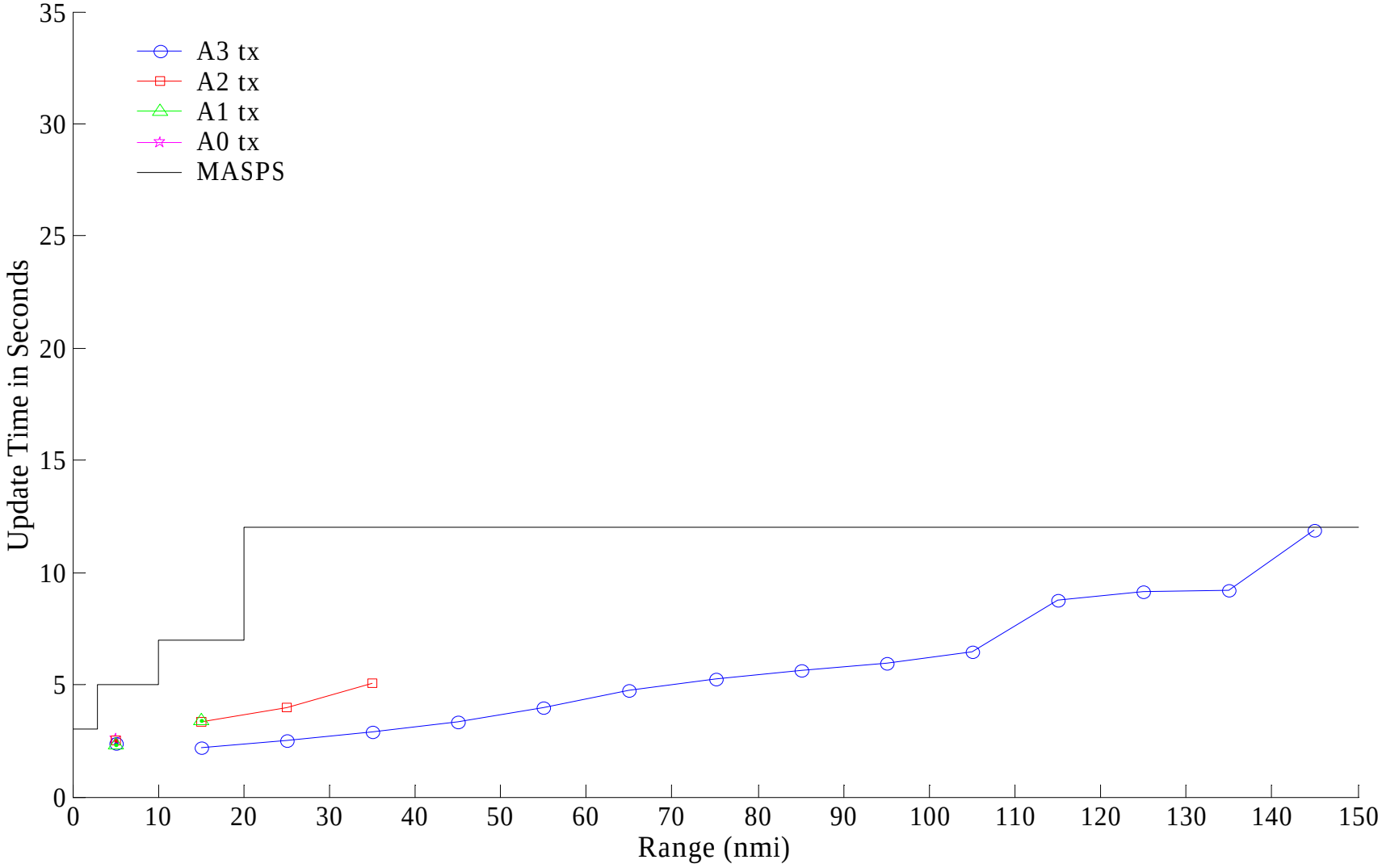
# A2 Receiver at High Altitude in LA



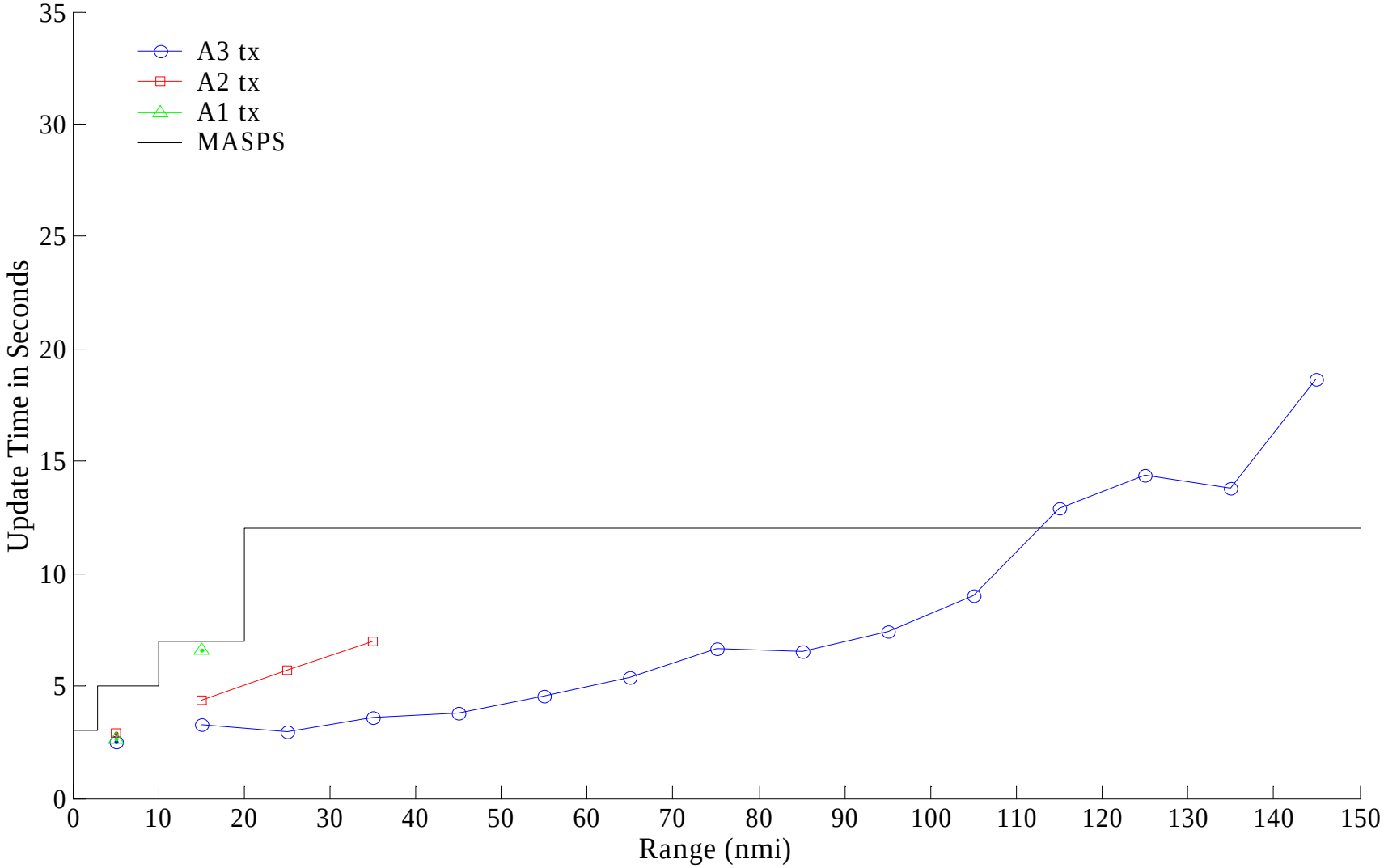
# A3 Receiver at FL150 in LA



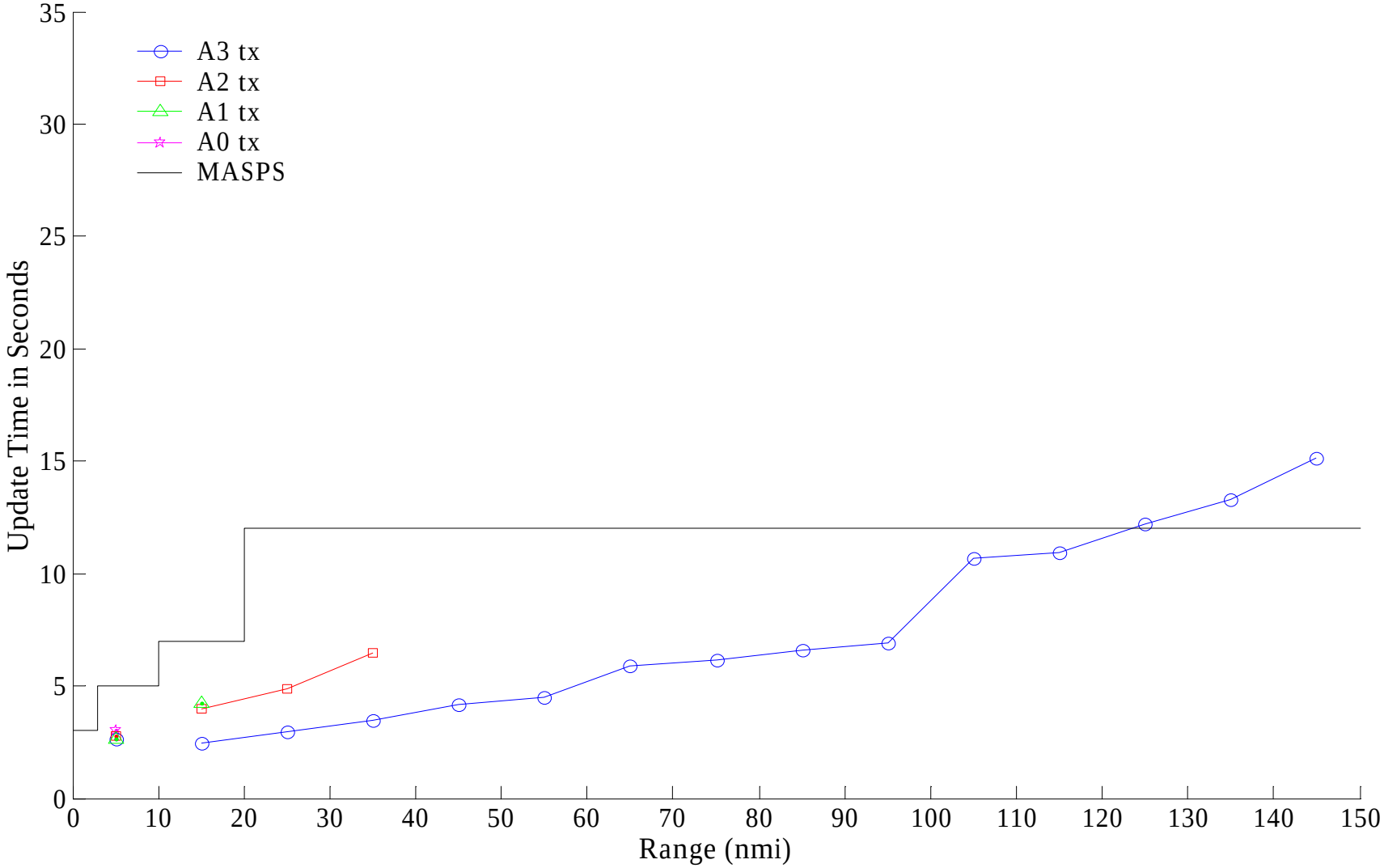
# A2 Receiver at FL150 in LA



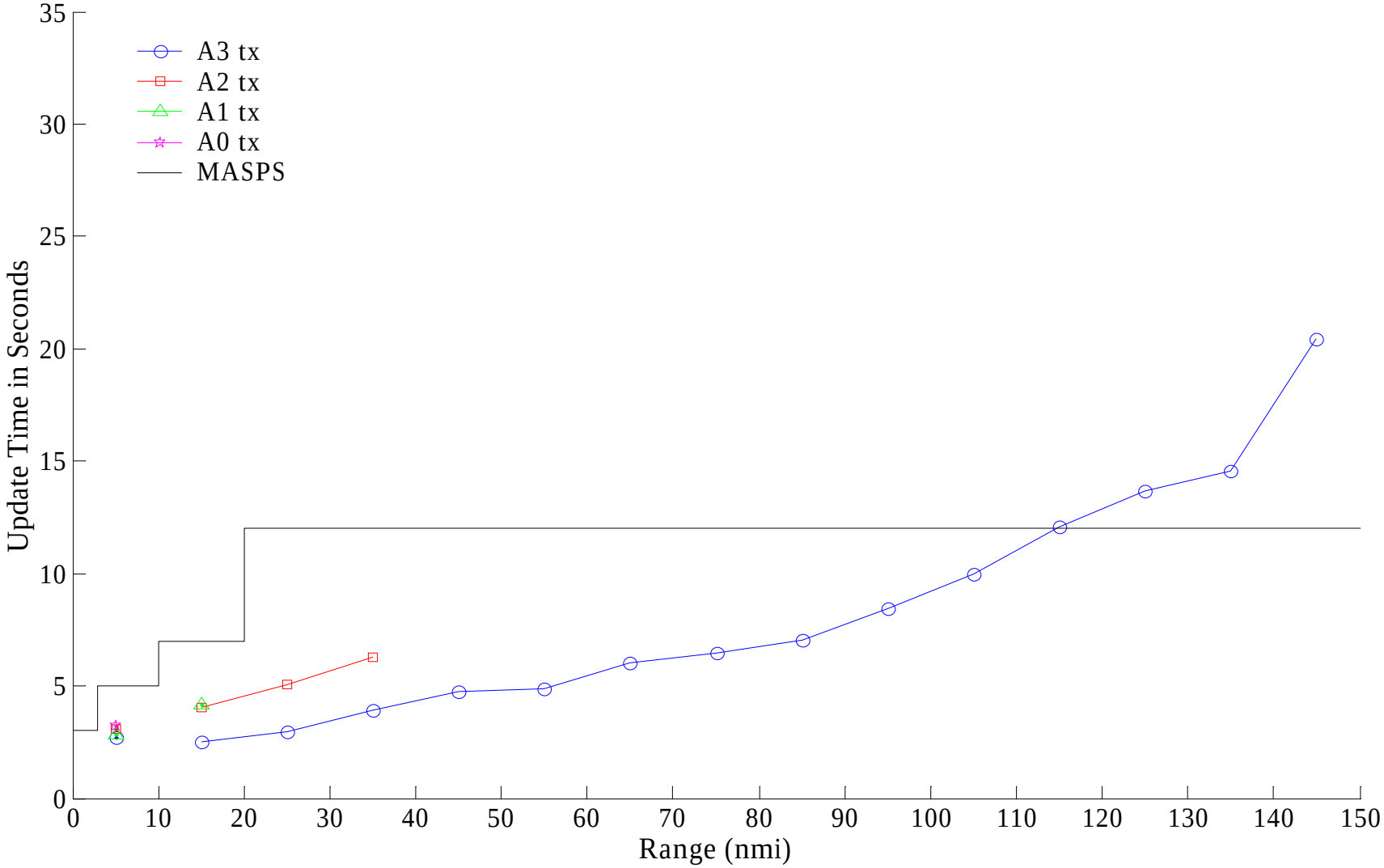
# A1 receiver at High Altitude in LA



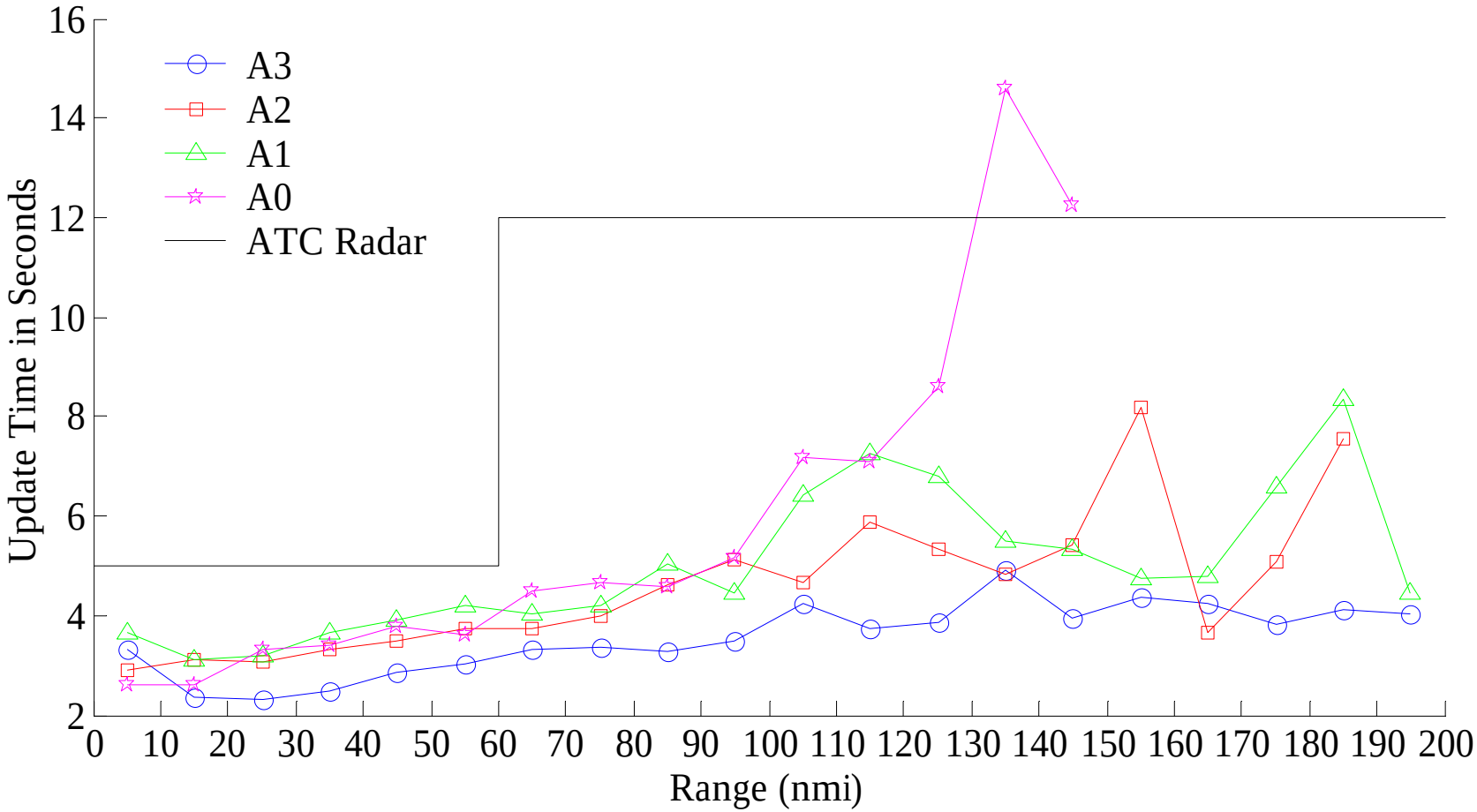
# A1 receiver at FL150 in LA



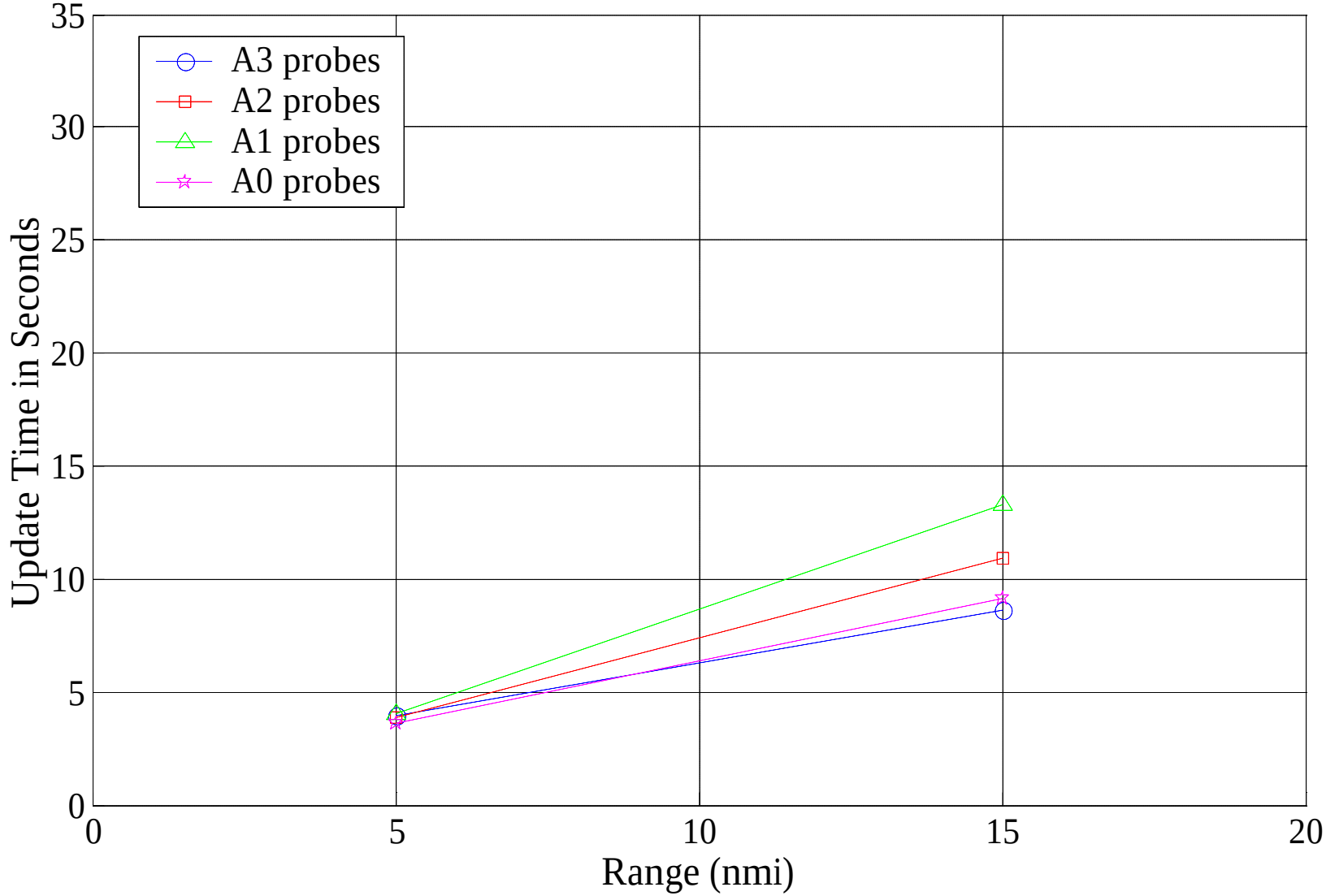
# A0 receiver at FL150 in LA



# Ground Receiver in LA



# Receptions from Ground Vehicles



# LA 2020 Results

- A1 sub-class appears to work in LA
- State vector update rates MASPS compliant in LA for all air-air cases
  - A3 at 150 nm?
- Air-ground state vector update rates look good for A1-A3
  - A0 transmitters can be seen out to 130 nmi

# Core Europe

# Core Europe Assumptions

- Link 16 Baseline, option B
- UAT self-interference
- Co-site 1030, 1090, DME, UAT transmissions assumed to prevent reception during time of transmission + 15 us
- Transmit Powers
  - A0/A1*: 38.5-42.5 dB
  - A1/A2: 42-46 dB
  - A3: 50-54 dB

A1* - subclass of A1 aircraft consists of 84% of A1 aircraft below FL180

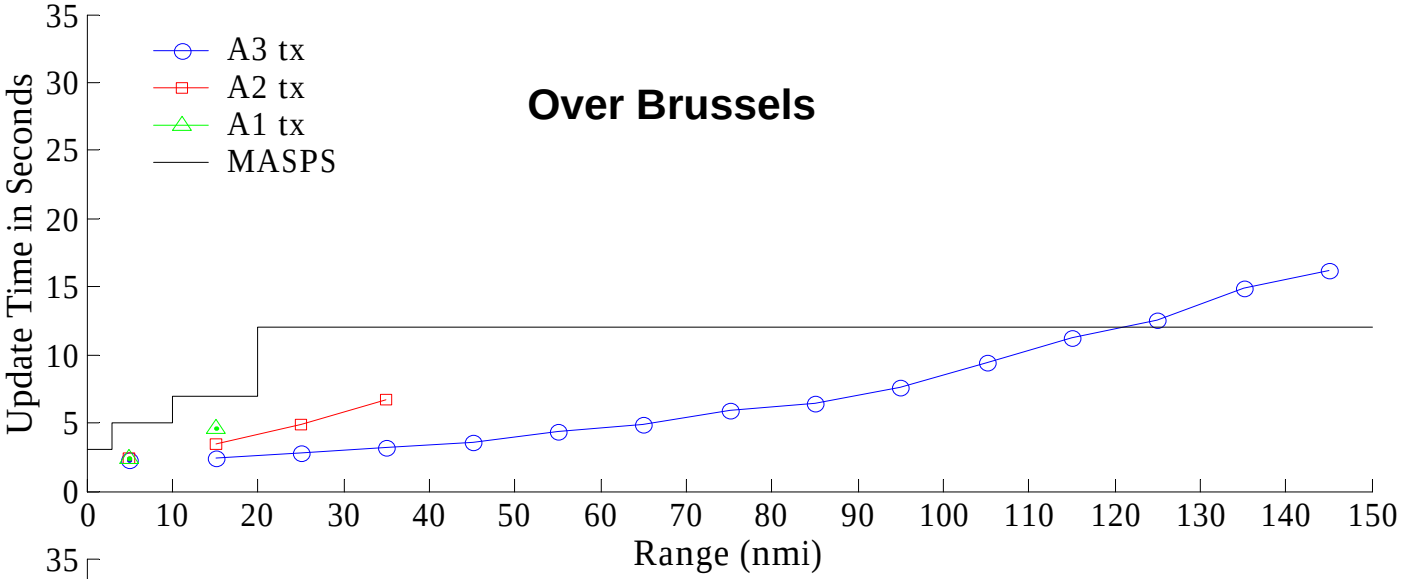
# DME Interference Levels for Europe in 2015

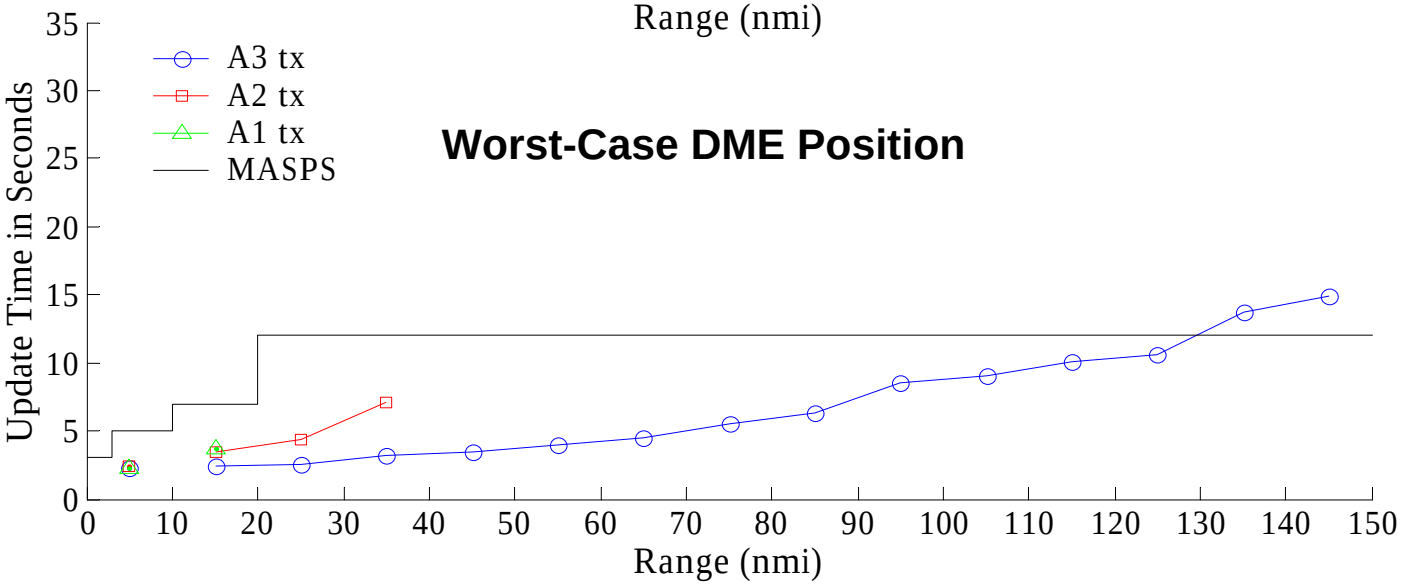
- Measured TACAN antenna pattern
- 8 dB rule implemented
- 1 dB power added to DME levels to account for MER/BER discrepancy

| Over Brussels | | | Worst Case DME position | | |
|---|---|---|---|---|---|
| High Alt. | Channel/Type | FL 150 | High | Channel/Type | FL 150 |
| -75 | Adj./DME | -75 | -75 | Adj./DME | -71 |
| -76 | Adj./TACAN | -68 | -69 | Adj./TACAN | -55 |
| -65 | Adj./TACAN | -67 | -61 | Adj./TACAN | -71 |

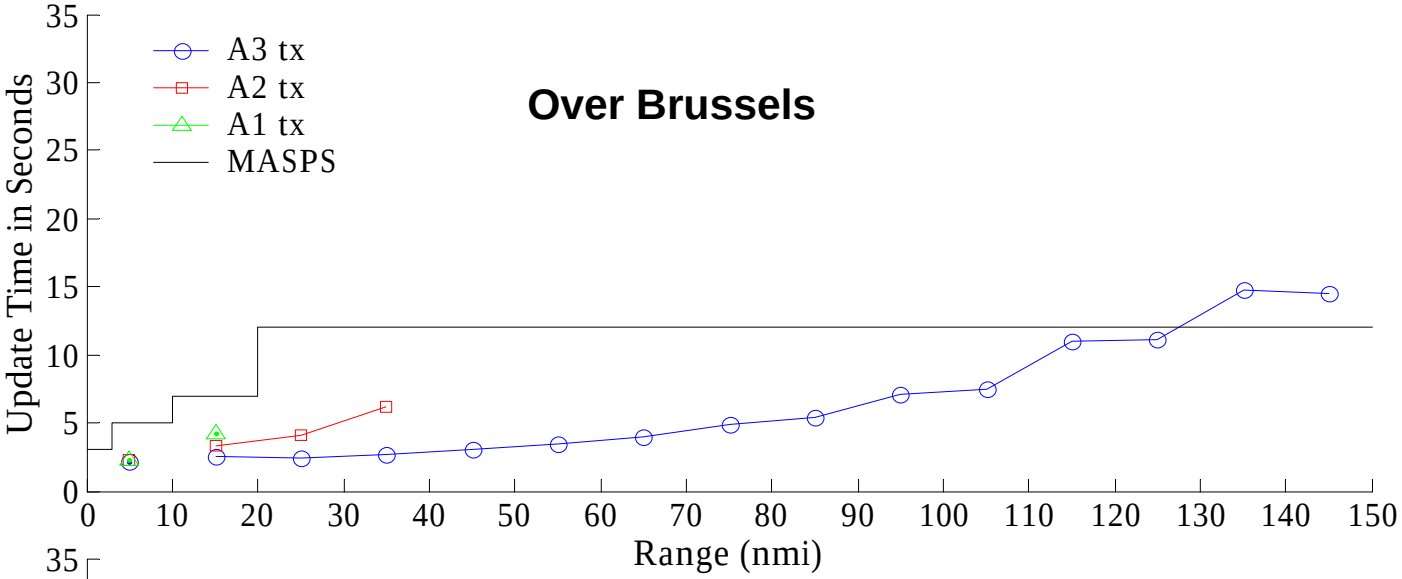
# Core Europe
# 2015 Results

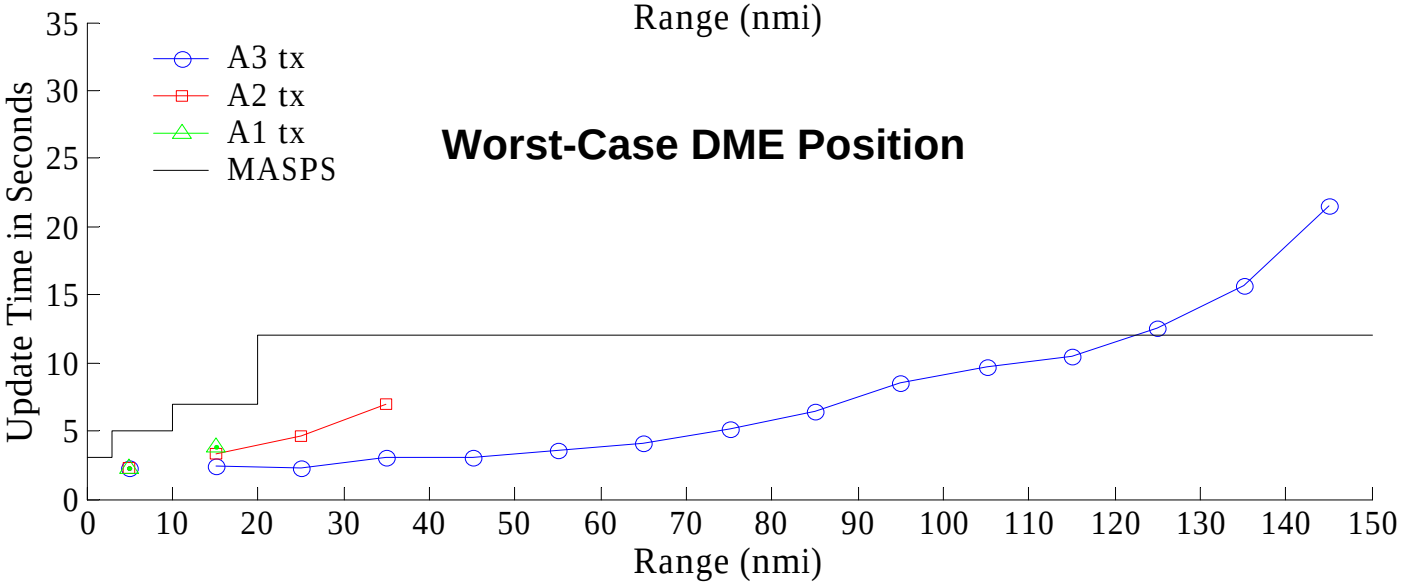
# A3 Receiver at High Altitude in Europe 2015



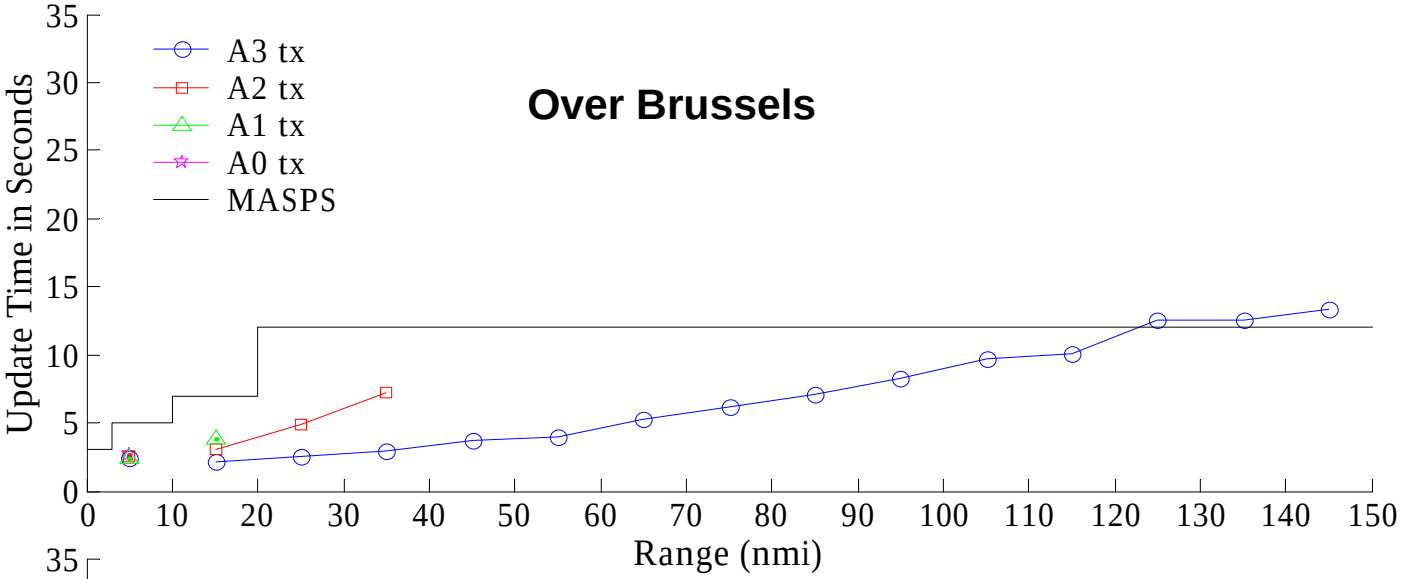



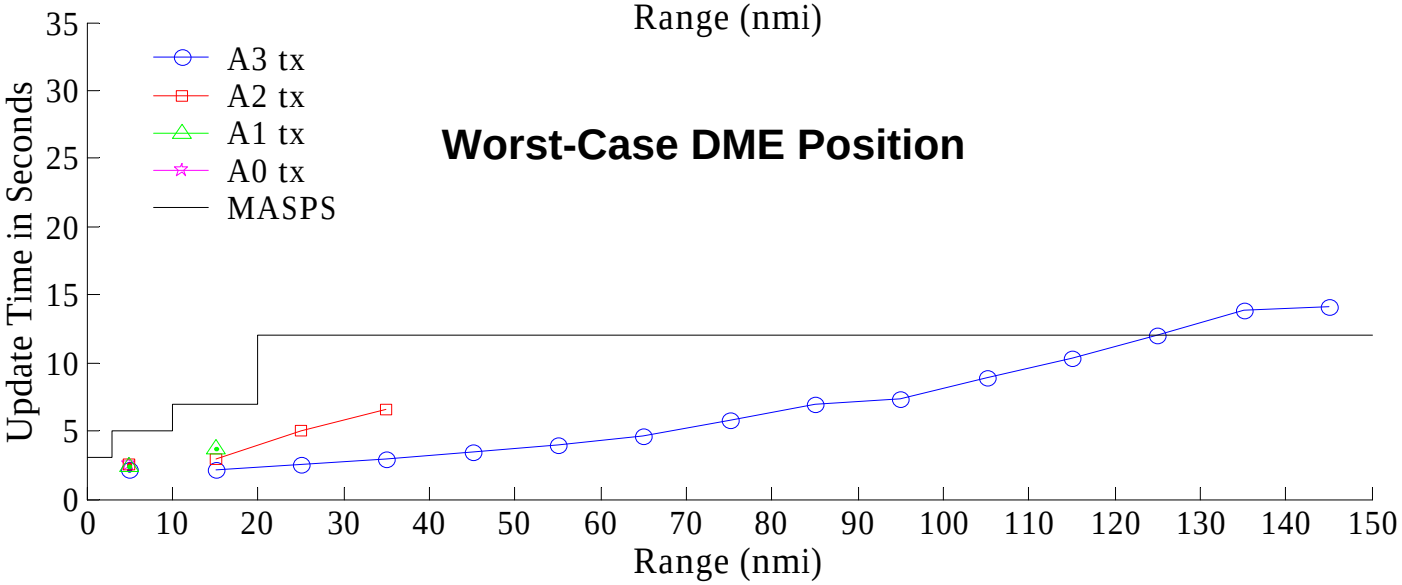
# A2 Receiver at High Altitude in Europe 2015



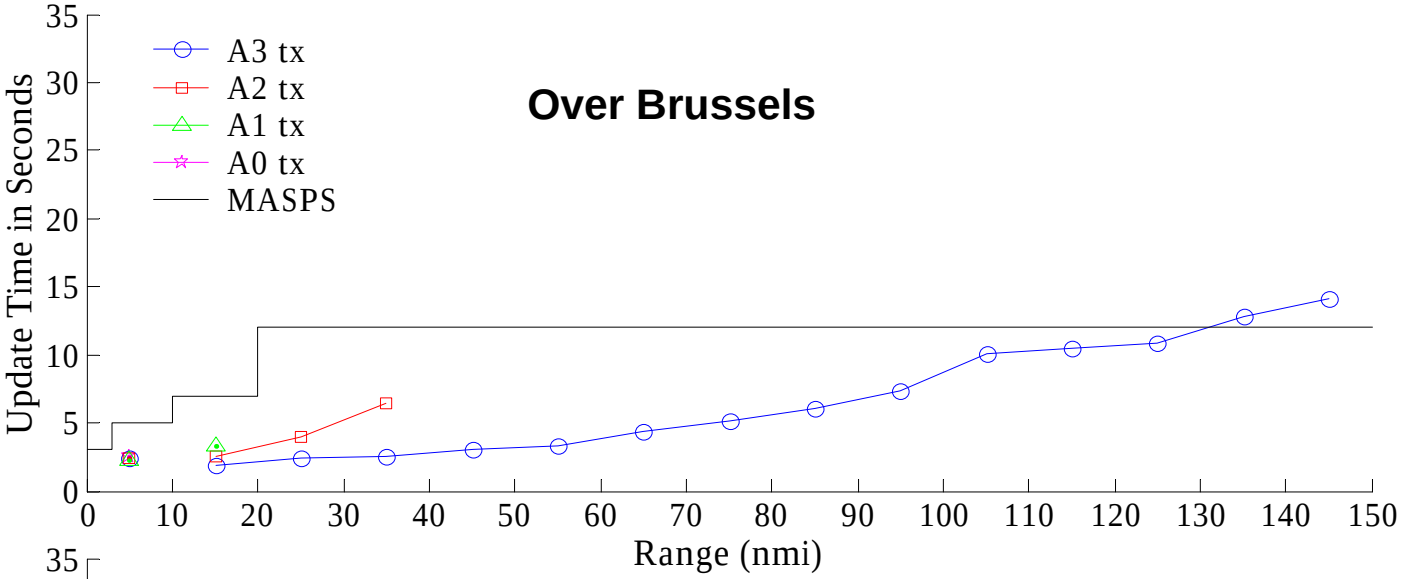



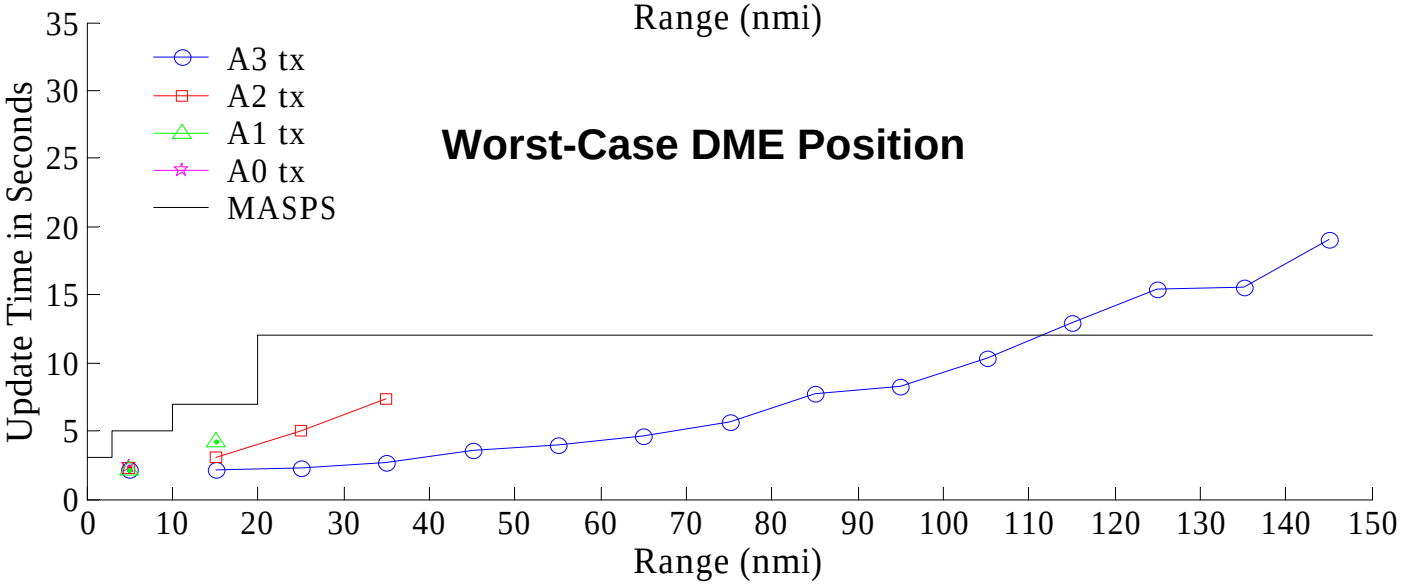
# A3 Receiver at FL150 in Europe 2015



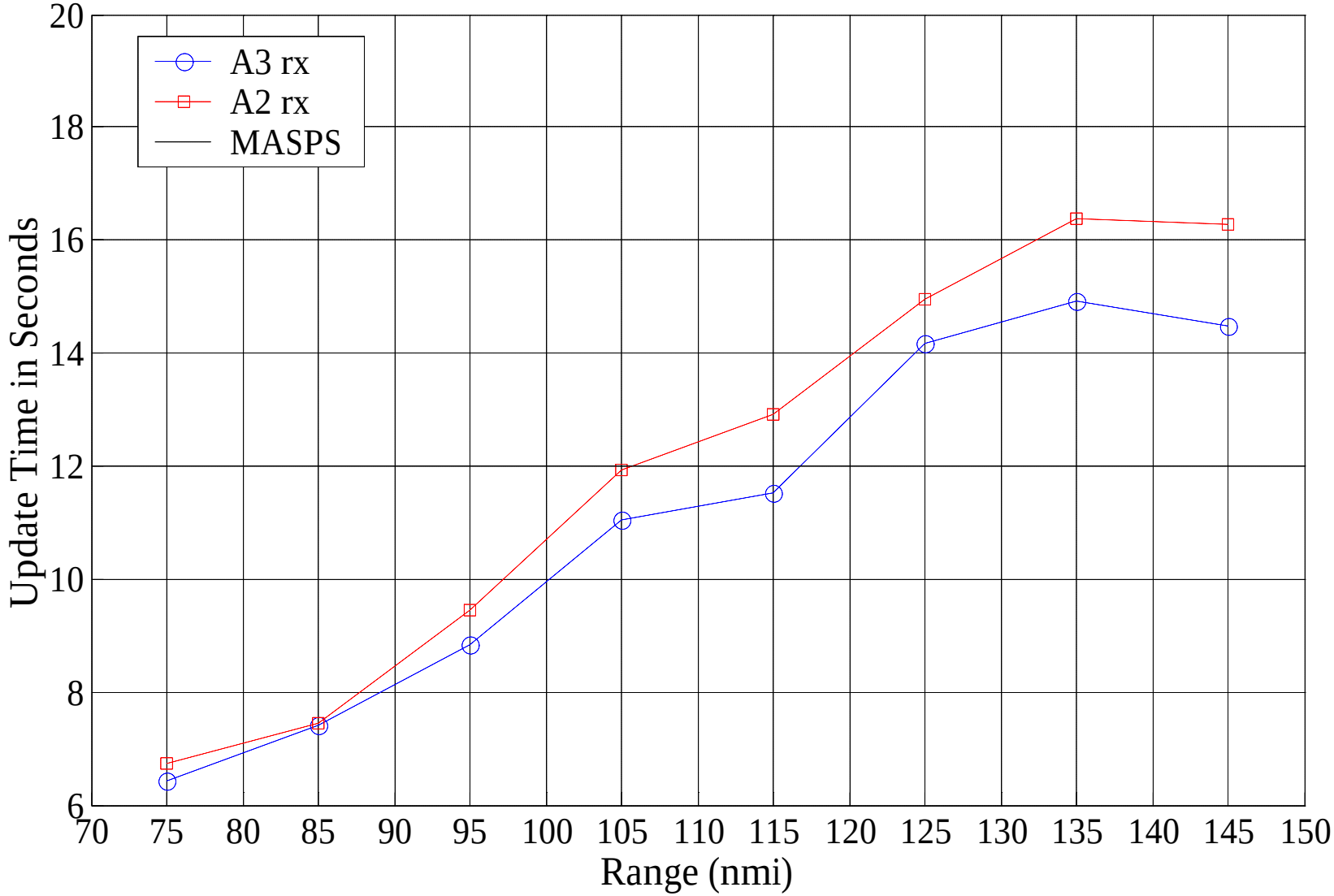



# A2 Receiver at FL150 in Europe 2015

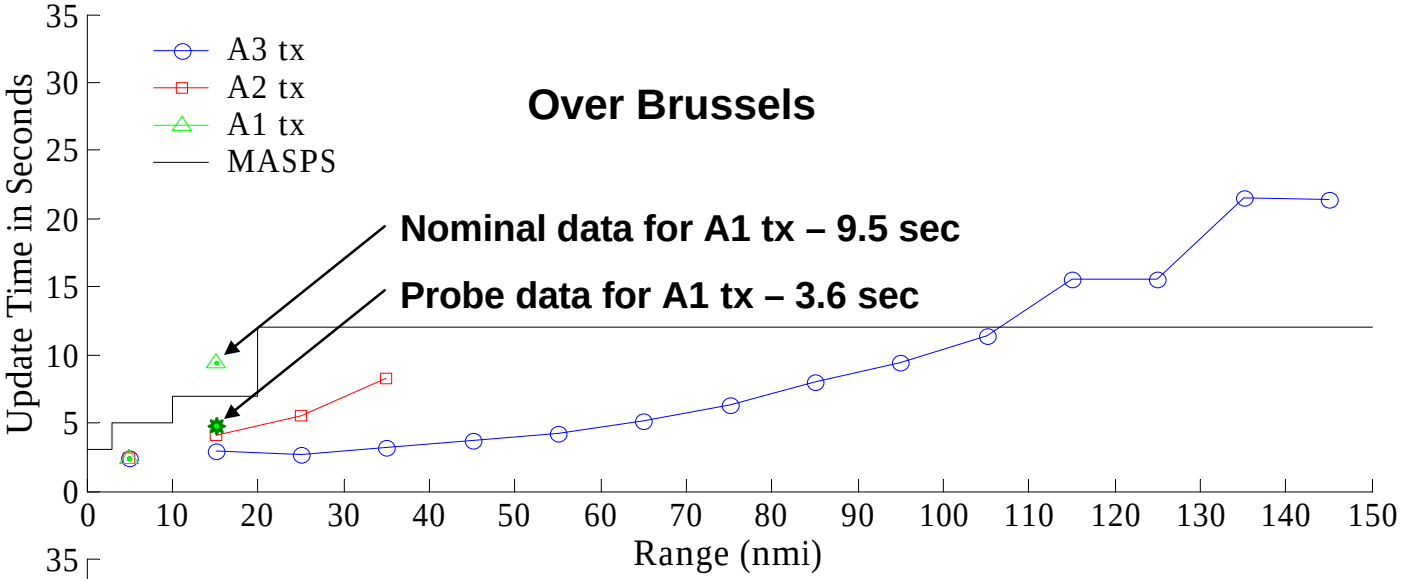


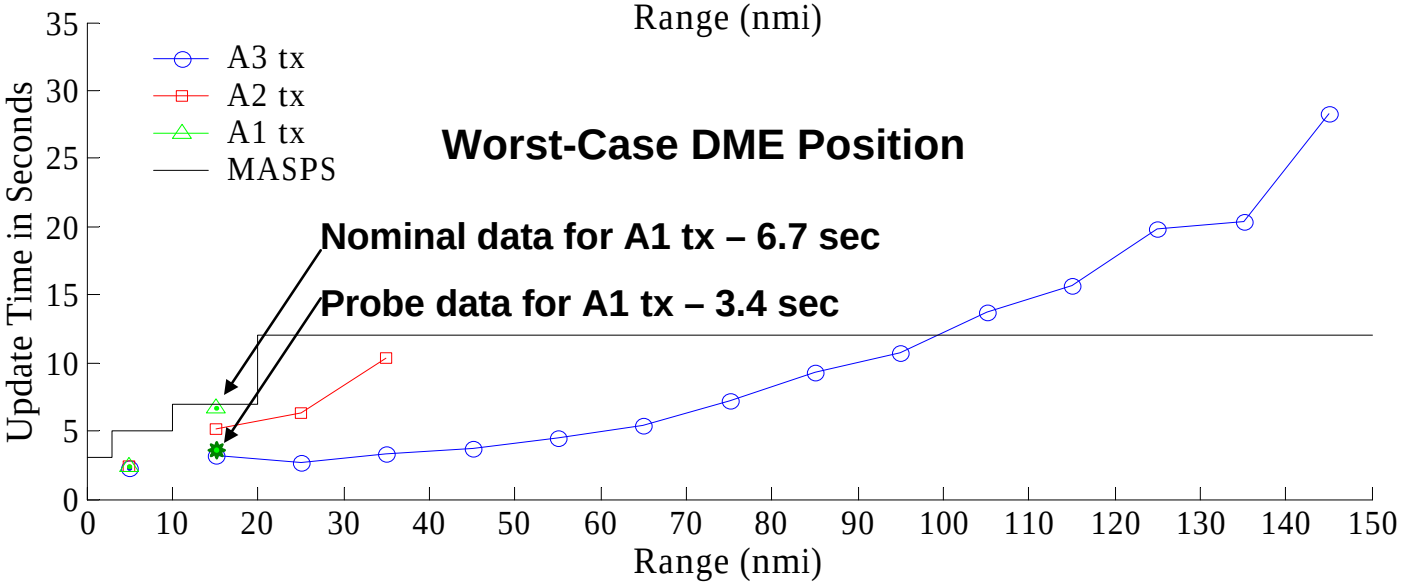



# Probe Receivers with A3 Transmitters in Europe 2015 Worst Case DME Position

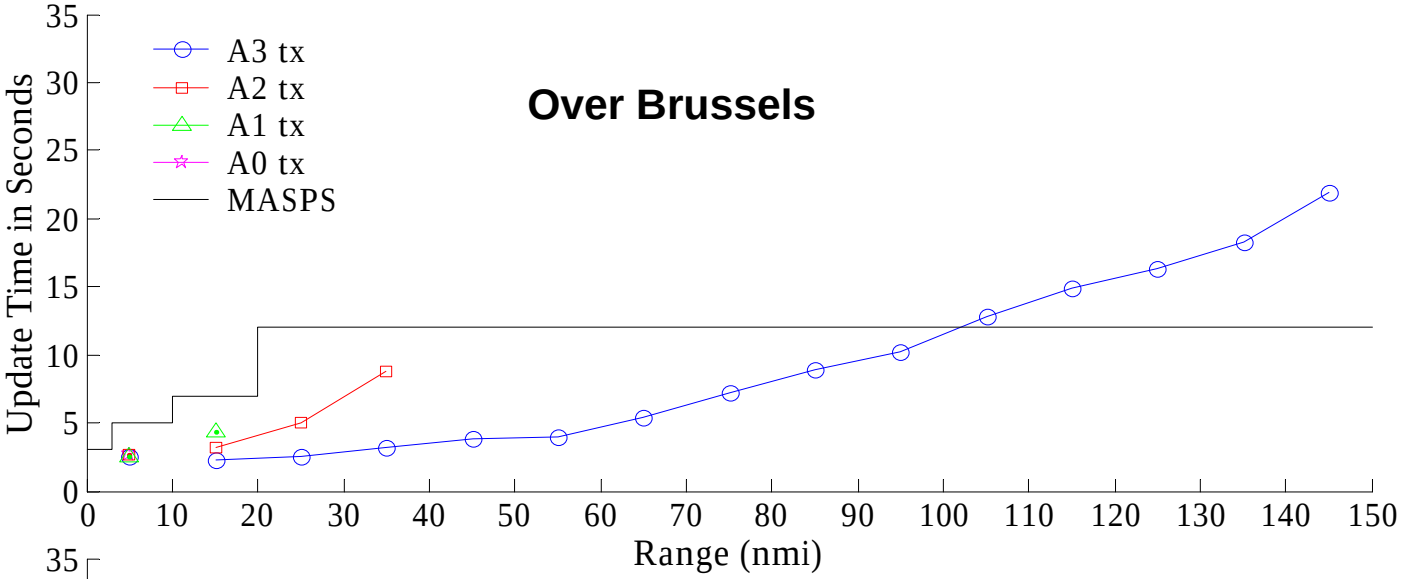


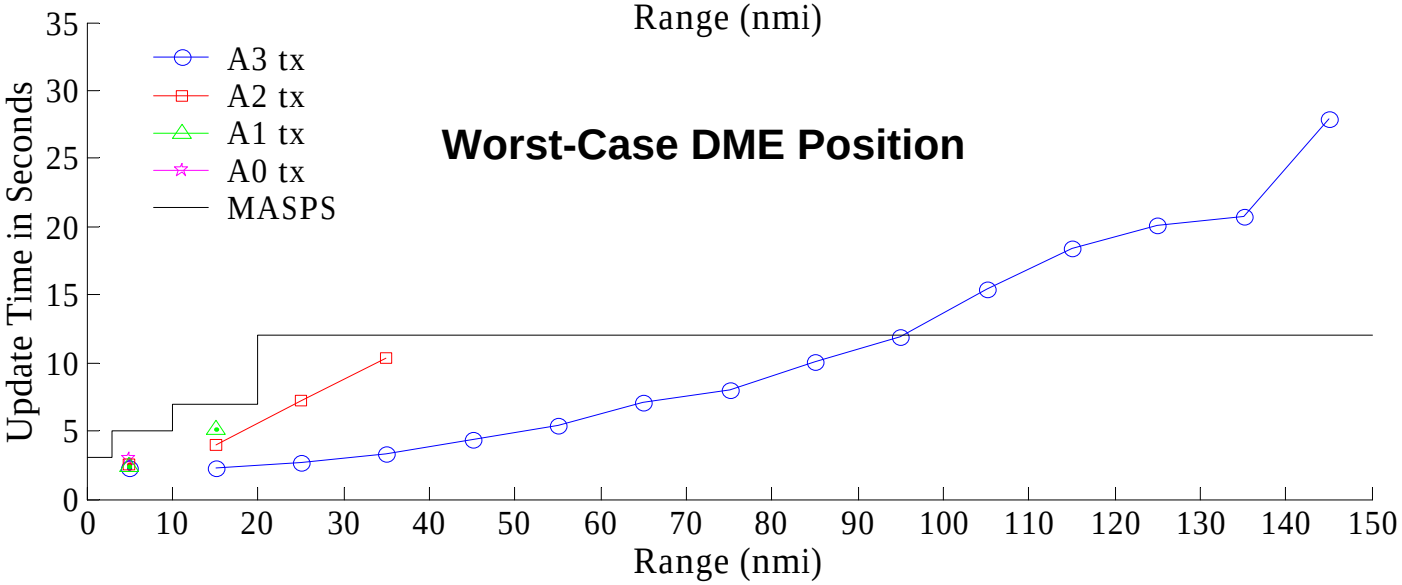
# A1 Receiver at High Altitude in Europe 2015



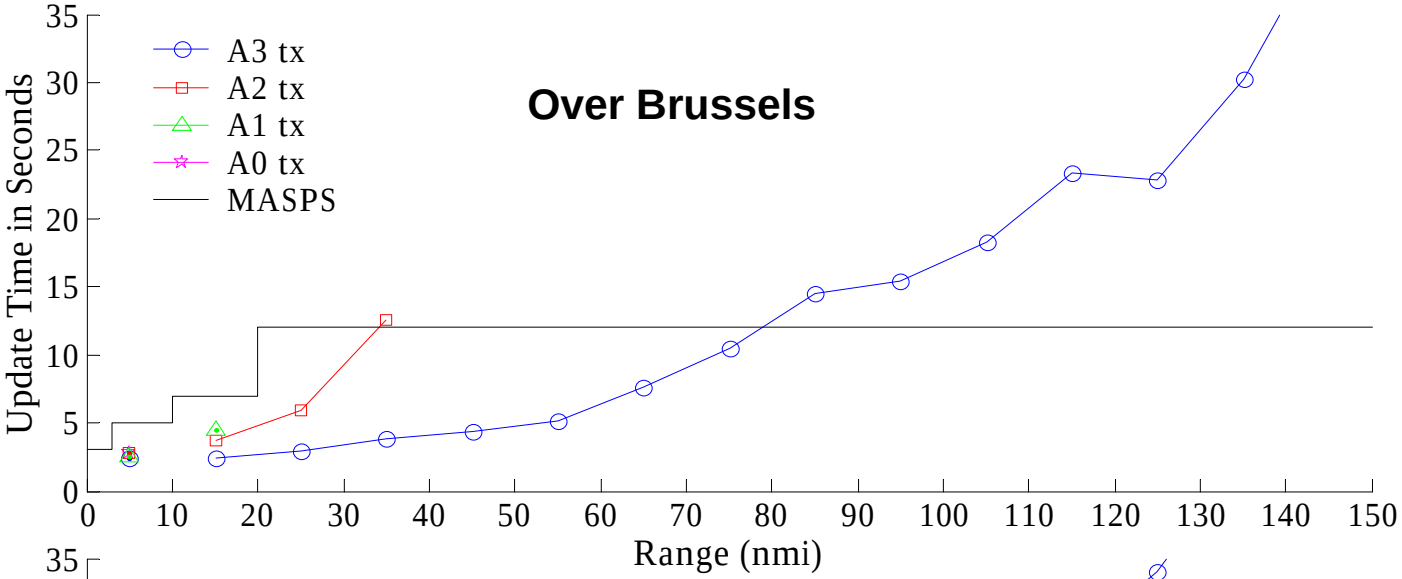



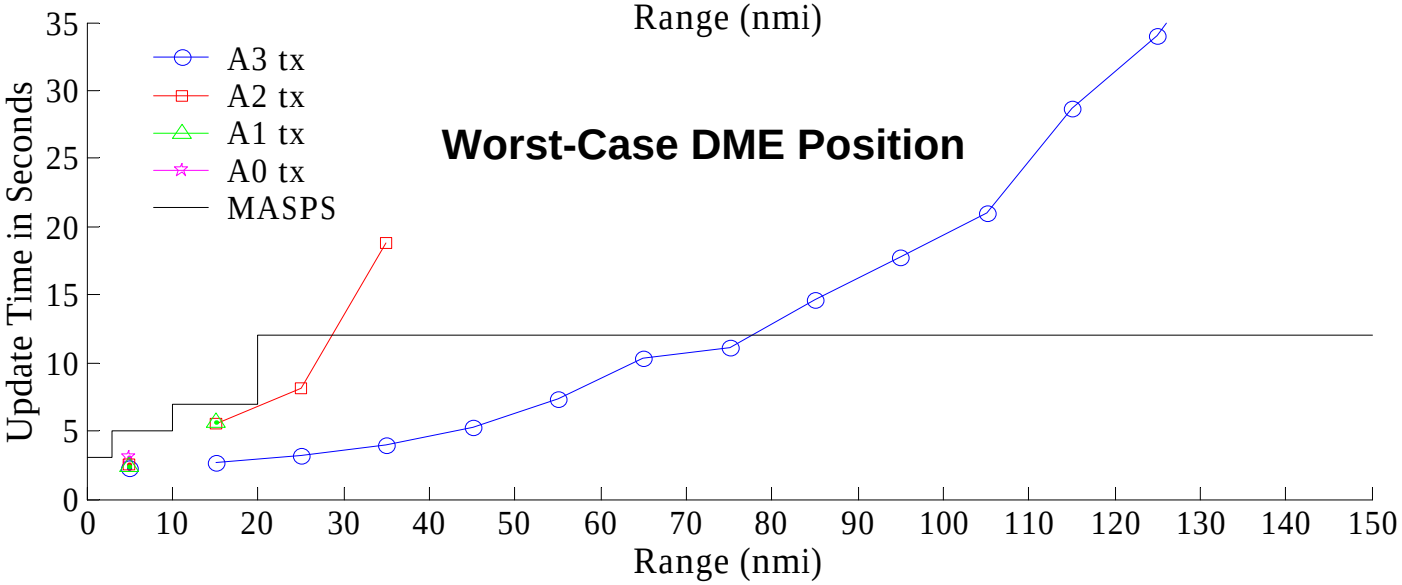
# A1 Receiver at FL150 in Europe 2015



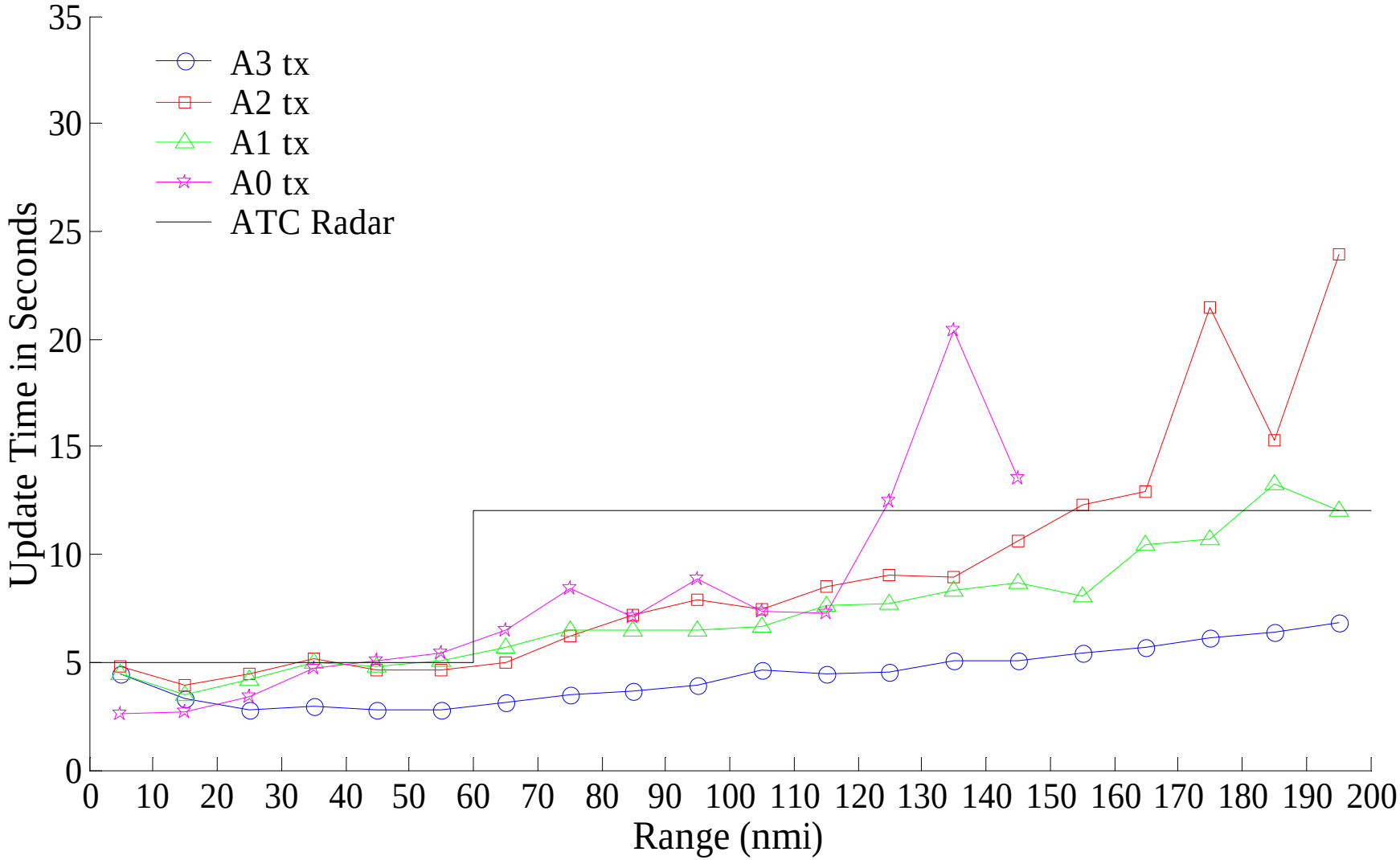



# A0 Receiver at FL150 in Europe 2015

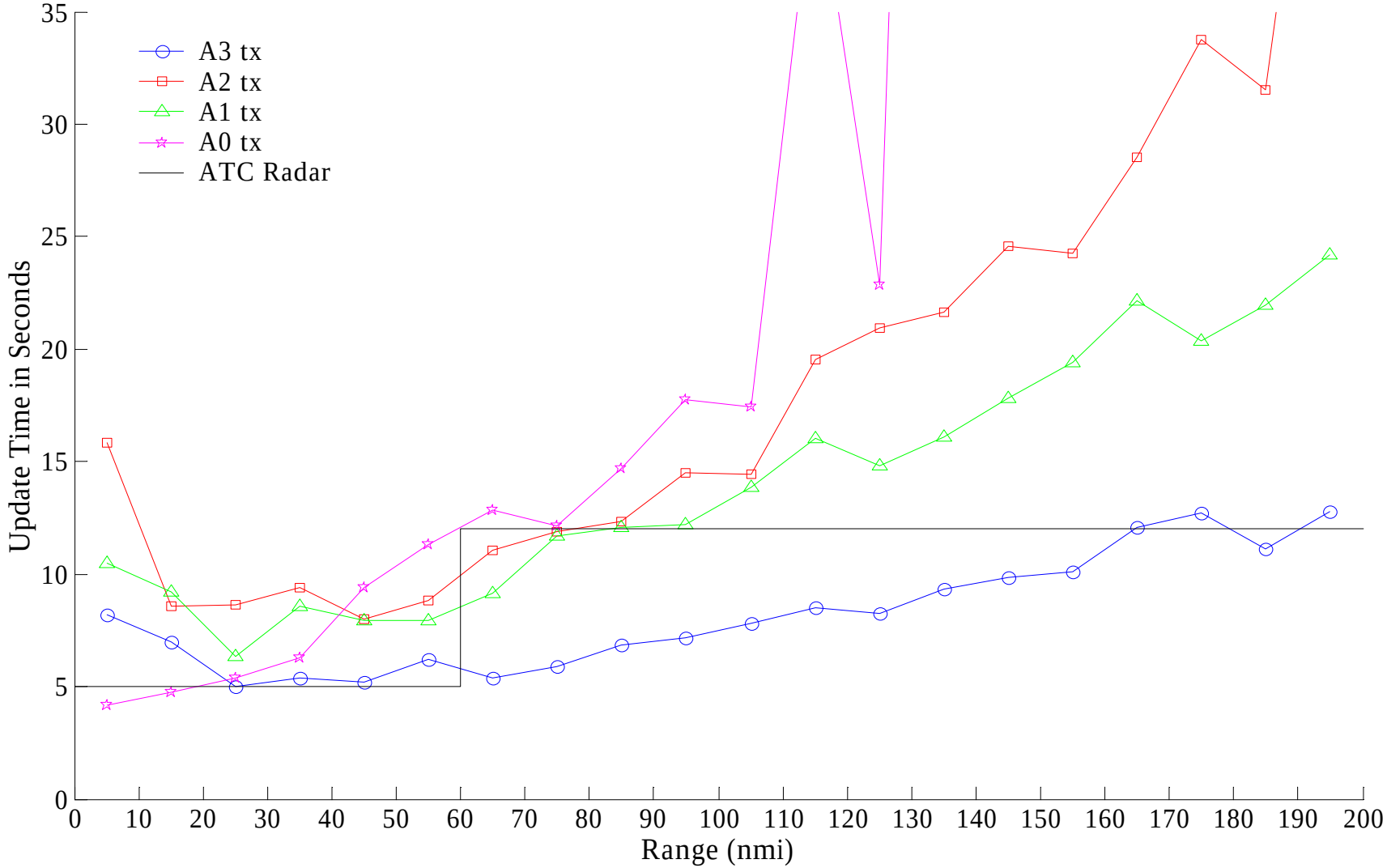


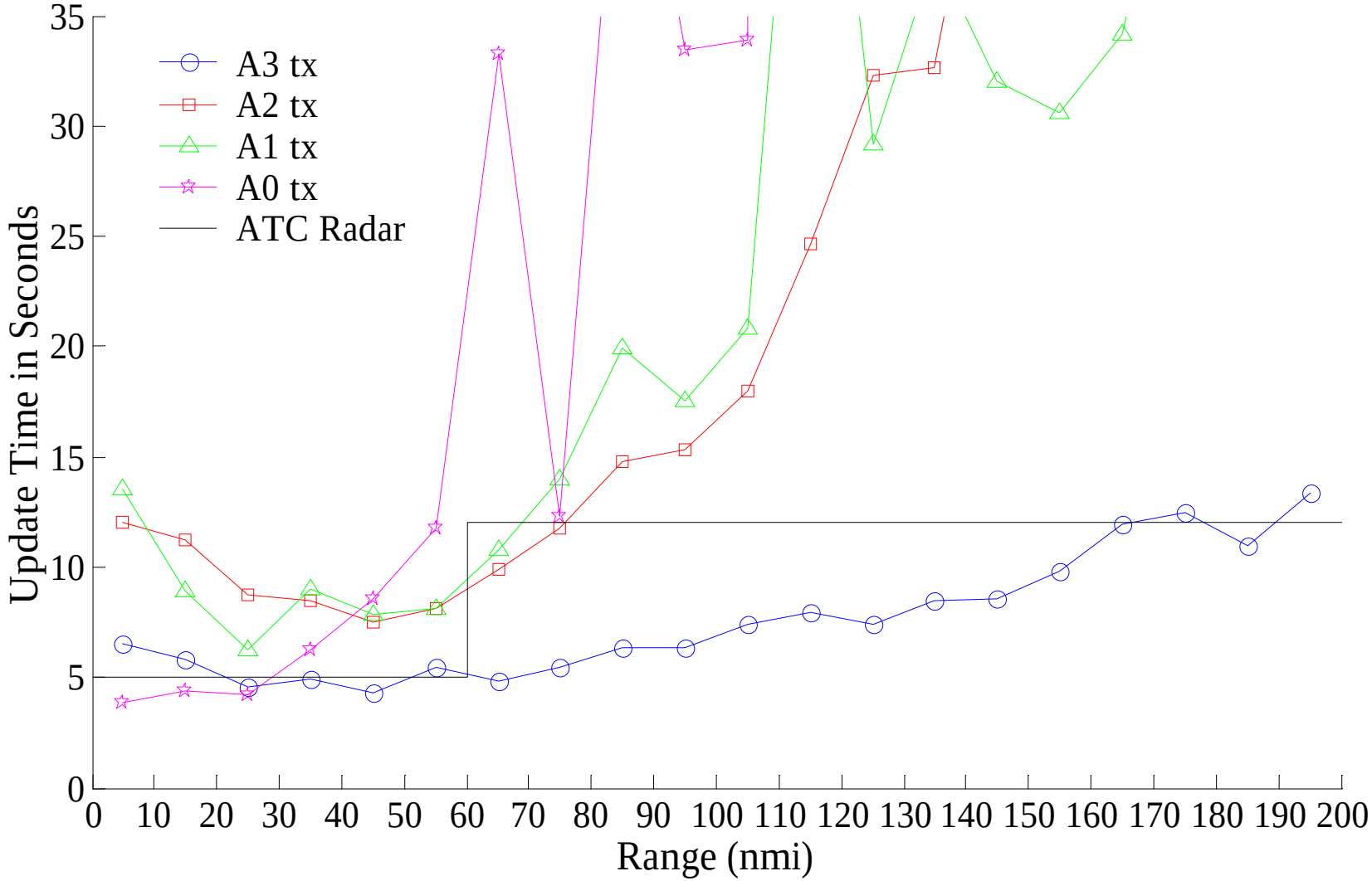
# Ground Receiver in Europe – No DME Present – with Probe data



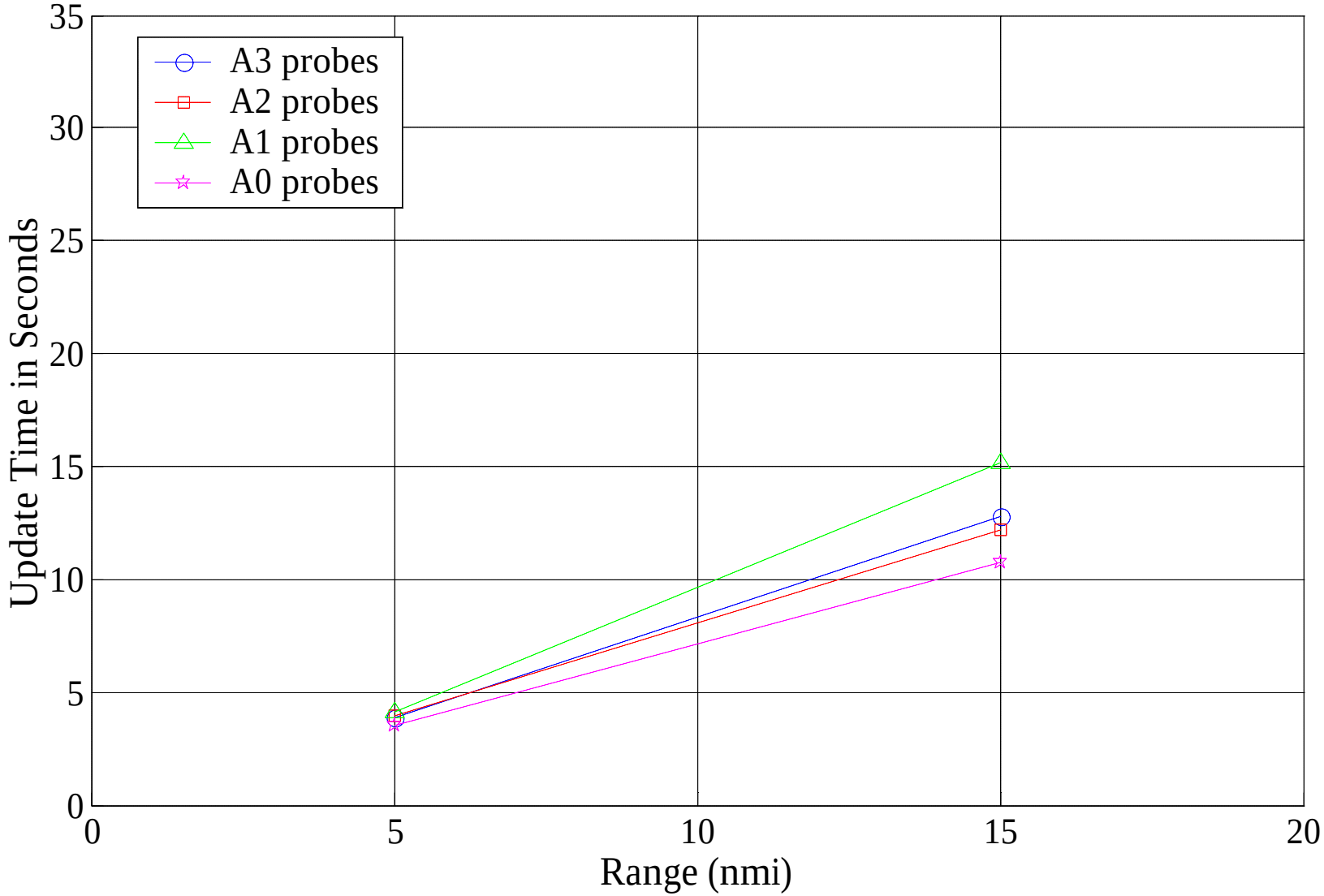
# Ground Receiver in Europe Co–Located with a 100 W TACAN Transmitter



# Ground Receiver in Europe Co-Located with 10 kW TACAN + Cavity Filter on UAT receiver



# Receptions from Ground Vehicles in Europe 2015



# Core Europe 2015 Results

- A1 sub-class appears to work in Core Europe
- State vector update rates MASPS compliant in Core Europe for all air-air cases
  - A3 past 120-130 nm?
- Air-ground state vector update rates appear to meet the MASPS requirements for A1-A3 classes for most ranges out to 150 nmi
  - Ranges between 40-60 nmi are on the borderline
  - A0 transmitters can be heard to 130 nmi

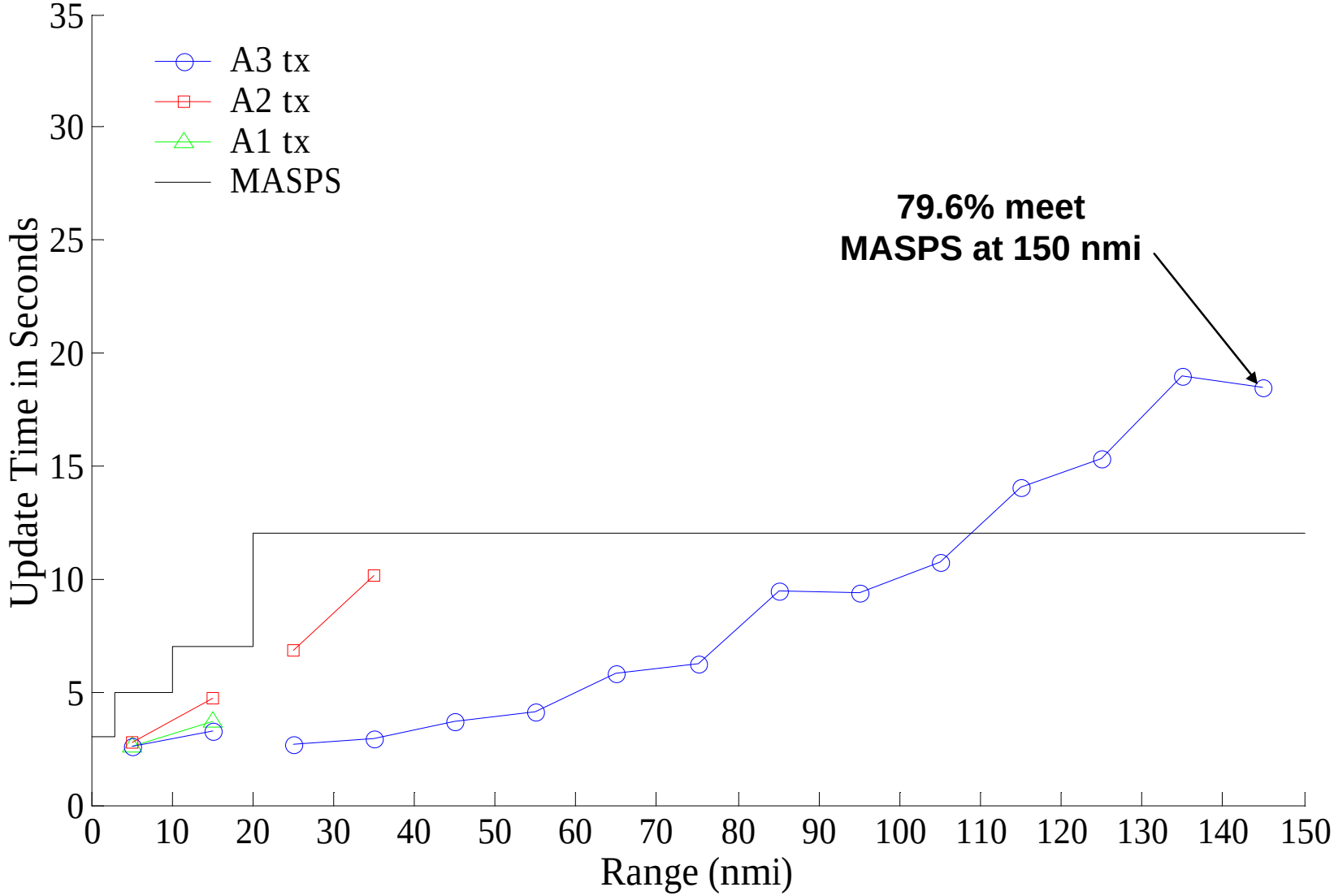
# Current Europe

# DME Interference Levels for Current Europe

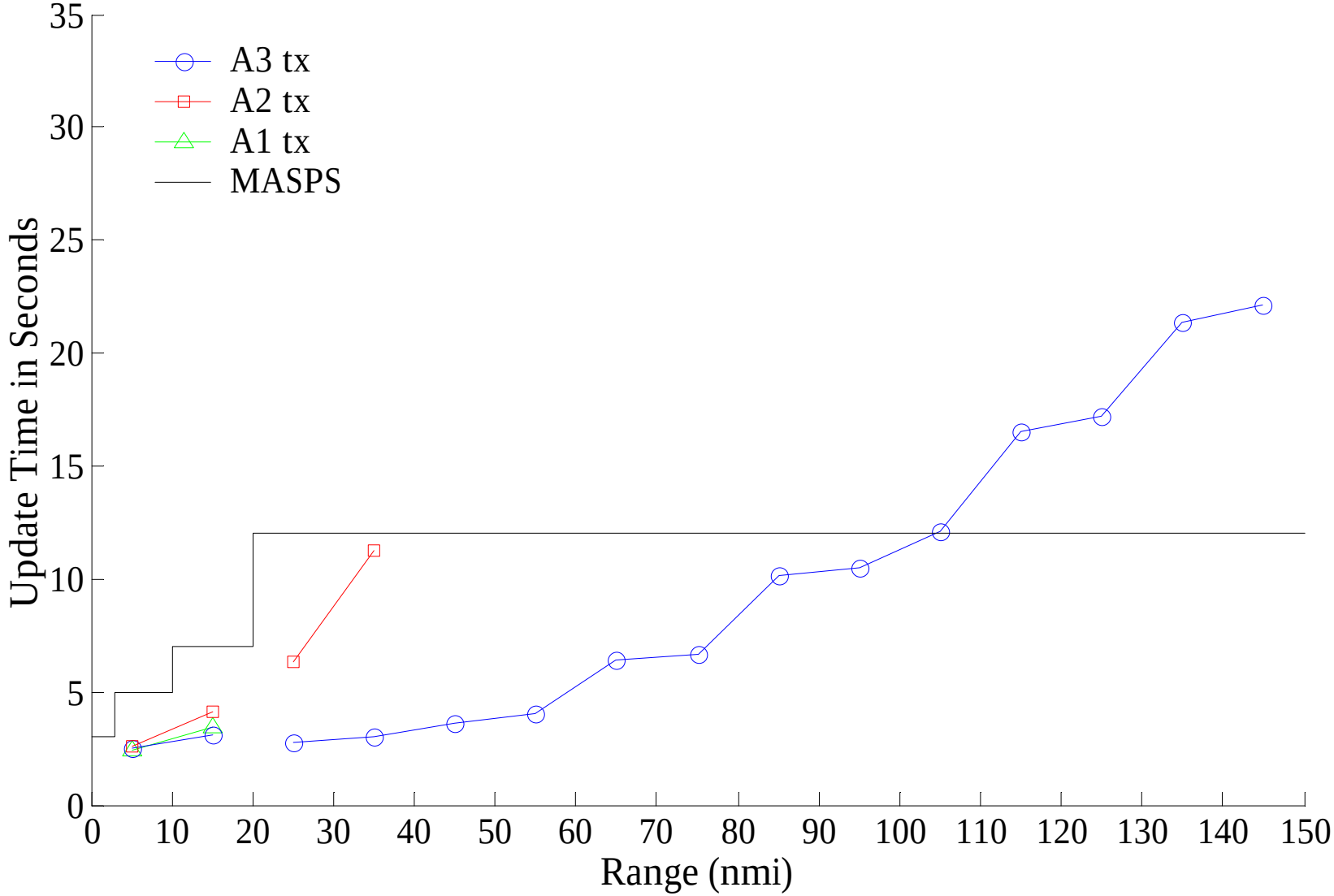
- Measured TACAN antenna pattern
- 8 dB rule implemented
- 1 dB power added to DME levels to account for MER/BER discrepancy

| Over Brussels | | | Worst Case DME position | | |
|---|---|---|---|---|---|
| High Alt. | Channel/Type | FL 150 | High | Channel/Type | FL 150 |
| -75 | On/TACAN | -74 | -73 | On/TACAN | -75 |
| -71 | On/TACAN | | -73 | On/TACAN | -75 |
| -65 | Adj./TACAN | -68 | -73 | On/TACAN | -76 |
| -78 | Adj./TACAN | | -56 | Adj./TACAN | -52 |
| | | | -74 | Adj./TACAN | -77 |

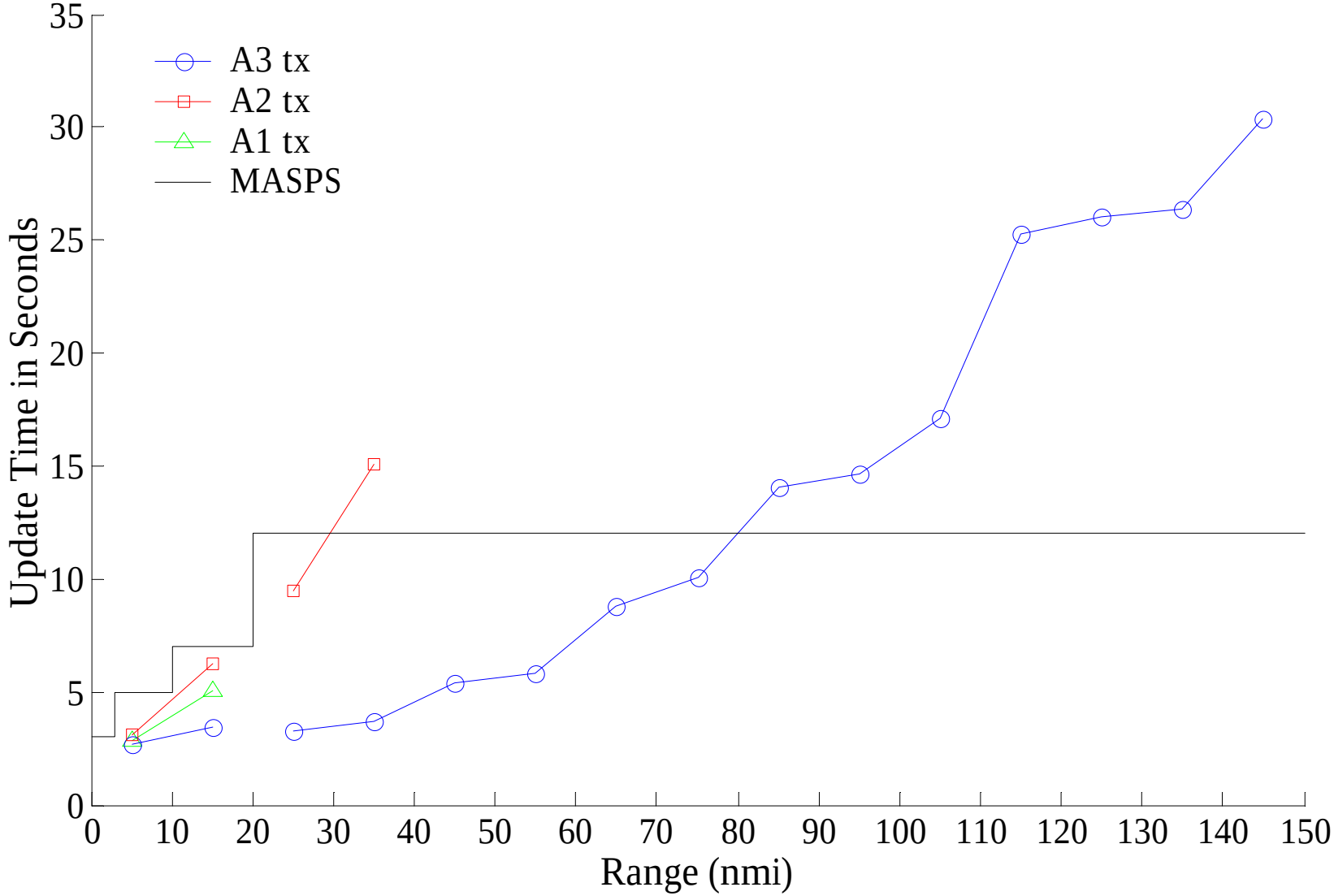
# A3 Receiver at High Altitude
# Current Europe



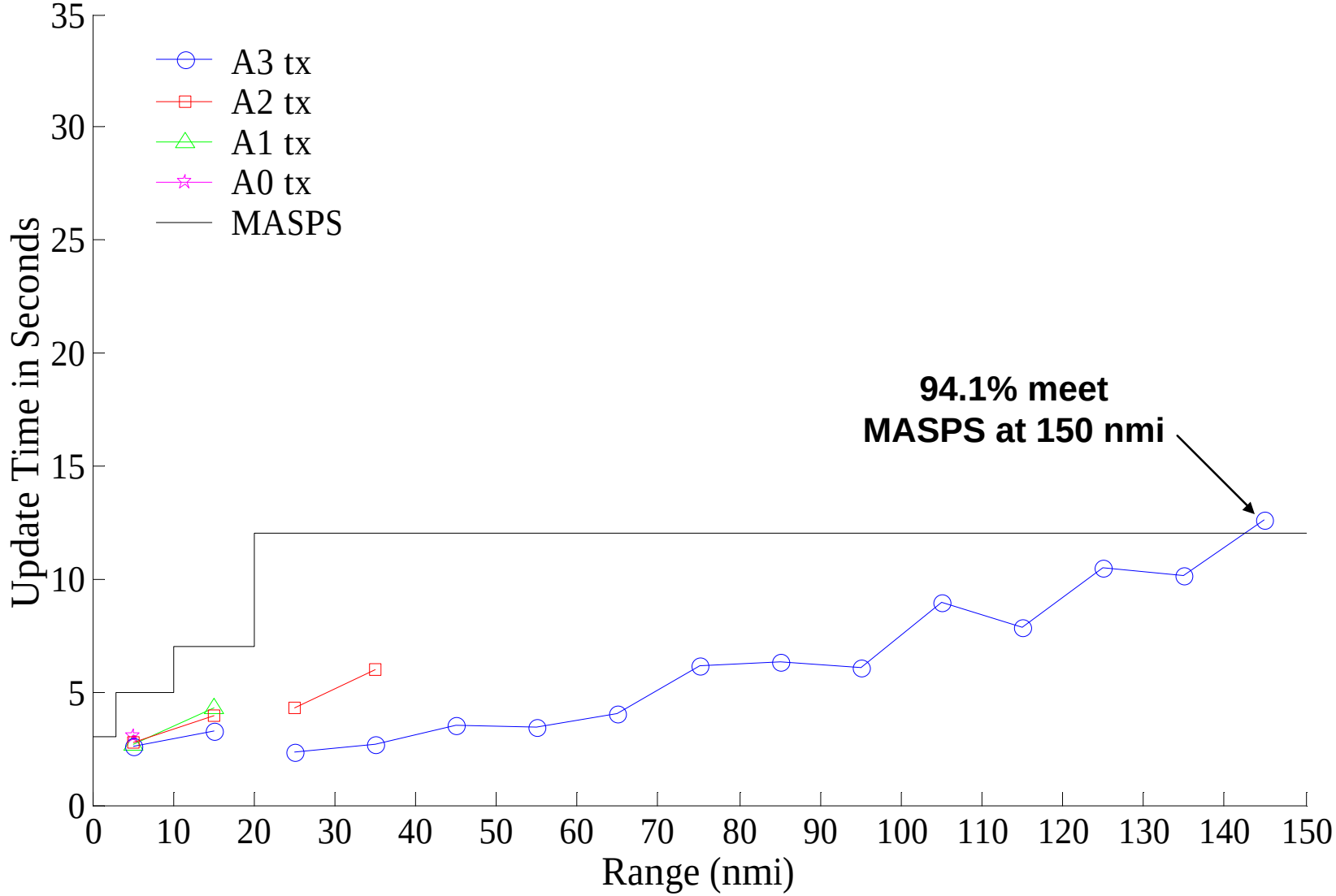
# A2 Receiver at High Altitude
# Current Europe



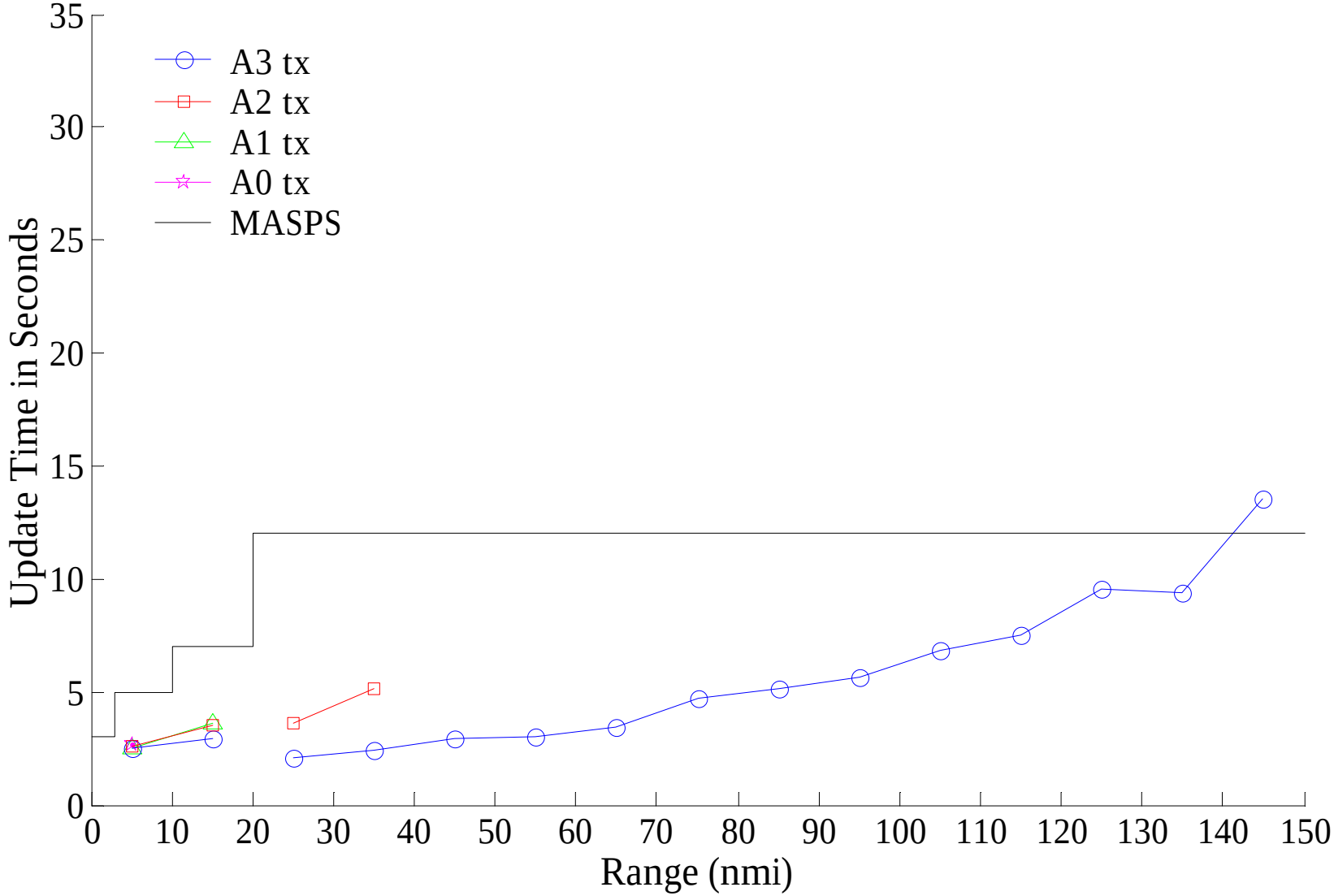
# A1 Receiver at High Altitude
# Current Europe



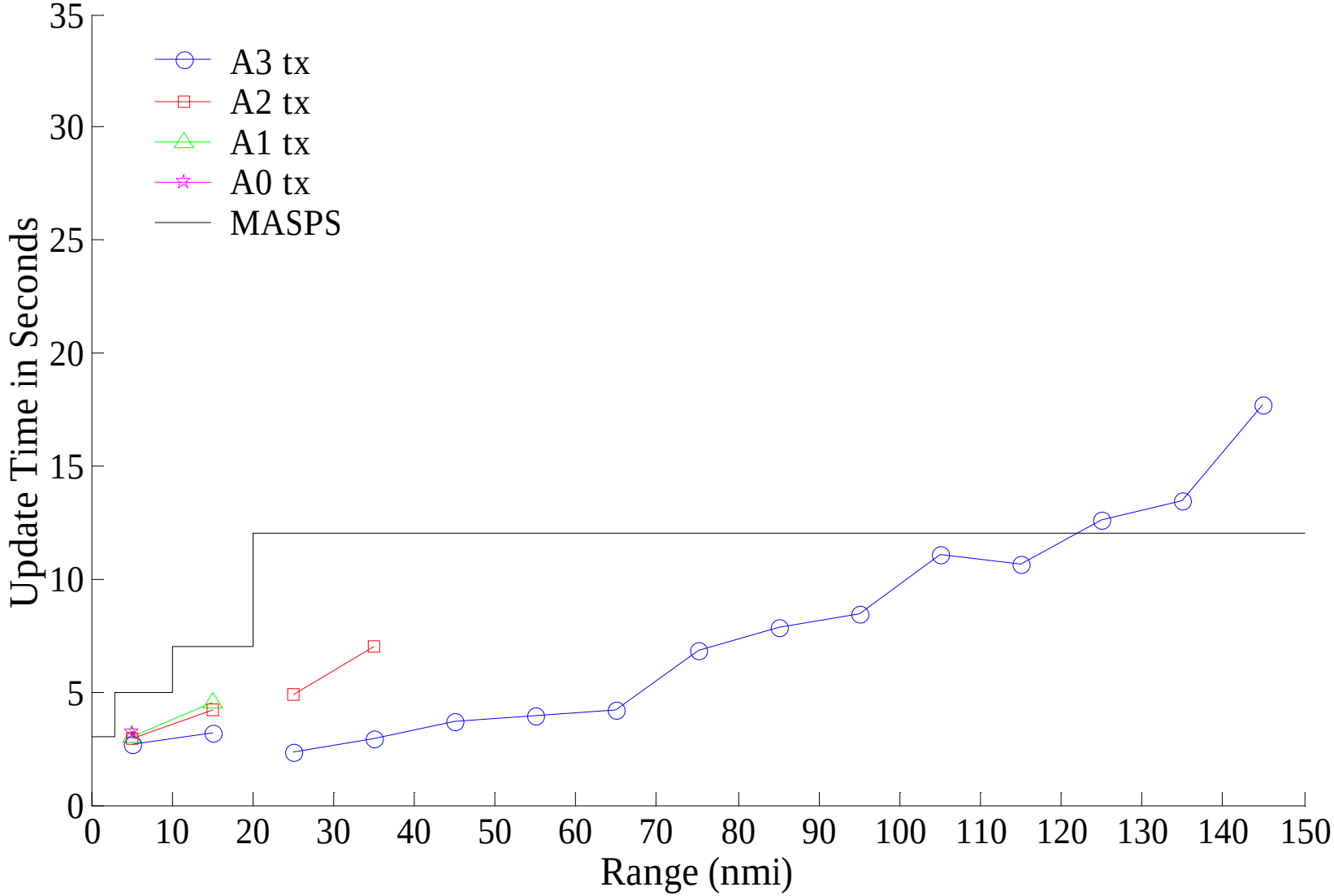
# A3 Receiver at FL150
# Current Europe



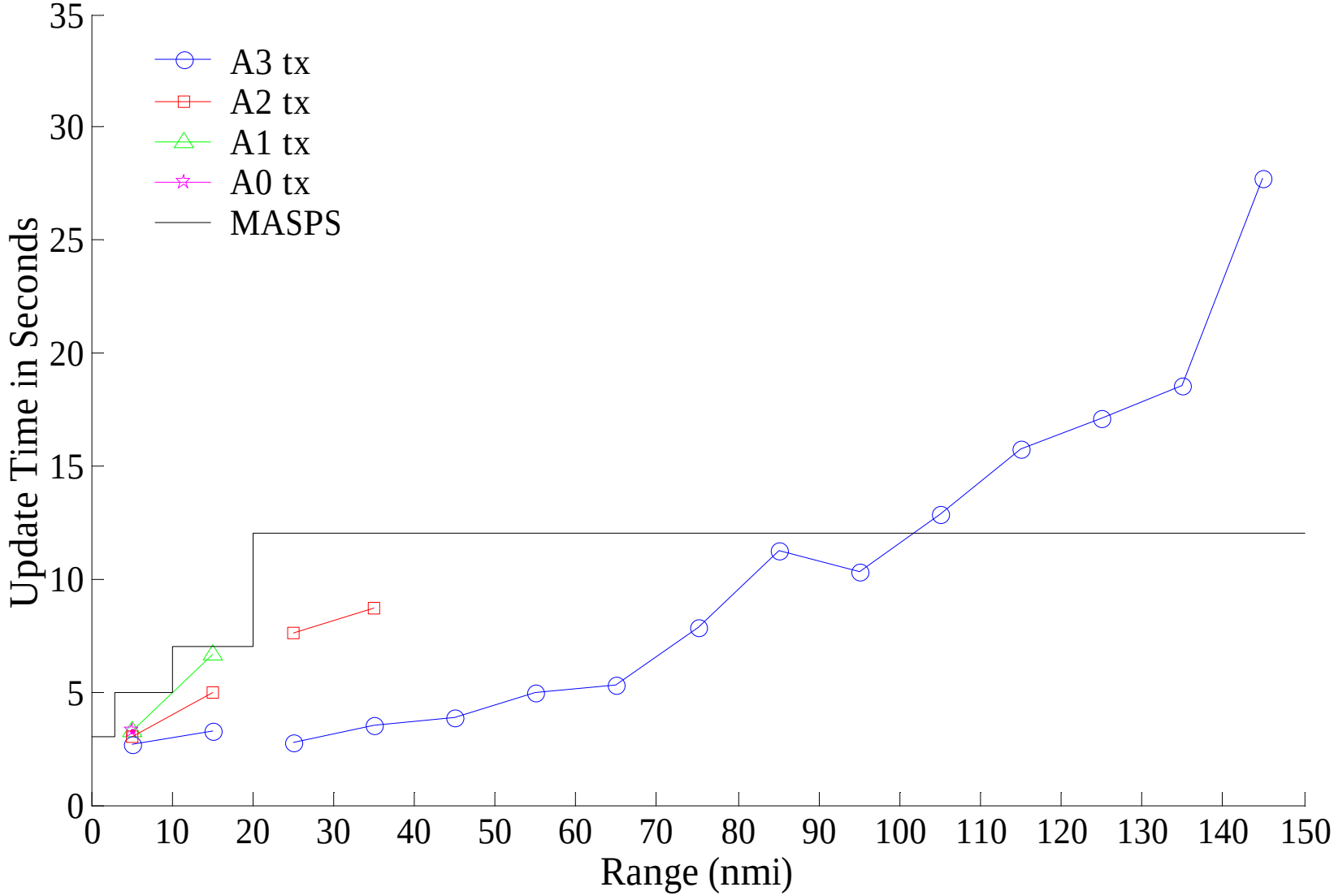
# A2 Receiver at FL150
# Current Europe



# A1 Receiver at FL150
# Current Europe



# A0 Receiver at FL150
# Current Europe



# Current Core Europe Results

- A1 sub-class is compliant with the MASPS for the current scenario in Core Europe over Brussels
- State vector update rates MASPS compliant in Core Europe for most air-air cases
  - A3 past 100-120 nm?
- Worst-Case DME position scenario needs to be simulated