

FMS 4D Trajectory Downlink for TBO

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FAA MOIE



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Problem



- **NextGen will rely upon 4-dimensional trajectory (4DT)-based operations to deliver better service and higher efficiency.**
- **Aircraft currently flying generate 4DTs on-board to provide guidance and steering along a flight planned route.**
- **This aircraft capability and the ability to share this information with the ground has not been studied in detail during actual operations to determine the level to which it can be used to support the NextGen operational vision.**

Background



- **Flight Management Computers (FMCs) on transport, regional, and business aircraft routinely compute and fly preplanned trajectories throughout the NAS.**
- **One generation of FMCs by GE Aviation has been updated for the B737 to enable an early version of down-linked trajectory, based upon ARINC 702A-1 via ACARS.**
- **This ACARS downlink can be sent periodically or on demand in support of ground operations.**
- **MITRE worked with Boeing and GE Aviation to activate the feature on 48 B737-800 aircraft in Continental Airlines fleet to form the basis for the analysis and requirements development that are part of this project.**

Objective



- **Short Term:** Analyze parameters of importance for 4D operations (e.g., Estimated Times of Arrival (ETAs), Required Time of Arrival (RTA), wind interactions). Develop visualization tools and playback of data to help the analysis and for evaluation of user interaction.
- **Long Term:** Gain operational experience in the use of downlinked 4D intent among air traffic specialists and airline operations personnel. Develop and evaluate the utility of 4D downlink information, including integration with planned ground automation and displays, with all key ATM participants.

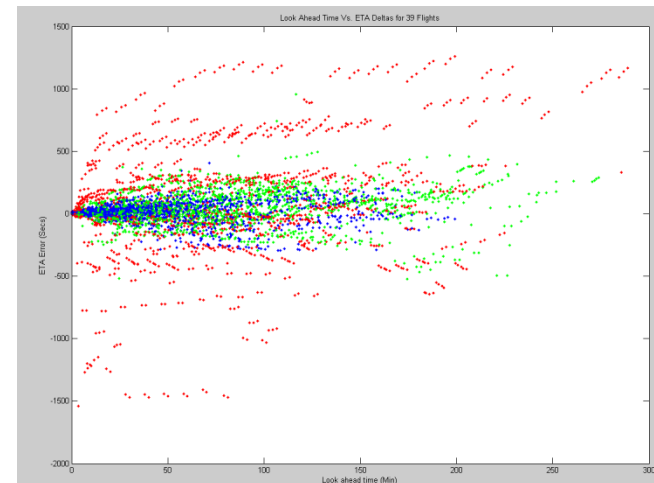
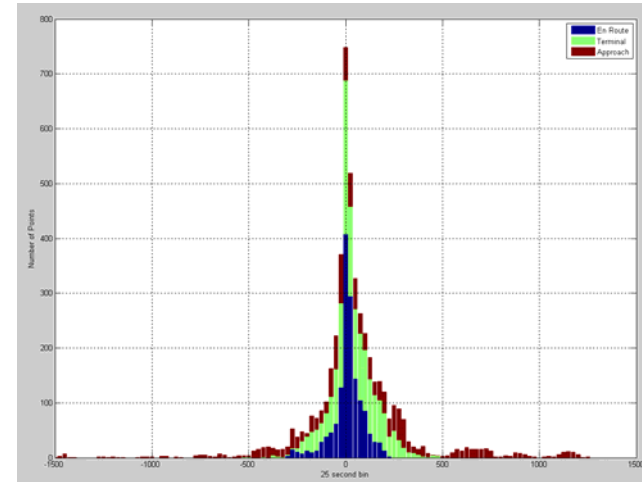
Activities



- **Data Collection** – 48 COA aircraft transmitting 4D trajectory data every 10 minutes each flight. Daily batch of downlinks sent to MITRE by COA for processing.
- **Data Analysis** – aircraft data is being combined with radar tracking data and flight planning data for each flight to begin the analysis of ETA accuracy under all conditions.
- **Data Visualization** – downlinked trajectories are being interfaced to graphical tools (TrajVisual & TARGETS) to show progressions of downlinks as the flight moves from origin to destination.
- **Data Playback** – methods are being developed to use “real” downlinks in the ATM lab environment to study various aspects of using the data.

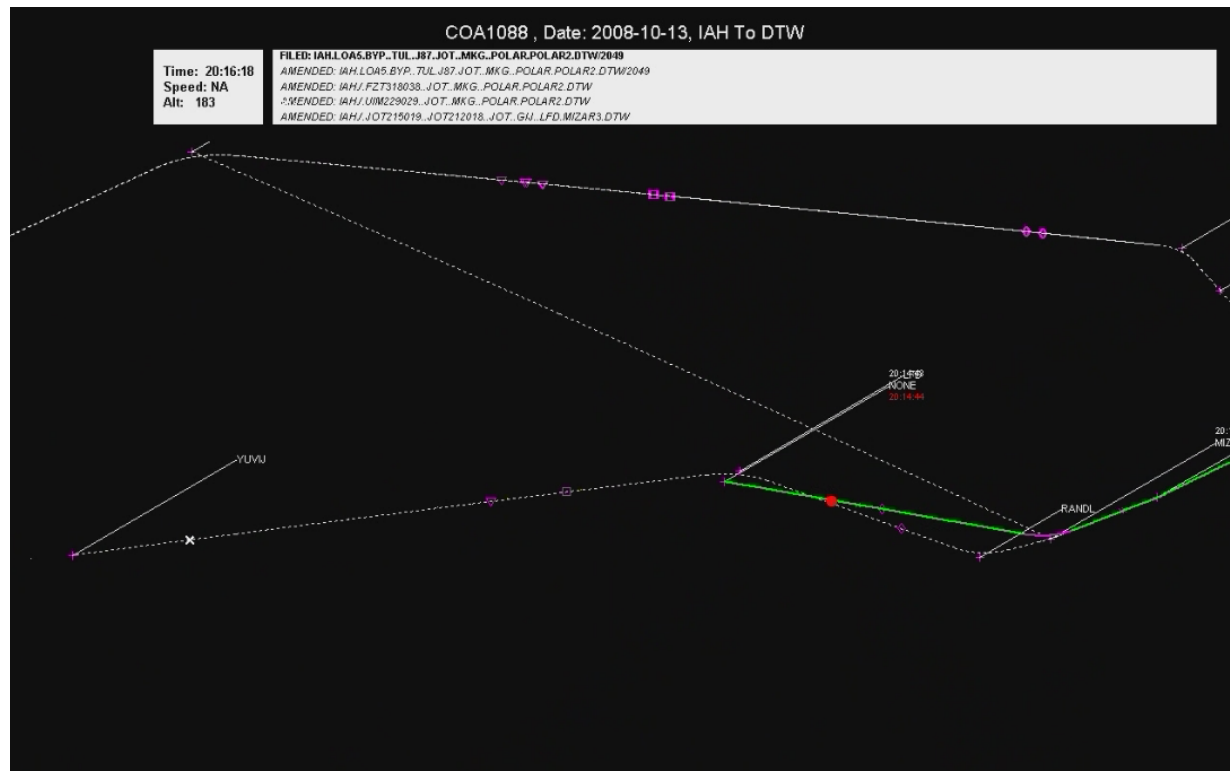
Highlight

- Histogram and scatter plot of ETA errors show approach has the widest variability.
- The primary cause for this is “open” arrivals to the approach that begin with vectors with undefined termination, preventing accurate predictions.
- This shows a need to revise our operations if predictions of ETA are to be accurate and useable.



Demonstration

- A prototype visualization has been developed, the aircraft is “flown” along the radar track with intent data displayed ahead of the aircraft for each successive downlink.



Green = current predicted path

White = previous predictions

Red dot = aircraft

Flight plan and amendments show in the box at the top.

Impacts



- **Provide detailed understanding of aircraft capability and performance in prediction of flight paths to aid in the NextGen discussion of TBO.**
- **Develop requirements that could be used as standards for operation in the ATC systems and aircraft of the future.**
- **Explore innovative ways to integrate ground system and aircraft system data to enable higher performing TBO.**

Future Plans



- **Continue analysis of FMS downlinked trajectory information in current operations**
 - **Apply knowledge gained to suggest modifications to current operating procedures in the NAS for NextGen**
 - **Compile and suggest changes to ARINC for updated intent downlink content.**
- **Form a team involving FAA and airlines to begin implementing changes suggested by the data in limited trials**
 - **Develop requirements for displays / interactions among Air Traffic Control, Airline Ops Centers and flight crews.**
- **Investigate the application of RTA in merging and spacing.**