MITSS Omni-Directional Antenna Analysis

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• Goal: Assess effect of omnidirectional TCAS antenna on spectrum environment and ownship Mode S and Mode C surveillance range

• MIT Surveillance Simulation (MITSS)
  – Used to inform DO-300A hybrid surveillance requirements

• Change equipage of existing aircraft in track data to Omni antennas

• Level 6 Whisper-shout from DO-197A change 1
  – DO-197A is TCAS I MOPS

• DO-185B Interference limiting
• Input file: Radar tracks centered at JFK from Sunday, November 29, 2009 between 17:00 and 18:00 EST because it was identified as worst case traffic density
  – Tracks taken from RADES and TRAMS and combined
  – Additional on ground aircraft added
RADES Data & TRAMS Data

MITSS Overview

Loop on update intervals from input file

Loop on aircraft data entries
- New Track
- or Existing Track

Loop on all TCAS aircraft

Surveillance Algorithm Execution
- Track Own Aircraft Position
- Calculate NTA
- Calculate IL Inequalities
- Perform Mode C Surveillance
  - WS Sequence Selection
  - Mode C Interrogations
- Perform Mode S Surveillance
  - Squitter Listening
  - Acquisition (Mode S Interrogations)
  - Active Tracking (Mode S Interrogations)
  - Passive Tracking (Extended Squitter)
- Update Scenario (1s)

Outputs:
- Transponder Utilization %
- Surveillance Range
- Interrogation/Reply Rates
• Metrics are averaged over all TCAS equipped aircraft less than 30nm from JFK sensor

• Transponder Utilization
  – Percentage of time transponder is in use
  – Affected by the following
    • Sent long and short replies
    • Received Whisper Shout interrogations that cause suppression
    • Received Mode S interrogations that require a reply
    • Received Mode S interrogations that cause suppression

• TCAS receiver occupancy
  – Percentage of time receiver is in use
  – Affected by the following
    • Sent and heard long and short replies (1090)

• Reliable Surveillance Range (nmi)
• Goal: assess the effect of running only active surveillance against hybrid surveillance, and extended hybrid surveillance when equipped with a top and a bottom omni antenna

• No significant change in Reliable Surveillance Range
• Goal: assess the effect of different percentages of aircraft equipping with omnidirectional antenna using only active surveillance

• %O is the percentage of all the aircraft assigned Top omni antenna and Bottom omni antenna

• %D is the percentage of all the aircraft assigned Top directional antenna and Bottom omni antenna
• Goal: assess the effect of different percentages of aircraft equipping with omnidirectional antenna while utilizing extended Hybrid Surveillance.

• No significant change in Reliable Surveillance Range
• Blue bars represent the runs with extended hybrid surveillance enabled

• Red Bars represent data using only active surveillance

• No significant change in Reliable Surveillance Range

• Omni antennas running extended hybrid surveillance is roughly equivalent to Directional antennas running just active surveillance in terms of transponder utilization
Results: Less Dense Airspace

- Goal: assess omni-antenna performance in less dense airspace environments using active surveillance

- All aircraft have a Top Omni antenna and a Bottom Omni antenna

- A random selection of aircraft were removed from the JFK airspace.
  - E.g., 25% means 75% of the aircraft have been removed
Results: More Dense Airspace

- **Goal:** assess omni-antenna performance in more dense airspace environments using active surveillance

- All aircraft have a Top Omni antenna and a Bottom Omni antenna

- A random selection of aircraft were added to the JFK airspace.
  - E.g., 100% means twice the number of aircraft in the original JFK dataset are simulated

- Reliable Surveillance range remained around 5.9nmi for all cases
  - Likely due to already being maximally limited
Future steps

- New degarbling methods
- New Whisper Shout sequences
- Reduce update rate