Aircraft Trajectory Data and Environmental Data Visualization

Federal Aviation Administration

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Aircraft Trajectory Data and Environmental Data Visualization

As higher quality aircraft trajectory data has become available, additional opportunities for analytical and communication purposes are possible

- **To take maximum advantage of these opportunities an integrated data management and data visualization framework is needed**
  - Create an Environmental use case specification for aircraft trajectory data which allows for the same data stream to be used throughout project phases
  - Identify more efficient data management and data access capabilities
  - Enable the use of emerging information technologies to support environmental analysis and outreach
  - Integrate existing tools and develop new tools to utilize a common data platform

Aircraft Trajectory Data

- **Aircraft trajectory data provides 4D vehicle position information**
  - Latitude, Longitude, Altitude, and Time (Speed can then be derived)
- **Trajectory information can be collected and combined from multiple sources**
  - Radar: CENTER/TRACON (Flight Sensor Radar), ASDE-X (Ground Based Radar)
  - Satellite: ADS-B
- **Trajectory data information is either accompanied by or can be augmented to include additional operational information from**
  - Aircraft registration data, Operator Information, flight plans
- **In general most uses only require an accurate representation of the aircraft path and the associated metadata**

Many Uses, Many Paths, One Source

- **Flight Tracking data has been used for Environmental Analysis in Multiple Ways**
  - Part 150 Studies
  - NEPA Review (including Nextgen procedure redesign studies)
  - Annual FAA noise and emissions inventories
  - CAEP analyses
  - Research
- **In most cases flight tracking data sharing a common source is being post processed individually for different programs**
  - This can lead to inefficiencies and potential consistency issues where the same data is processed slightly different
  - When used for environmental analysis and public communication a common approach for data processing will ensure more consistent outcomes

One Source, One path, Many uses

- **AEE has been developing an approach to processing operational data for use with its environmental modeling tools**
  - For the past 20 year and its approach is the recognized method for use in CAEP analyses
  - In coordination with MITRE's ThreadedTrack program, AEE is leveraging their 10+ years of development to create an AEDT optimized flight track data set
- **Preparation of a complete flight track data set optimized for environmental analysis and visualization can consistency serve multiple purposes**
  - Will not require individual project pre-processing
  - The final target of this work will be to make the information readily available for download by any project

Benefits of the Single Source Approach

The single source approach will have a variety of benefits:

- Data quality and consistency
  - The data will be based on centralized, proven, and maintained post processing methodology with outputs subjected to in depth Validation and Verification
- Modeling accuracy
  - The quality and trajectory data and associated metadata will be targeted to ensure compliance with the FAA modeling tools requirements
- Consistent communication
  - The common source of data will ensure the consistency of internal and external communication in terms of both data and visuals
- Schedule decompression and financial savings
  - Having readily available baseline data will significantly reduce the time needed to proceed to modeling and analysis resulting in very significant project cost reductions

MITRE Threaded Track Processing Overview

Mitre has developed TreadedTrack for the FAA to provide customized flight track processing to meet specific use cases

Core concepts include:

- Data integration fusing a range of radar surveillance sources throughout the flight envelope into a single synthetic trajectory with key flight meta-data
- Analytics based estimates of the trajectory determination between the various radar sources based on a weighted least squares model
- Supported on a Connected Data Architecture Platform for enterprise level data management and analysis

Threaded Track vs. Raw Radar Data

A Complete Flight Trajectory Requires Analysis of Multiple Radar Data Sources

- Raw radar surveillance data provides only local coverage at the facility/sensor and flight information is not continuously integrated between facilities/sensors

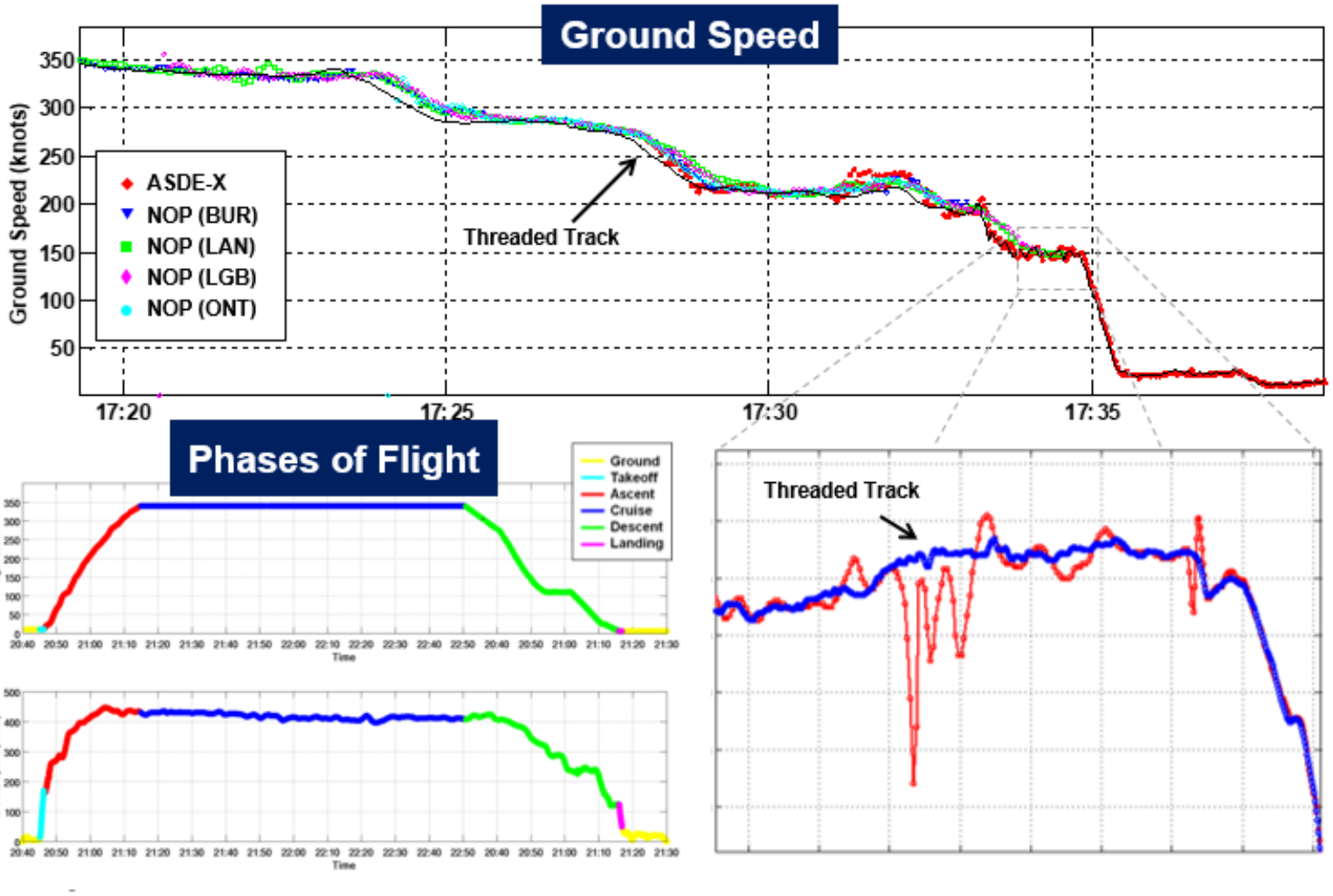
Threaded Track Provides the Ability to Manage:

- **Overlapping Radar Coverage**
  - Which source files should be examined for specific flights?
  - Which system is providing the most accurate position?
  - ETMS/TFMS data supplementation for better VFR

- **Data quality checks**
  - Removal of noise and extraneous hits (ghost targets)?
  - Should position and altitude reports be smoothed? How?
  - How to best fuse multiple radar surveillance data sources?

- **Data Completeness**
  - Provides for supplementation of ETMS/TFMS based radar inputs for better VFR coverage and data resolution improvements

Threaded Track



MITRE

Upcoming Work Using Threaded Track

- **AEE and Mitre are continuing coordination to refine Threaded Track data optimization for AEDT**
  - Threaded Track will be used to support both the calendar year 2019 FAA Annual Noise and Emissions Inventory and a noise and emissions rebaselining review for data from 2005, 2010 and 2015
  - Evaluating data reduction techniques and their compatibility with BADA4 performance data
  - Integrating AEDT aircraft fleet assignments
  - Coordinating on technology transfer and FAA EIM integration

Single Source Data Status

- **MITRE-FAA Technology Transfer for the optimized thread track approach to an operational state has been initiated**
  - The process will require further coordination with existing FAA flight track archiving programs (e.g. NOP, PDARS/DVARS, SWIM)
  - Will rely on the integration with the FAA Enterprise Information Management (EIM) system to manage the required software architecture

Final timeline to completion is yet to be determined as the integrated system approach is still in development as is the EIM

FAA Enterprise Information Management (EIM) Platform

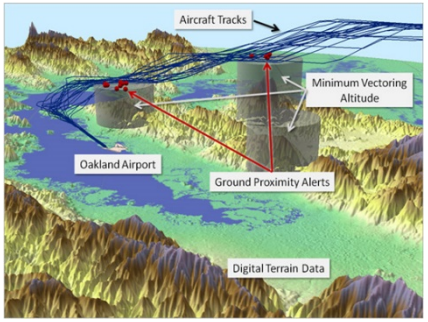
- **The FAA is in the initial phases of standing up an EIM platform to support broad data management and analytics capabilities efficiently across the agency**
  - Provides access to Federal Cloud based computational resources as well as a technology “stack” of software and analytical resources
- **AEE is exploring the EIM as a management tool to support environmental data visualization and modeling**
  - The EIM will be used to manage the 2019 annual noise and emissions inventory and a re-baselining efforts -- to re-model 2005, 2010 and 2015 operational conditions using a common version of AEDT and modeling assumptions
  - The existing AEDT codebase will be used for initial testing with the EIM, however to take maximum advantage of the available EIM resources, AEDT architecture changes will be needed

AEDT Architecture Evolution

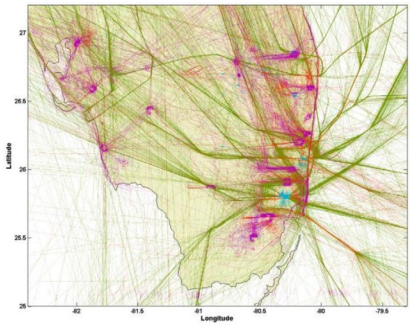
- **The current AEDT architecture (C# codebase supported by MSSQL database) was designed around a desktop computational environment**
  - The desktop computational model provides easy access to users, but is difficult to evolve sustainably with emerging technologies including non-relational databases, GPU enabled computing and advanced distributed computational methods
  - An enterprise based architecture provides much greater flexibility and sustainability but requires a platform to manage the resources
- **The EIM can now provide a stable platform to explore options for AEDT architecture change not previously feasible**
  - AEE is working with the FAA EIM project managers to explore these opportunities
  - AEE is also engaged with other stakeholders including MITRE, Volpe, Stanford and Georgia Tech to inform what enterprise level capabilities can be leveraged for future AEDT development

Visualization

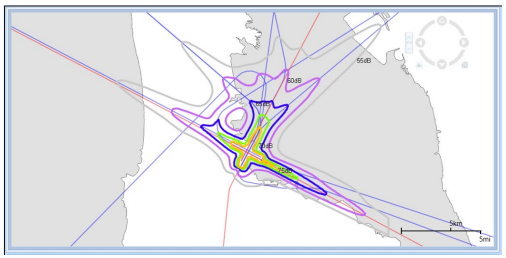
- **Visualization serves many purposes in the agency**
  - Support operational awareness
  - Support data understanding and manipulation
  - Facilitate data review and validation
  - Report and Communicate information



- **Visual presentation is often tailored to the task**

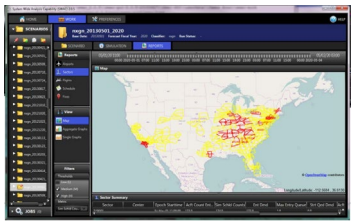


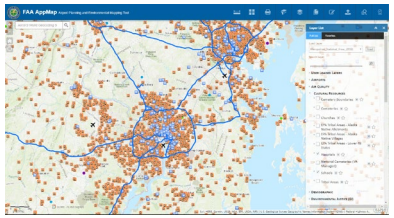
- **Reporting and Communication are the activities that most benefit from a common and consistent visual language**

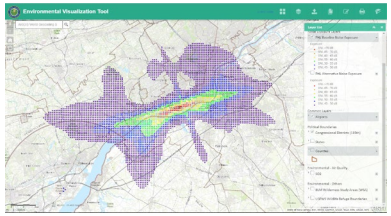


FAA Tools Visualization Approaches

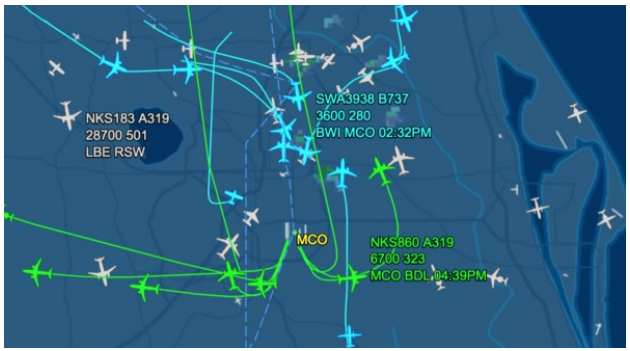
- **FAA subject matter of purview is inherently spatial**
- **Many tools are used that display geospatial information**
  - **Modeling and simulation**
    - AEDT (Aviation Environmental Design Tool)
    - TARGETS (Terminal Area Route Generation and Traffic Simulation)
    - SWAC (System-Wide Analysis Capability)
  - **Planning and NEPA compliance analysis**
    - GETIT (Geospatial Evaluation Tool with Integrated Technology)
    - APPMAP
  - **Communication**
    - EVT (Environmental Visualization Tool)





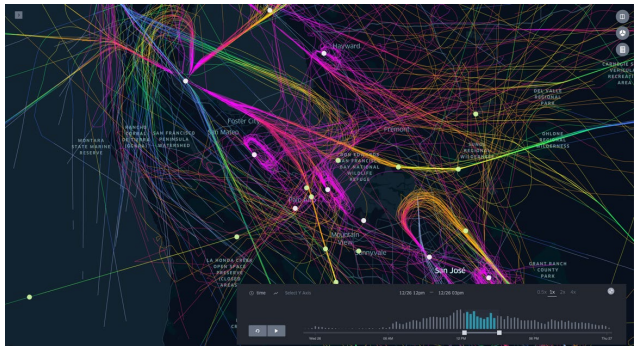


Other Approaches



- There are many examples of geospatial visualization of aviation data outside of FAA
- All approaches have advantages and disadvantages depending on the tools used and goals

- The visual language and interface vary greatly
- Data and tools availability are facilitating development and proliferation



Integrated Vision

- **The FAA is in great need of a consistent approach to communicating its spatial data and the information it embeds**
- **An agency-wide platform could foster consistency in**
  - Reference data use and quality
  - Analysis data use and quality
  - Visual communication language
  - Messaging
- **The tools and methods adopted must be readily maintainable by the agency**
- **AEE and APP have taken an initial towards such integration with the design and infrastructure used by EVT and APPMAP**