RTCA SC-186 WG-3
Meeting #14

Preliminary Simulation Results for Various Scenarios

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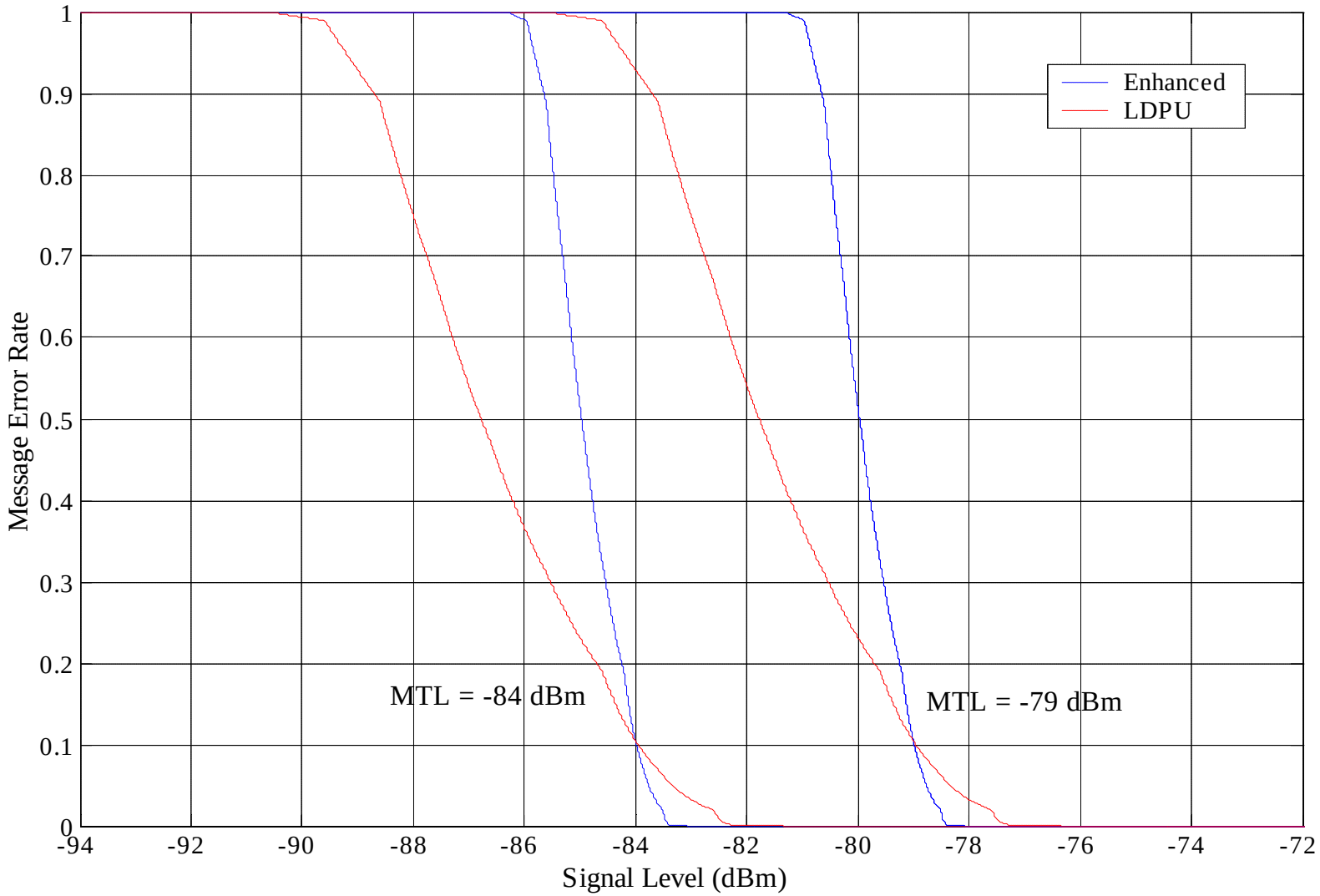
LA 2020 Assumption Modifications

- Ground vehicles added
  - LA 2020 scenario: 50 vehicles spread among airports
  - Transmit power: 47 dBm
  - 2.2 ES/sec
- Aircraft on ground only transmit from top antenna
- All A0 are assumed to be ATCRBS
  - FAA link decision is for GA to equip with UAT
- ATCRBS rates (>-84 dBm):
  - 24K/sec
  - 30K/sec
  - 51K/sec
- Receiver location changed to be directly over LAX at FL400

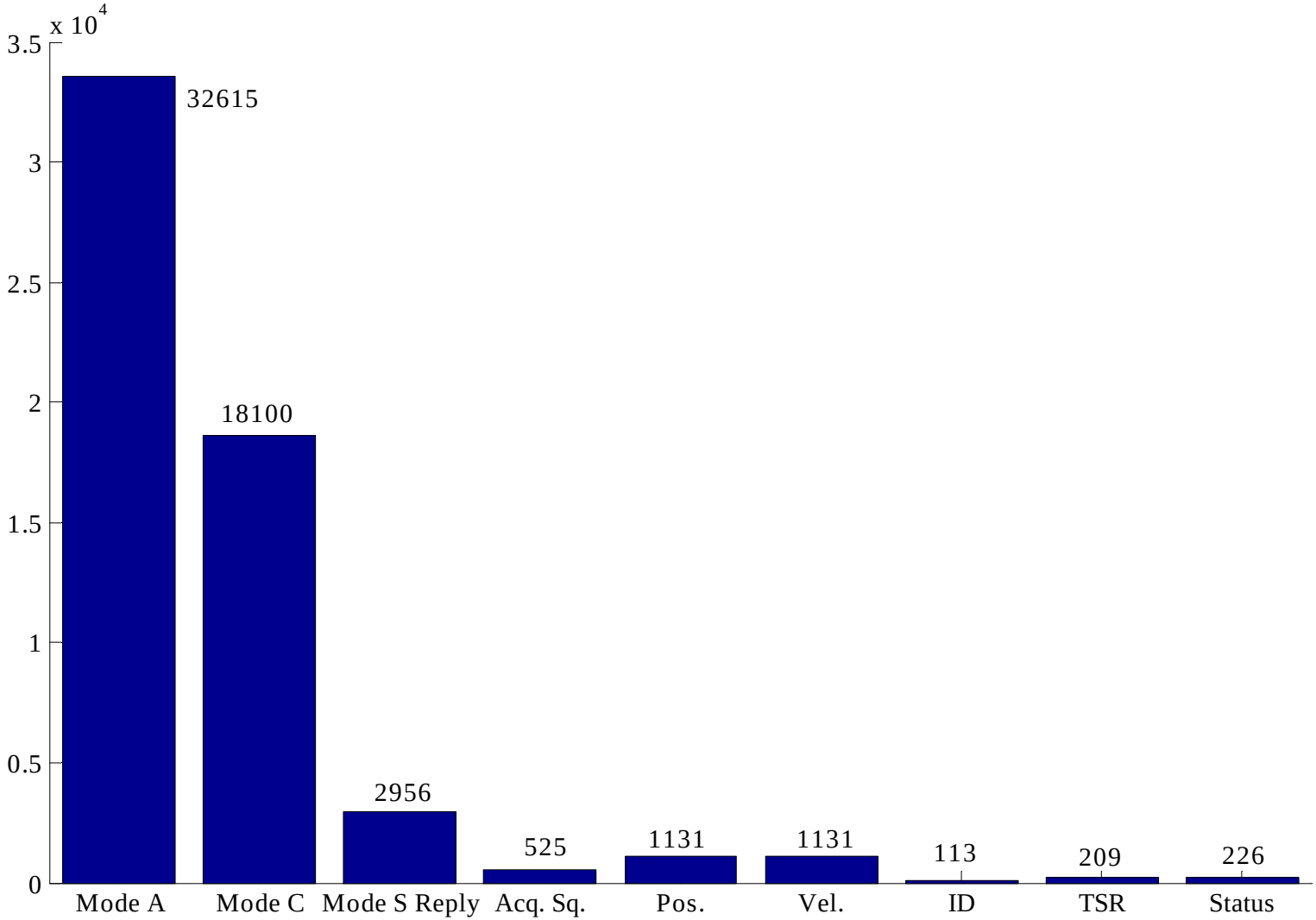
LA 2020 Assumption Modifications (cont.)

- Receiver performance model
  - “Mapped” to reproduce LL simulation results at –84 dBm sensitivity
  - Dead time removed
- A1 MTL is –79 dBm

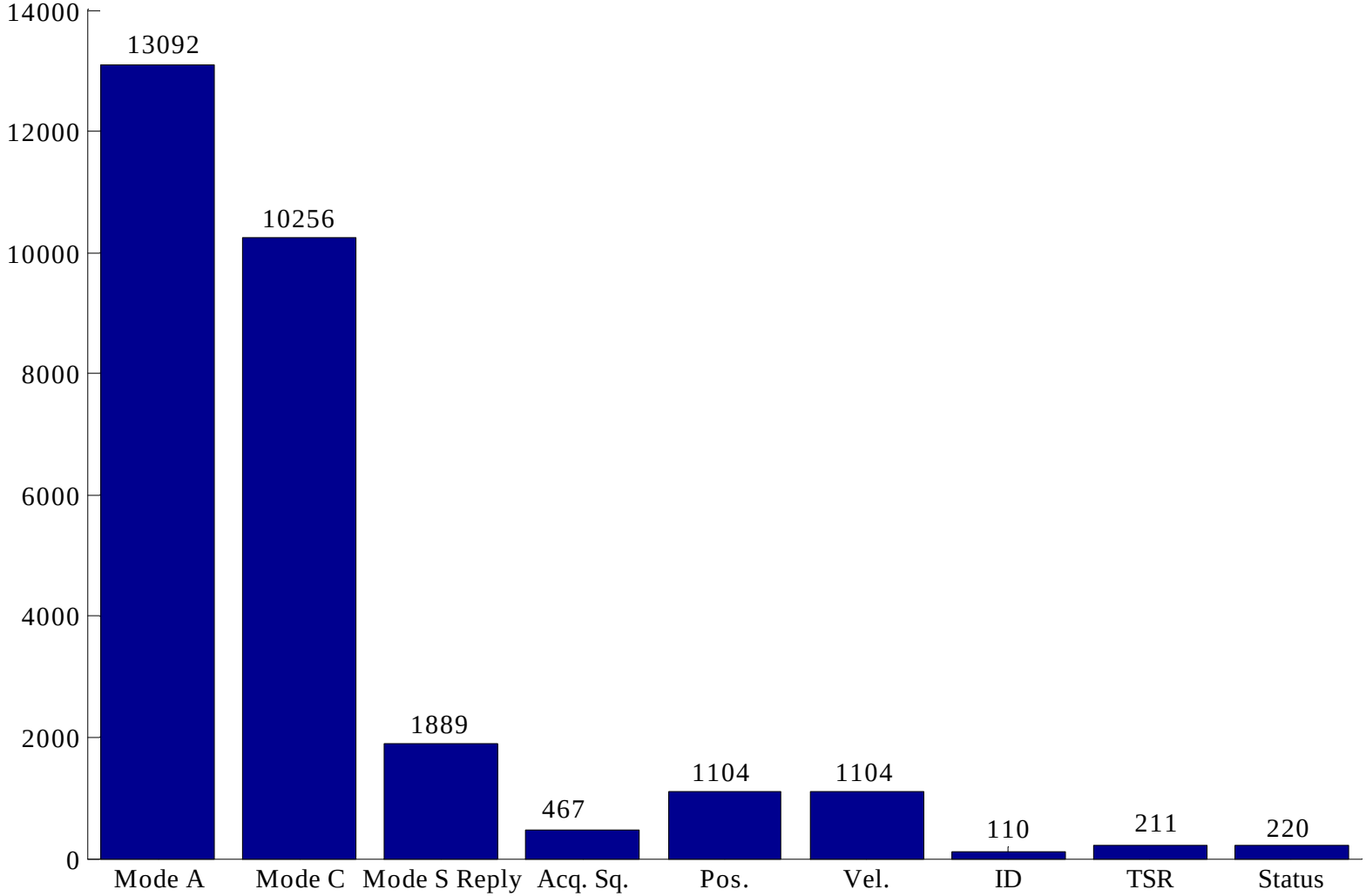
Comparison of Enhanced Decoder and LDPU for Two MTL Values



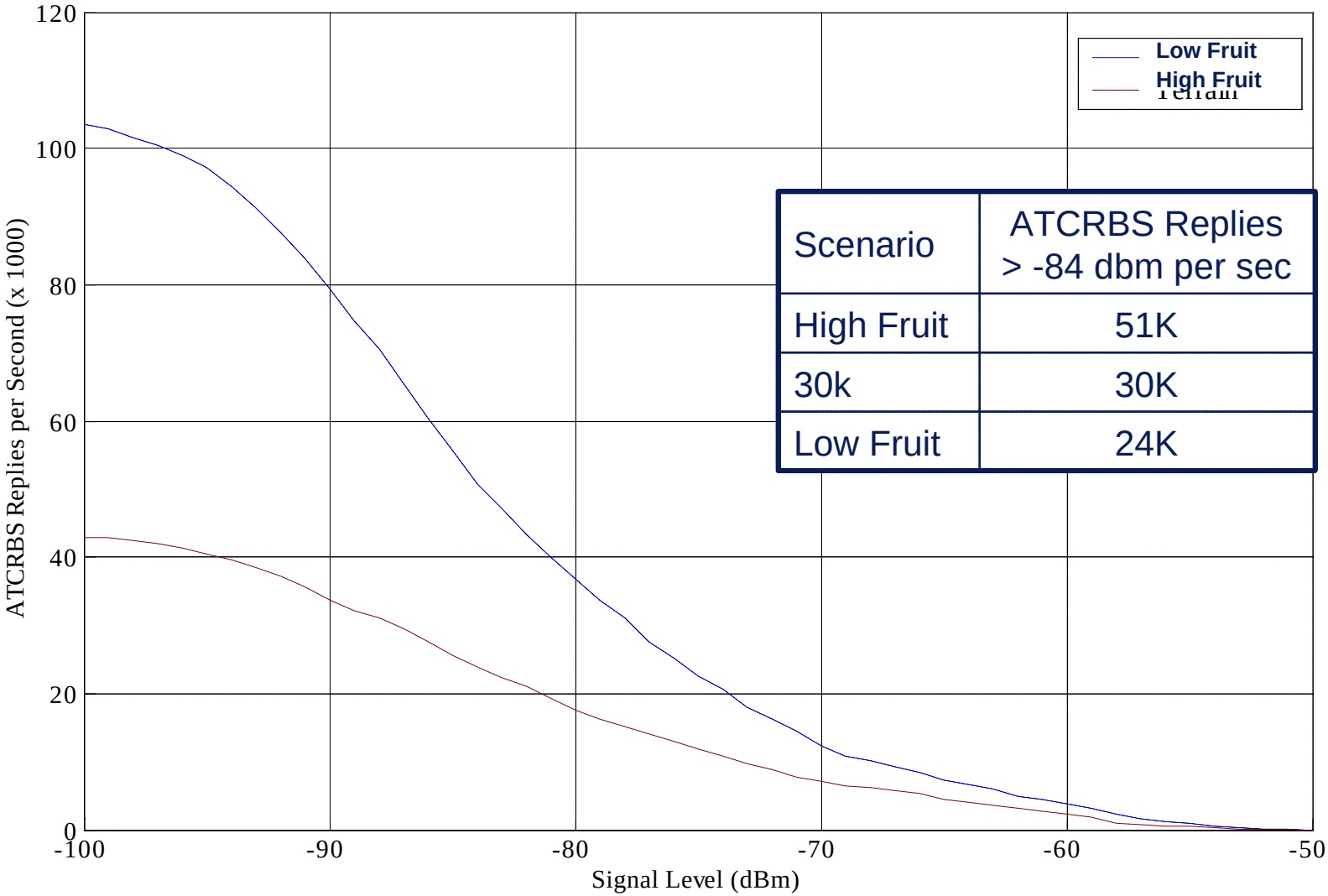
Message Arrival Rates (>-84 dBm) LAX 2020 (High Fruit)



Message Arrival Rates (>-84 dBm)
LAX 2020 (Low Fruit)

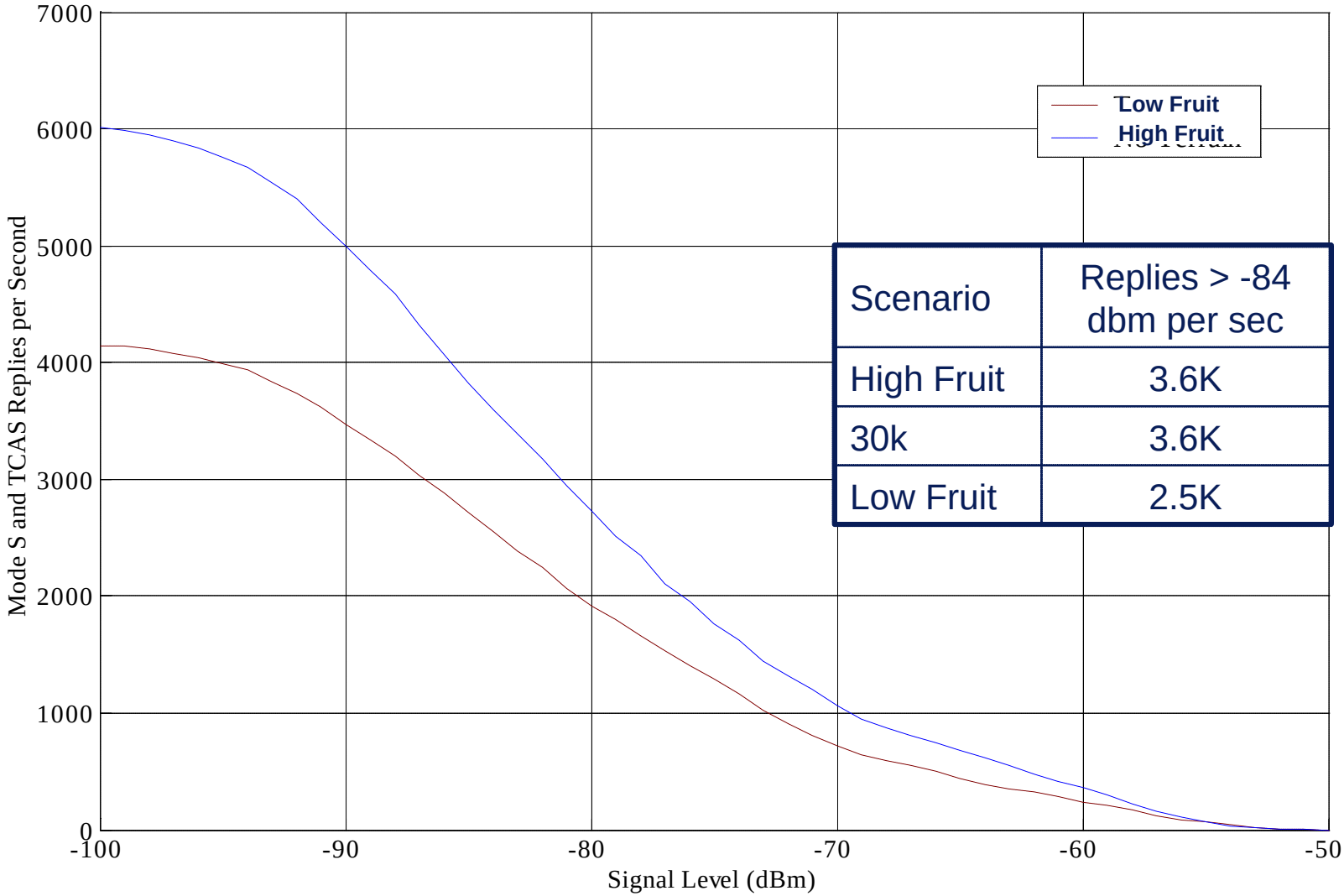


LAX2020 Scenarios
ATCRBS Reply Rates



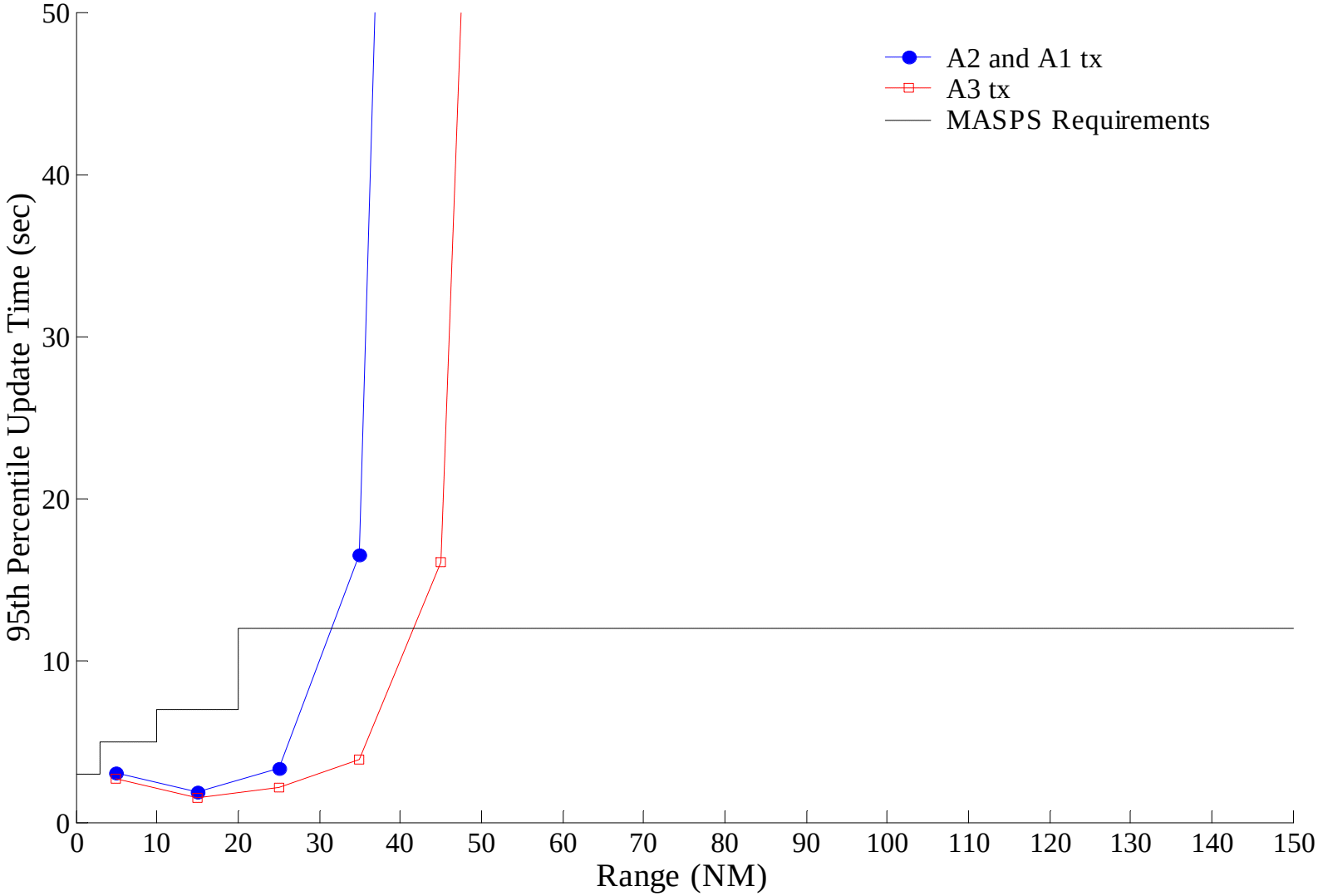
Scenario	ATCRBS Replies > -84 dbm per sec
High Fruit	51K
30k	30K
Low Fruit	24K

LAX2020 Scenarios - Mode S Reply & Acquisition Squitter Rates

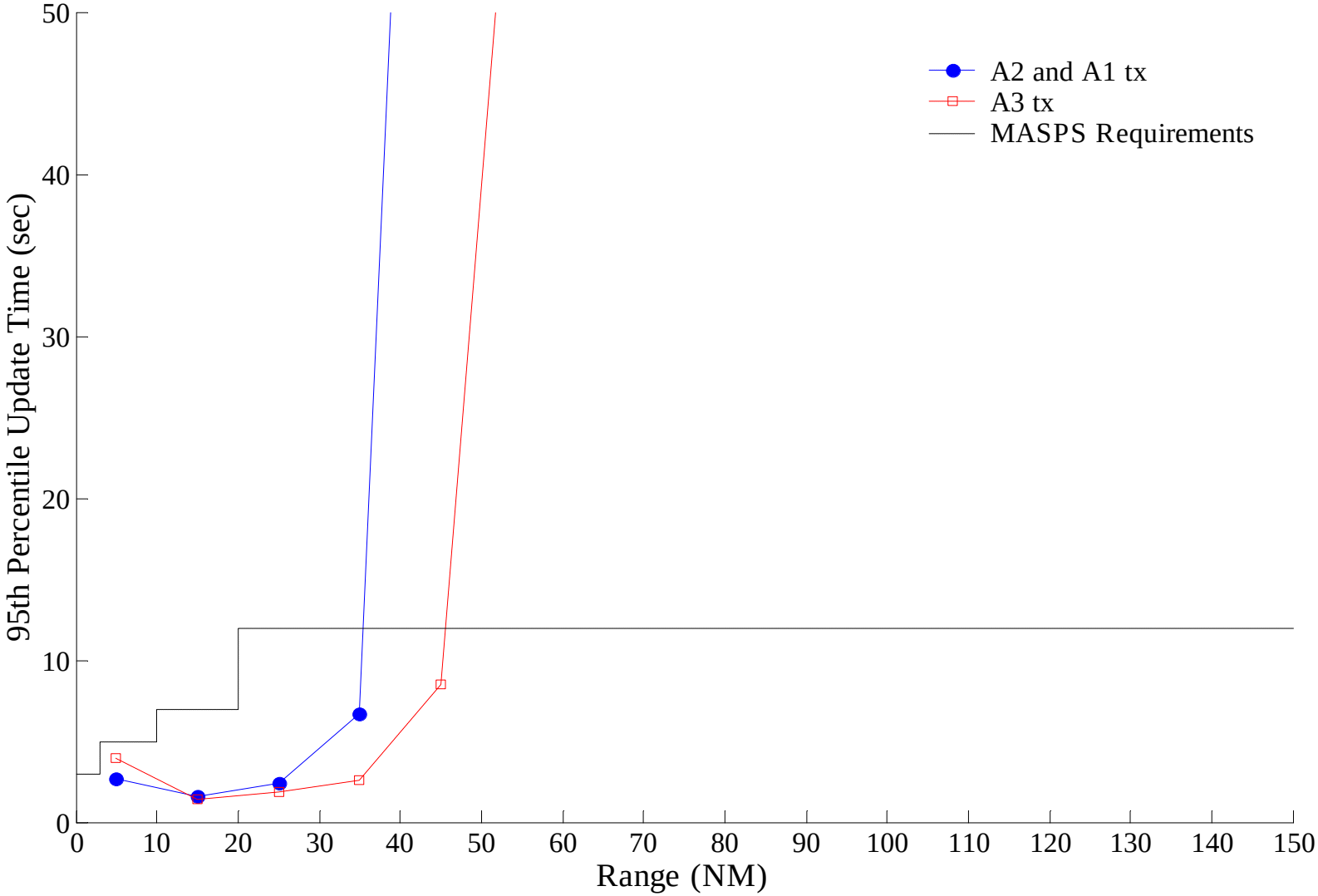


Scenario	Replies > -84 dbm per sec
High Fruit	3.6K
30k	3.6K
Low Fruit	2.5K

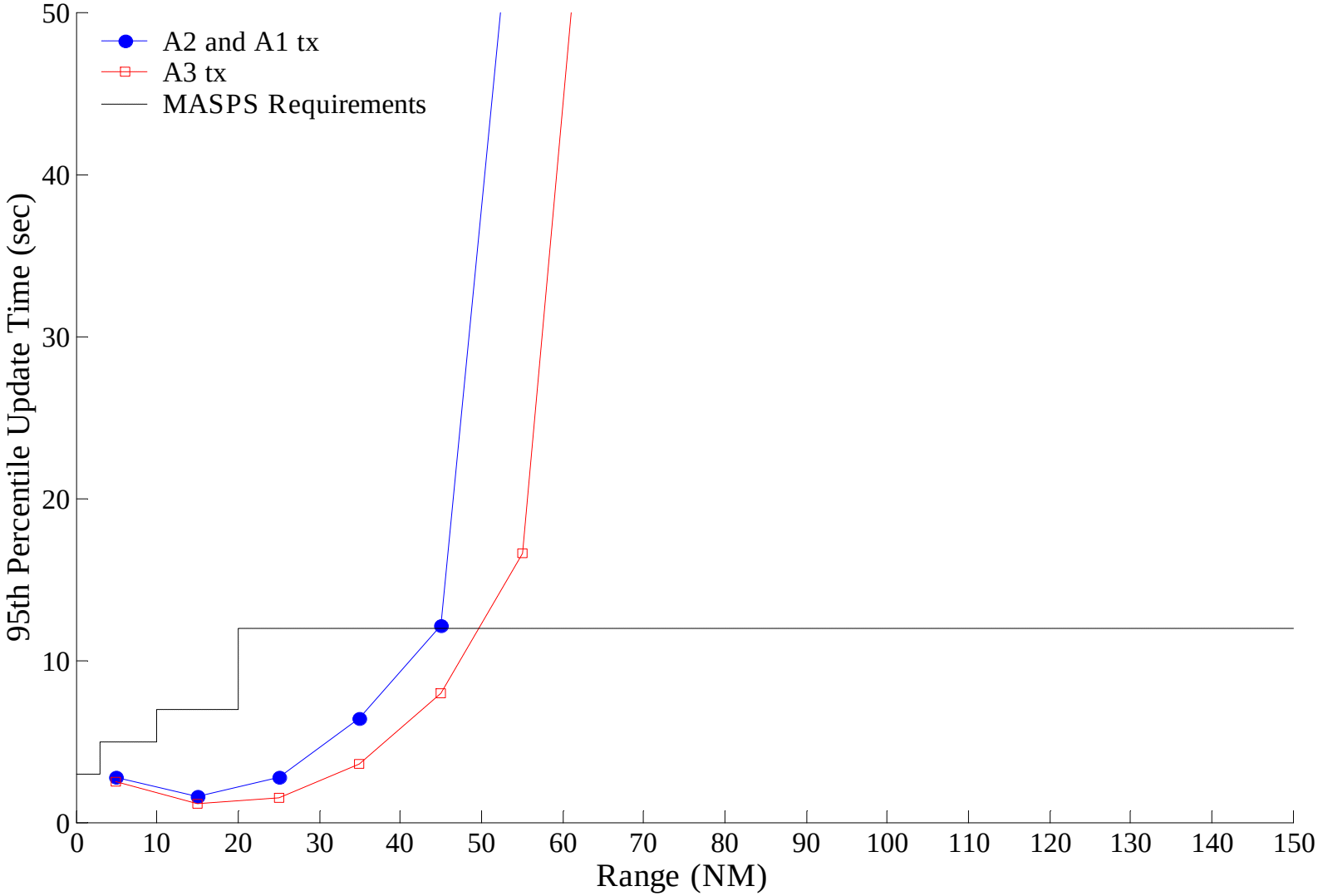
LAX 2020 (51K ATCRBS) State Vector 95th Percentile Update Times



LAX 2020 (30k ATCRBS) State Vector 95th Percentile Update Times



LAX 2020 (24K ATCRBS) State Vector 95th Percentile Update Times



Preliminary Results for LAX 2020

- Location over LAX, reduced Mode S equipage results in ~10% higher ATCRBS rates than previous simulations
- A3 receive state vector update rates dependent on interference levels
  - Transmitters
    - A3 range varies with decreasing fruit rate from 40-50 NM
    - A2/A1 range varies with decreasing fruit from 30-45 NM

Remaining Analysis for LAX 2020

- A2/A1 reception
- Ground reception
- Intent update rates

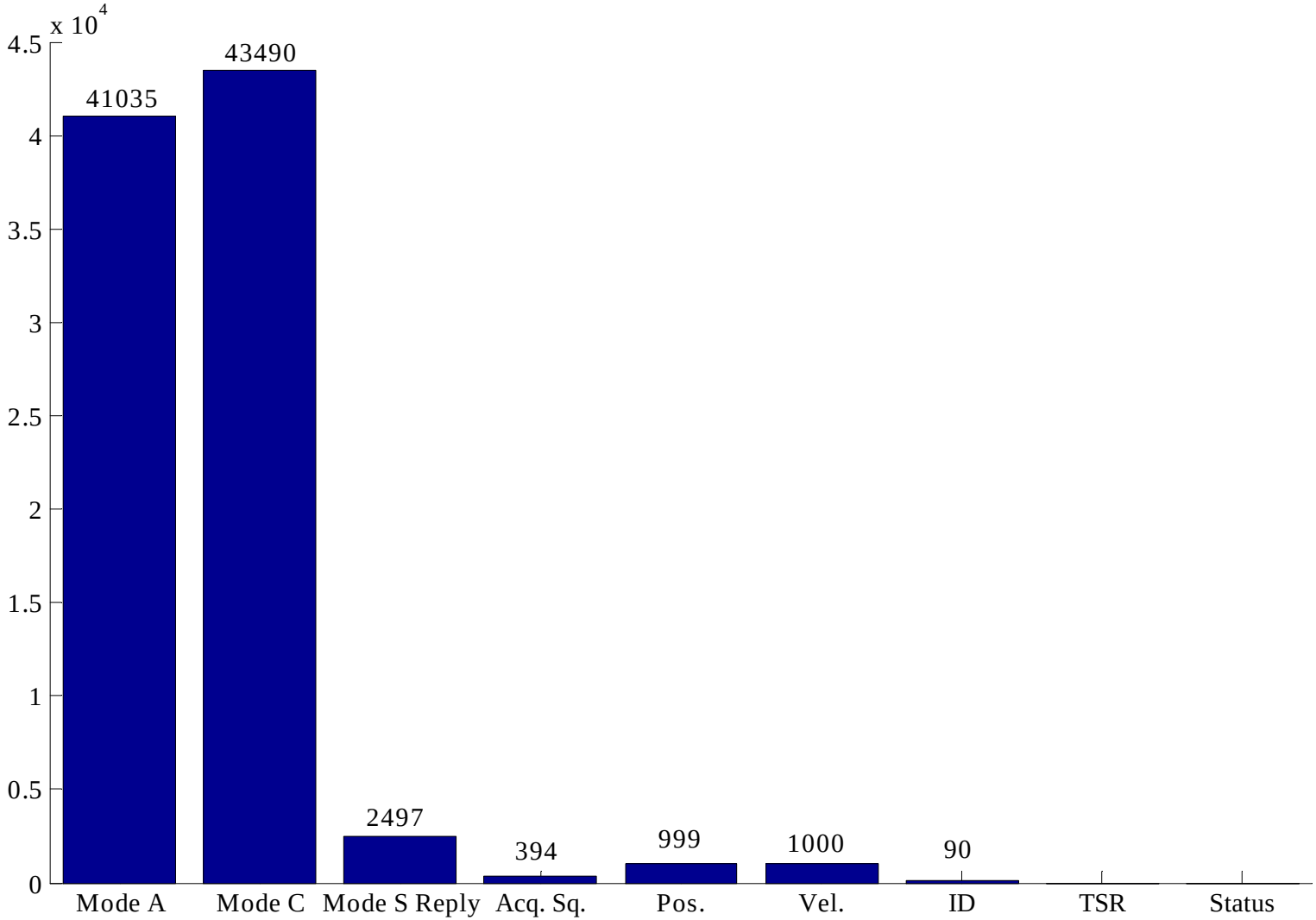
Assumptions for CE 2010

- New scenario defined April, 2002 by Eurocontrol (TLAT did CE 2015)
- 1744 airborne aircraft, 75 ground vehicles
  - All ADS-B equipped
  - 80% of aircraft Mode S
  - 75% of aircraft TCAS (Change 7)
  - All transmitting 4.2 ADS-B extended squitters/second (No intent)
- Radars in European scenario defined by Eurocontrol
  - Only kept those within 350 NM of center
  - Three cases:
    - All civilian and military radars
    - All civilian and 50% military radars
    - Civilian radars only
- Volpe model provided 1090/1030 environment
  - APL model adds DME co-site and ground transmissions

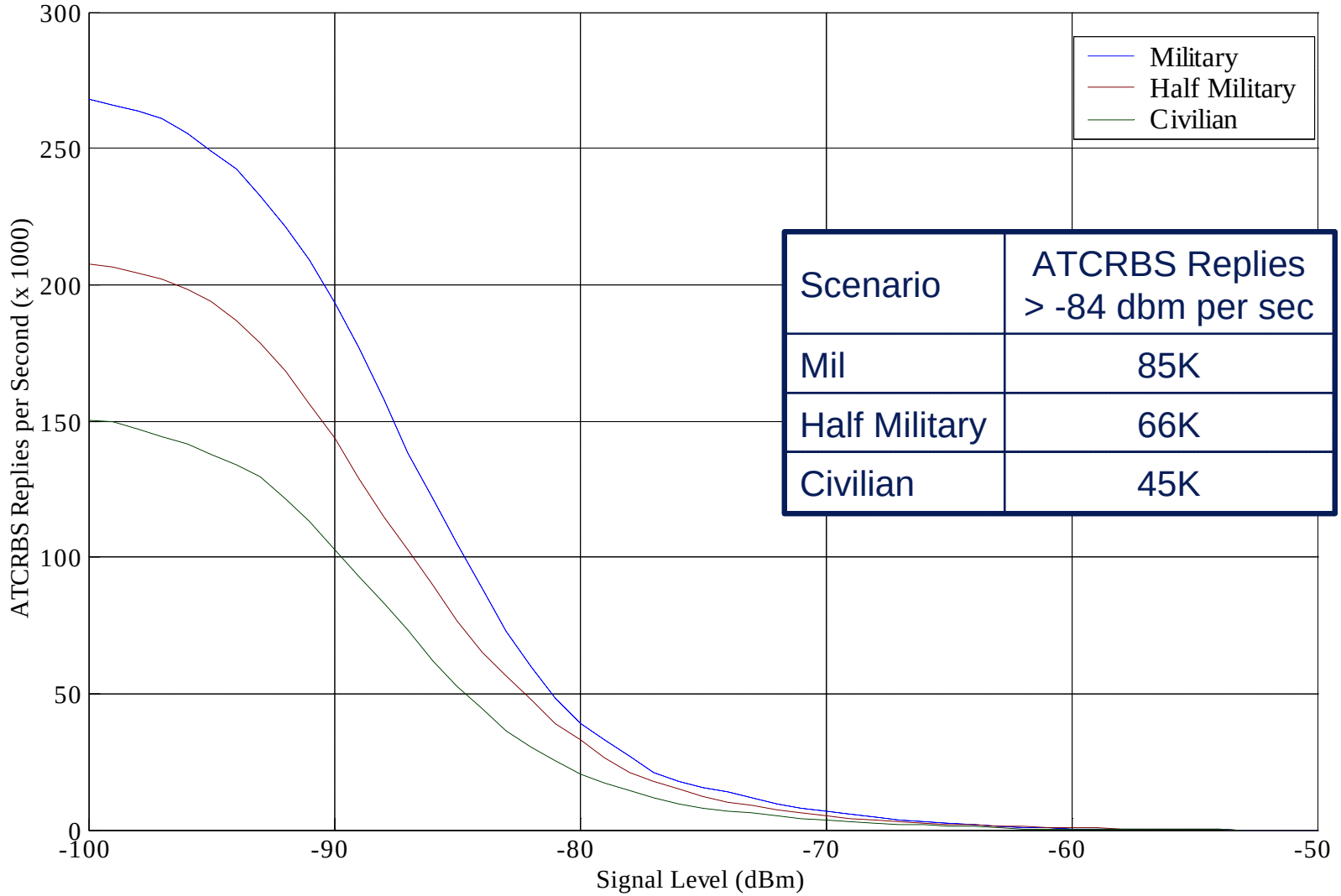
Assumptions for CE 2010 (cont.)

- Single position or velocity reception assumed to result in state vector update
- Alternating transmissions
- Receive characteristics
  - “Mapped” enhanced decoder receiver performance model
  - MTL at antenna: = -84 dBm
  - Receiver diversity (two receivers)
  - Receiver blanked during co-site transmissions (ADS-B, ATCRBS, TCAS, DME)
- No Mode S load (enhanced Mode S surveillance)

Messages Rates (>-84 dBm) in CE 2010 (All Civil and Military Radars Included)

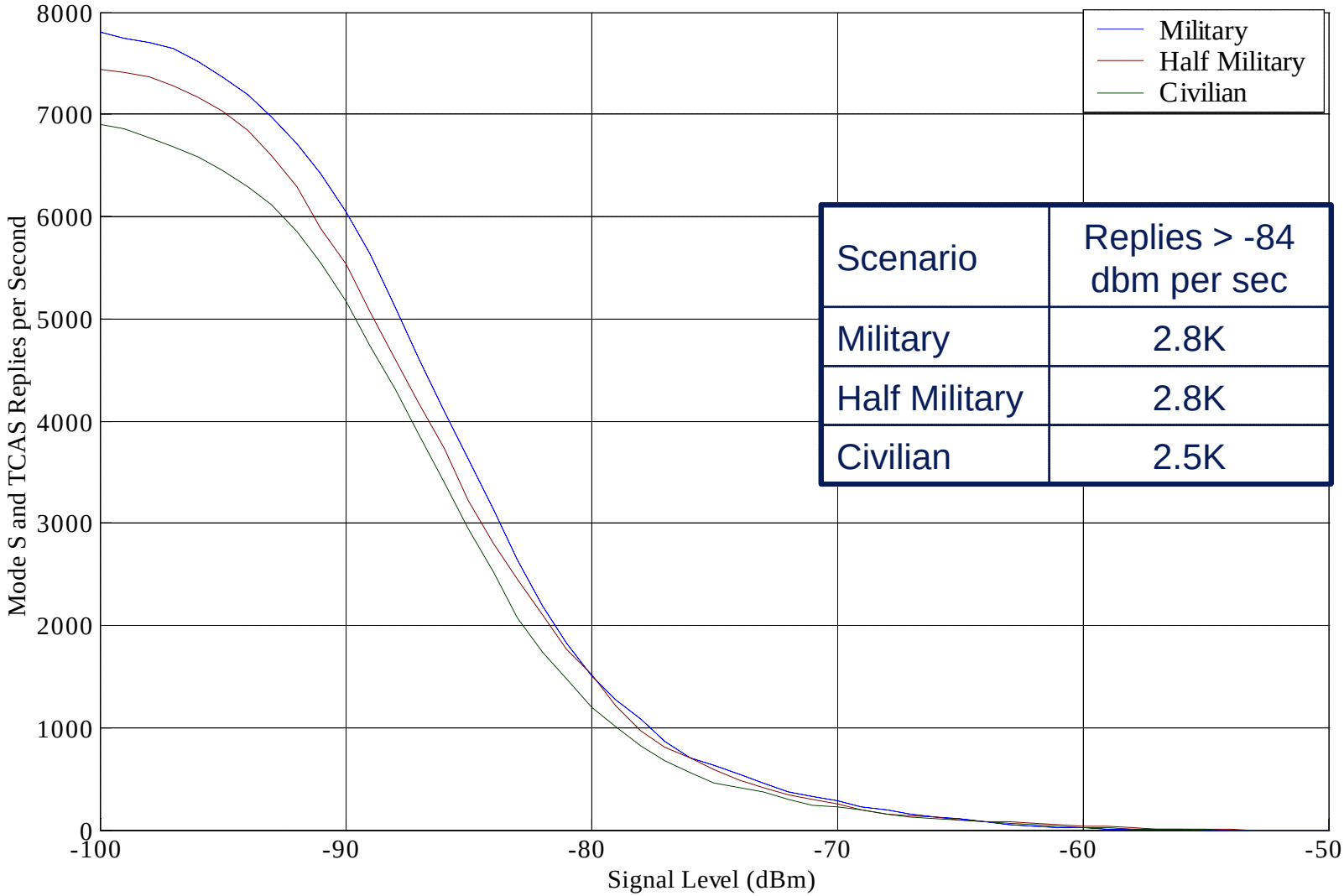


CE 2010 Scenarios ATCRBS Reply Rates



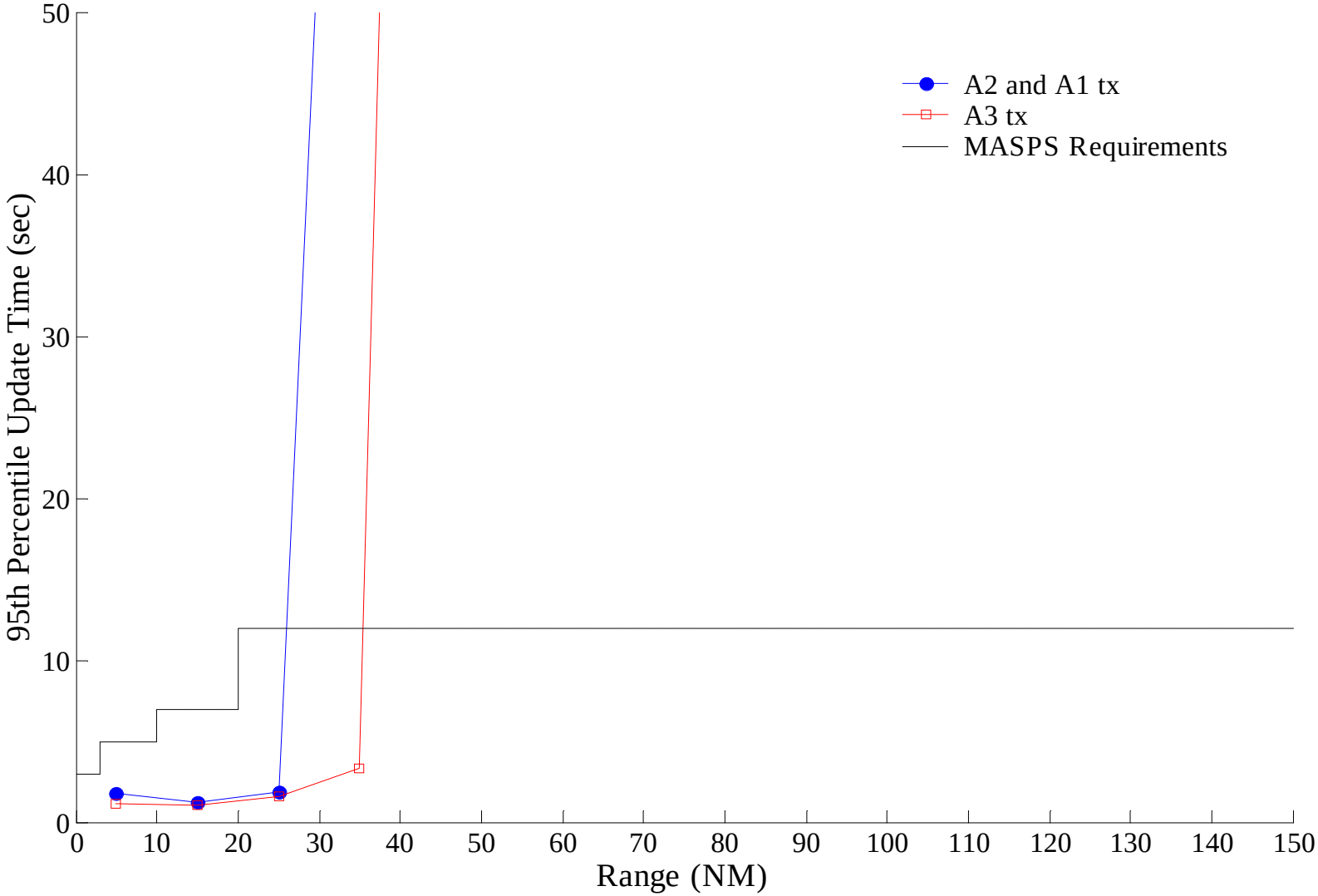
Scenario	ATCRBS Replies > -84 dbm per sec
Mil	85K
Half Military	66K
Civilian	45K

CE 2010 Scenarios
Short Squitter Rates

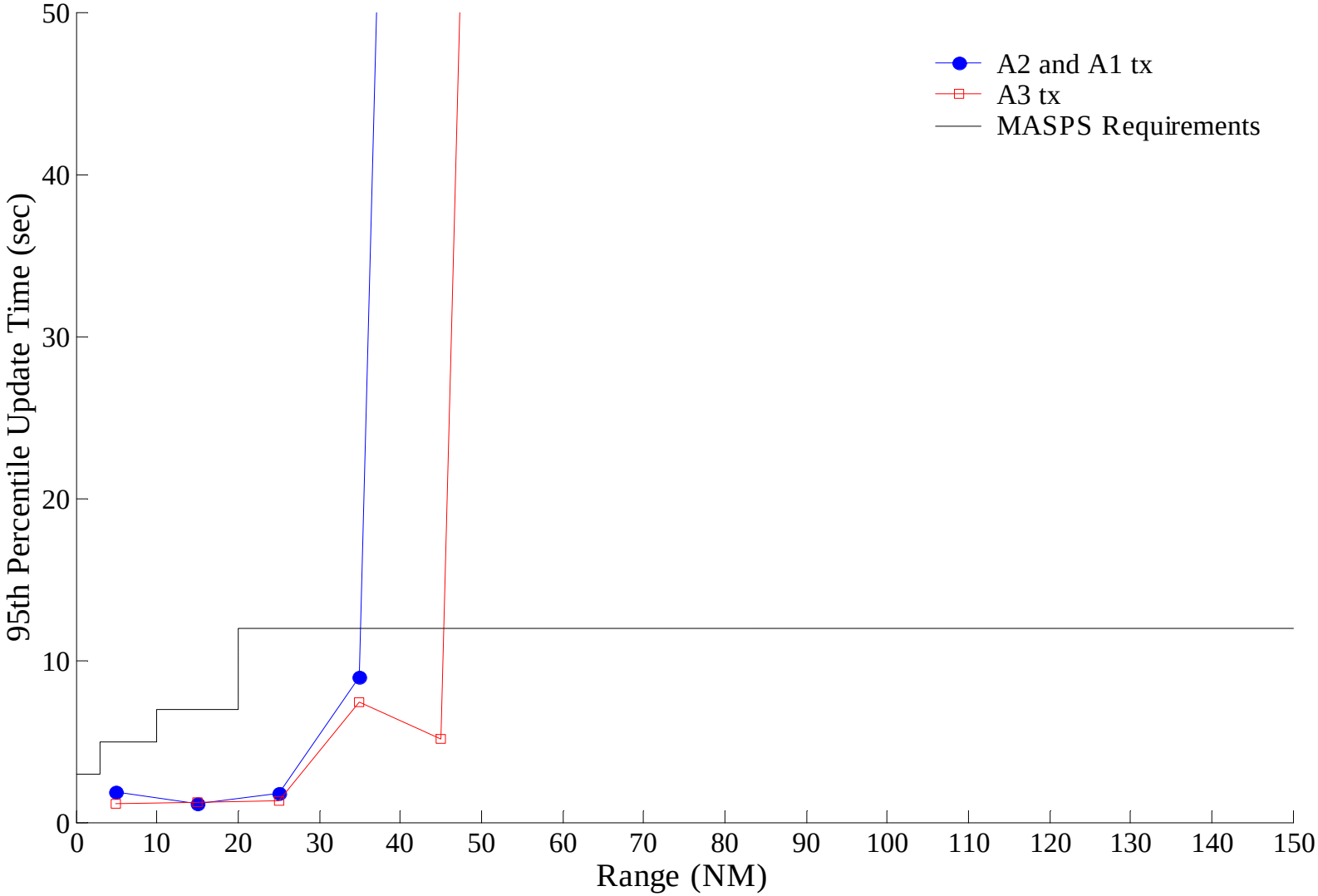


Scenario	Replies > -84 dbm per sec
Military	2.8K
Half Military	2.8K
Civilian	2.5K

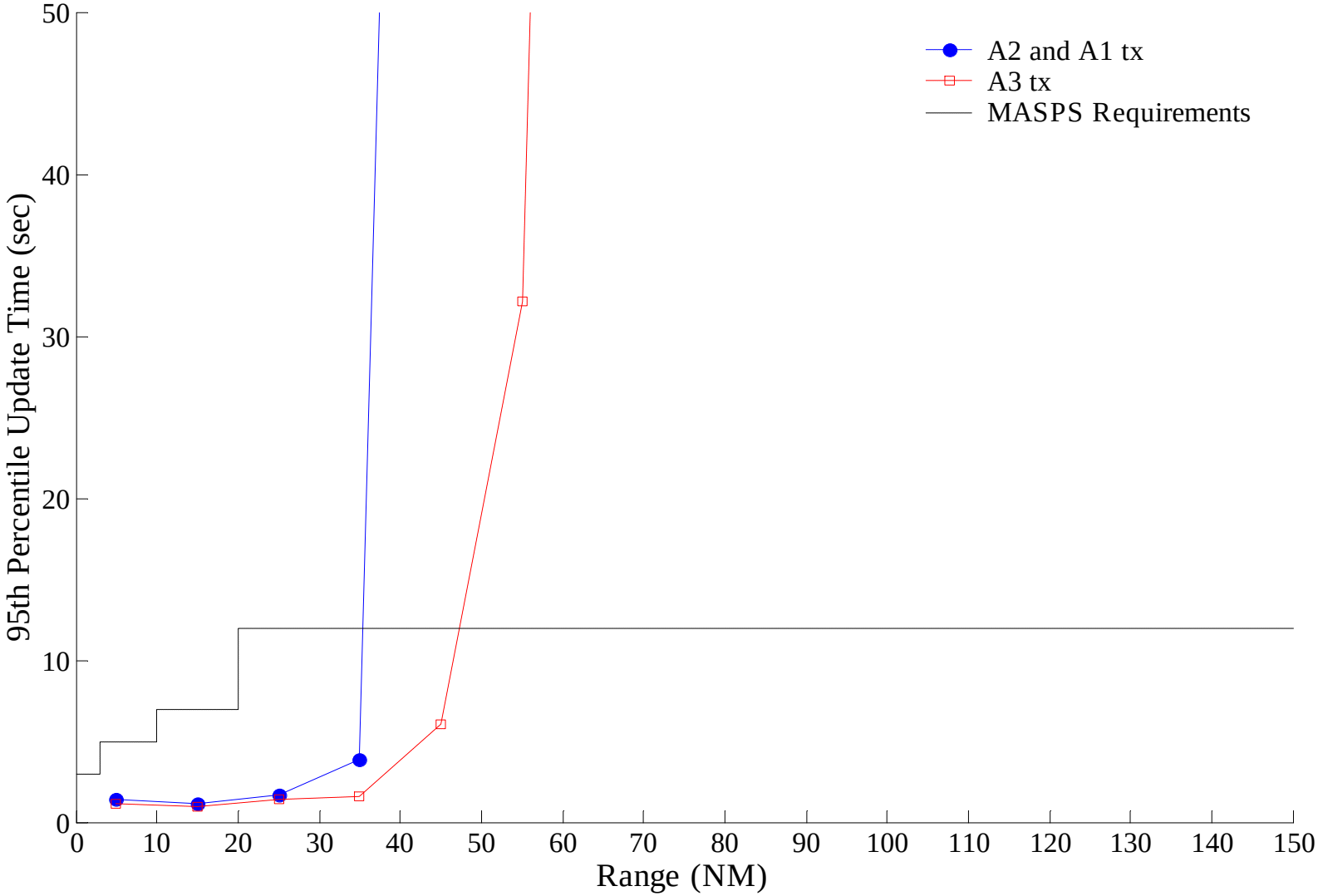
CE 2010 (85K ATCRBS) State Vector 95th Percentile Update Times



CE 2010 (66K ATCRBS) State Vector 95th Percentile Update Times



CE 2010 (45K ATCRBS) State Vector 95th Percentile Update Times



Preliminary Results for CE 2010

- Dense ATCRBS environment
- A3 receive state vector update rates dependent on interference levels
  - Transmitters
    - A3 range varies from 35-50 NM
    - A2/A1 range varies from 25-40 NM

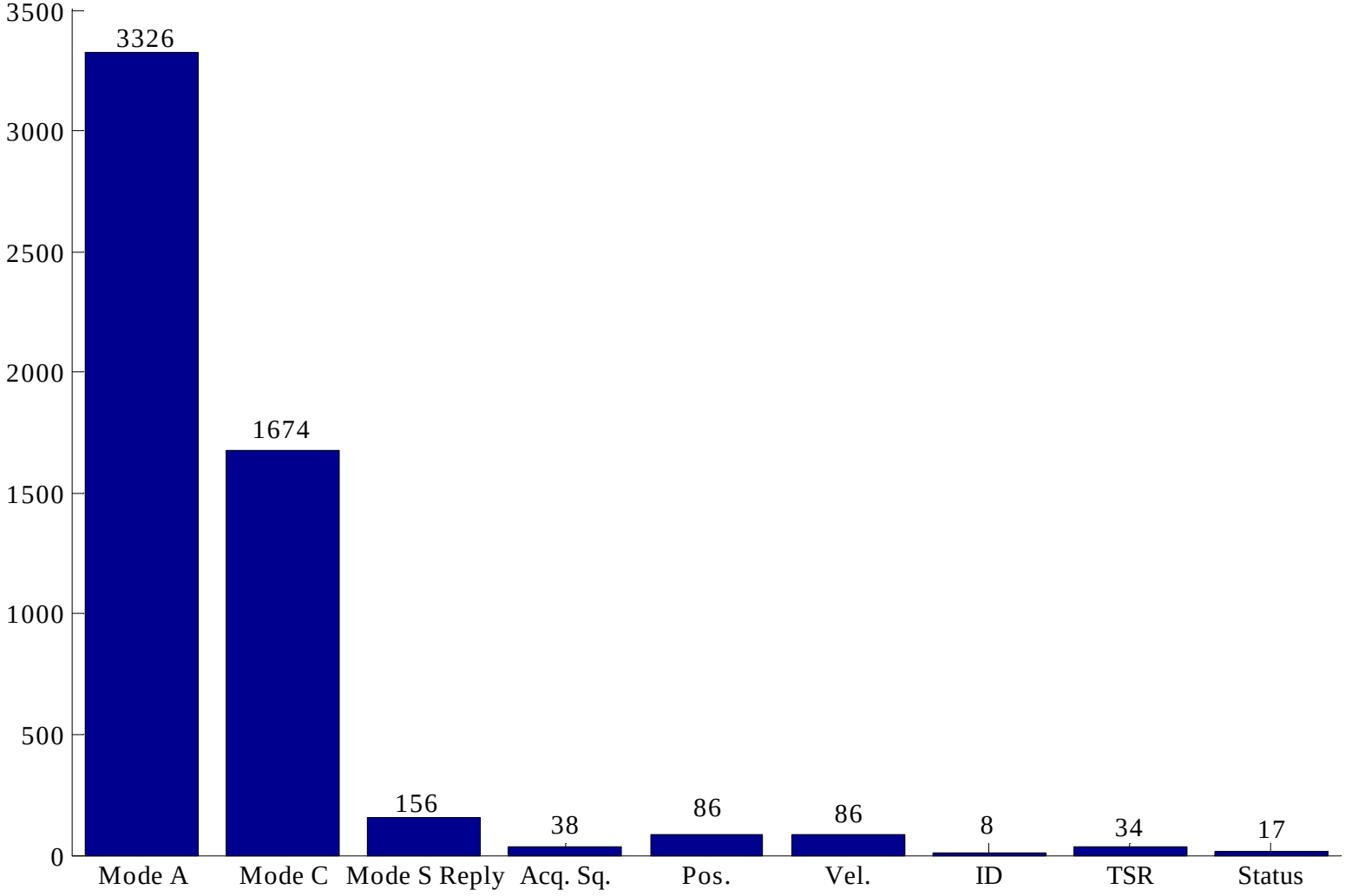
Remaining Analysis for CE 2010

- A2/A1 reception
- Ground reception
- Intent update rates

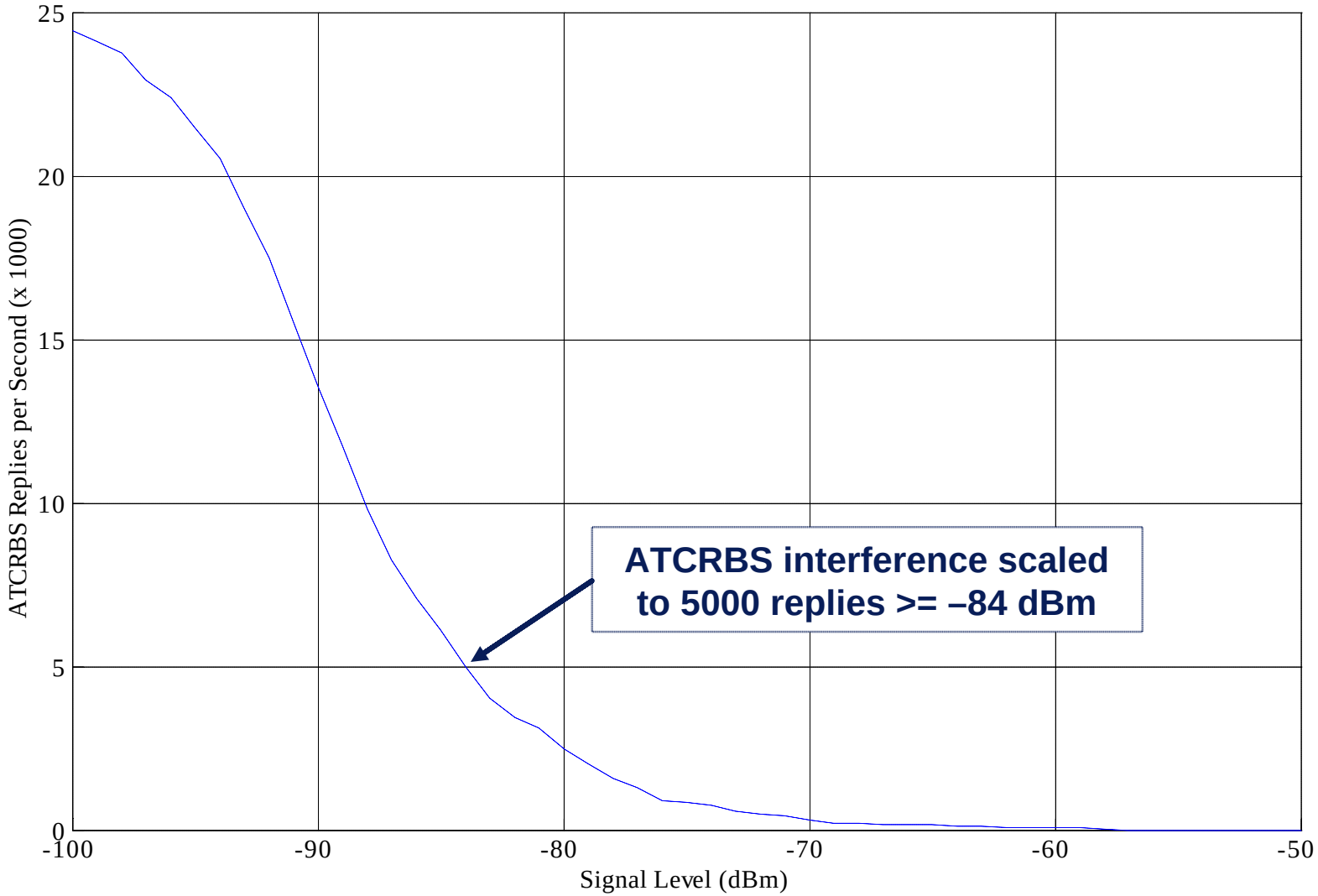
Assumptions for Low Density Scenario

- 360 A3 aircraft uniformly distributed in circle of 400 NM radius between FL 250-370
- ATCRBS >= -84 dBm: 5000/sec

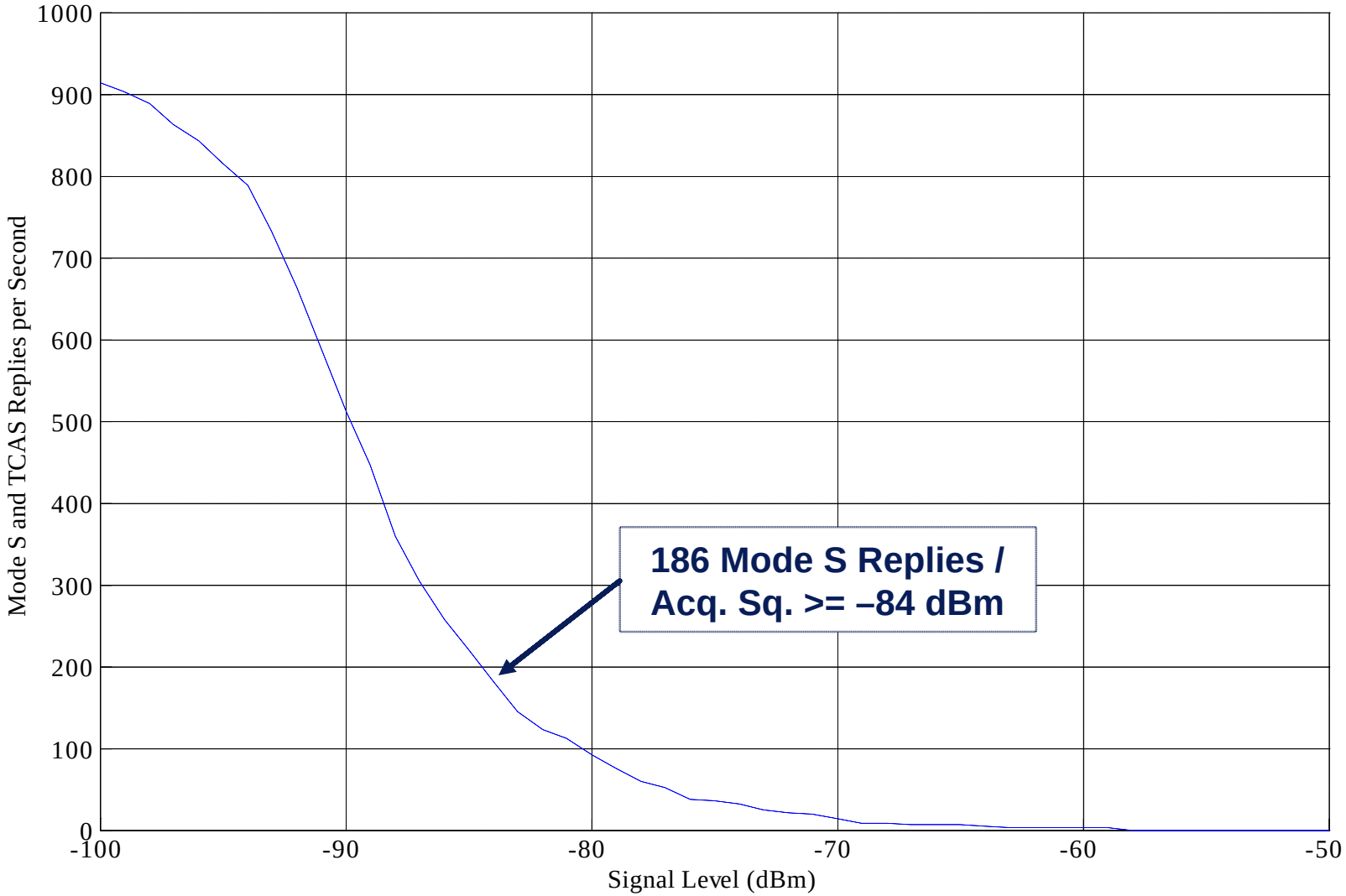
Messages Rates (>-84 dBm)
Low Density Scenario



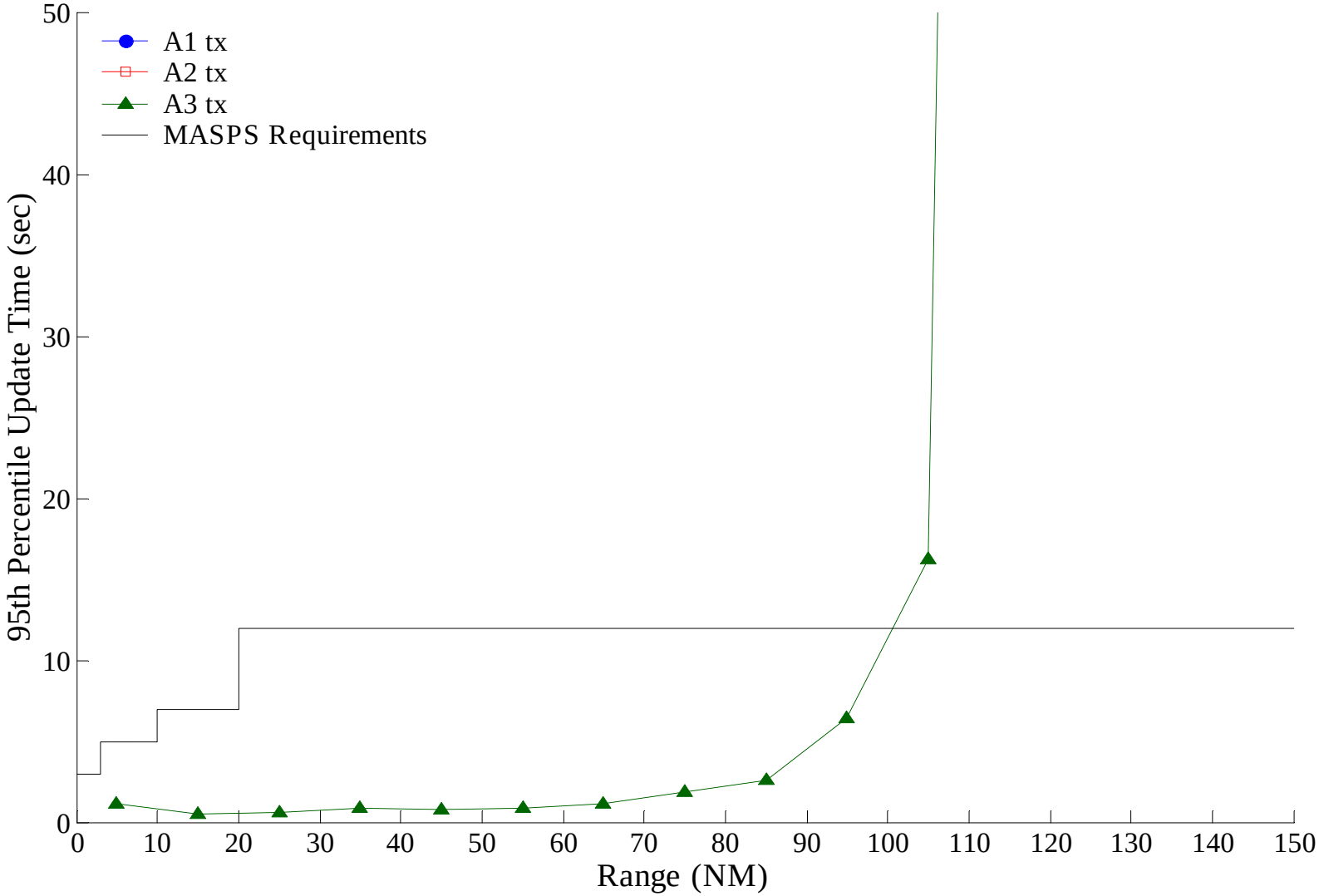
Low Density Scenario
ATCRBS Rates



Low Density Scenario - Mode S & Acquisition Squitter Reply Rates



Low Density Scenario
State Vector 95th Percentile Update Times



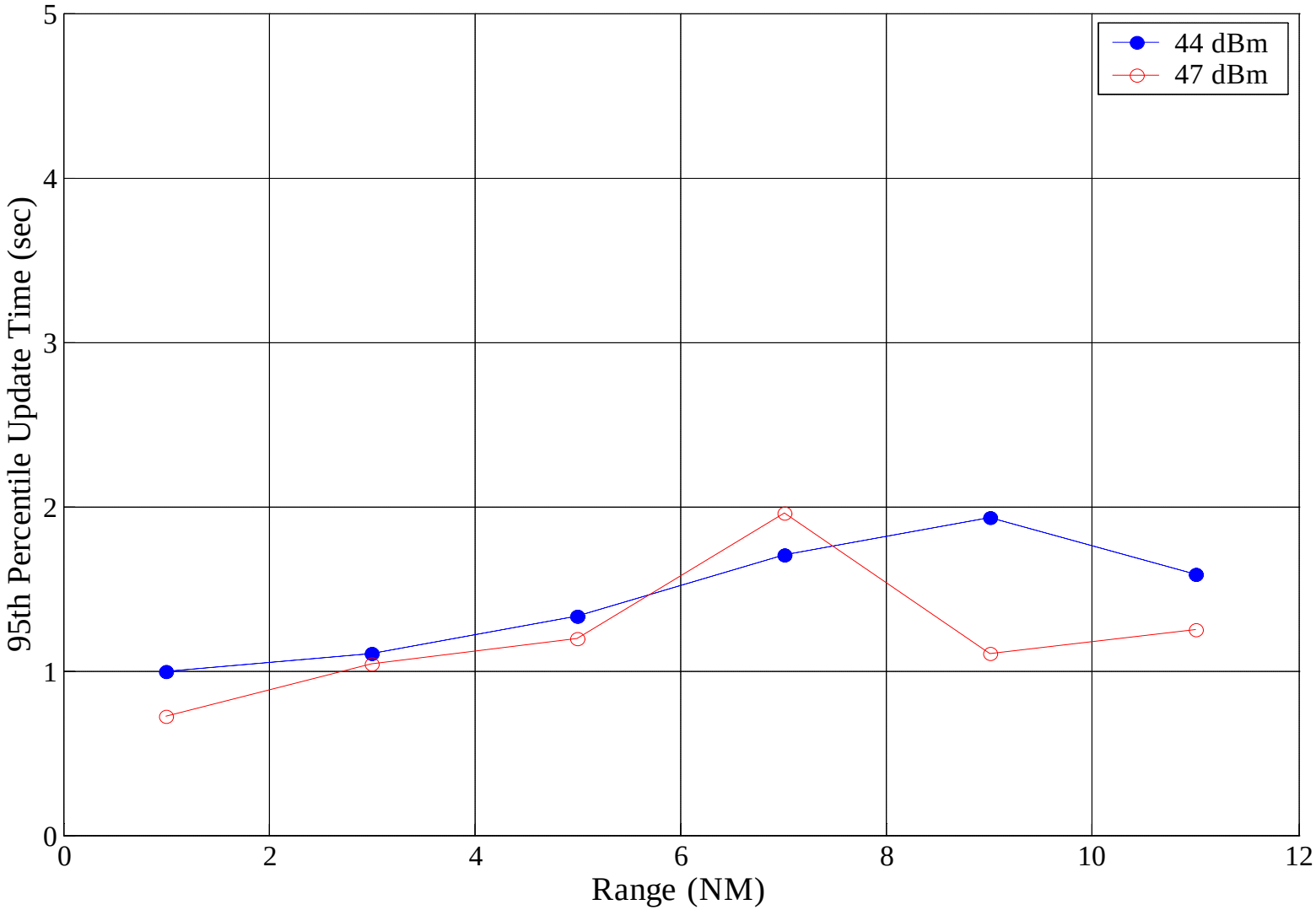
Preliminary Results for Low Density

- Low interference environment
- A3-A3 state vector update range to 100 NM

Assumptions for Ground Vehicle Power Study

- Victim receiver approaching LAX at 2000 ft
- Ground vehicles transmitting at 2.2 ES/sec
- Two power levels used (47 dBm and 44 dBm)
- 95th percentile state vector update calculated for reception of ground vehicle transmissions

95th SV Updates from Ground Vehicle Transmissions in LAX 2020 by an A3 at 2000'



Issues

- Receiver performance mapping requires validation by bench testing
- Receiver performance model for A2, A1 performance estimates
- Include Mode S load in CE 2010

Backup Slides

Assumptions/Parameters I

- Full ADS-B equipage
- LA 2020 scenario
  - 2469 airborne aircraft
  - 225 ground aircraft
  - Ground vehicles (Now included)
  - Aircraft equipage
    - A3: 30%
    - A2: 10%
    - A1: 40%
    - A0: 20%
  - Interrogators as defined by Volpe/TASC with modifications for future radar upgrades

Assumptions/Parameters II

- Transmit characteristics
  - Transmission rates – baseline case
    - All aircraft
      - *Position squitters: 2 per second*
      - *Velocity squitters: 2 per second*
      - *Aircraft ID squitter: once every 5 seconds (0.2/sec)*
      - *Status: once every 2.5 seconds (0.4/sec)*
    - Additional A2/A3
      - *Target State squitters: once every 1.25 seconds (0.8/sec)*
  - Transmitter power at antenna
    - A3: 53-56 dBm
    - A1/A2: 51-54 dBm
    - A0: 48.5-51.5 dBm
  - Alternate transmissions from top and bottom antennas for A1-A3
  - A0 transmit on top only

Assumptions/Parameters III

- Receive characteristics
  - MTL at antenna
    - A1: <= -79 dBm
    - A2: <= -79 dBm
    - A3: <= -84 dBm
  - Receiver diversity for A1-A3 (two receivers)
  - Receiver blanked during co-site transmissions (ADS-B, ATCRBS, TCAS, DME)
  - Not interested in A0 reception (link decision)

Assumptions/Parameters IV

- Other Issues
  - Equipment mix (TCAS, decoder types)
    - TCAS future equipage same as current in LA Basin (40%)
    - Baseline evaluation will focus on enhanced decoder (A2/A3)
    - All A0 are assumed to be ATCRBS
  - TCAS operation
    - Reply rate is modeled as ideal
    - Future LA scenario assumes terrafix no longer required
  - FIS-B implementation will be on UAT, so no 1090 uplink messages
  - No Mode S datalink load (CE: enhanced Mode S surveillance)
  - Results vs. ATCRBS rate
    - No terrain
    - 30K ATCRBS/sec
    - Terrain