SWIFT:

SWIM Industry Collaboration Workshop #9

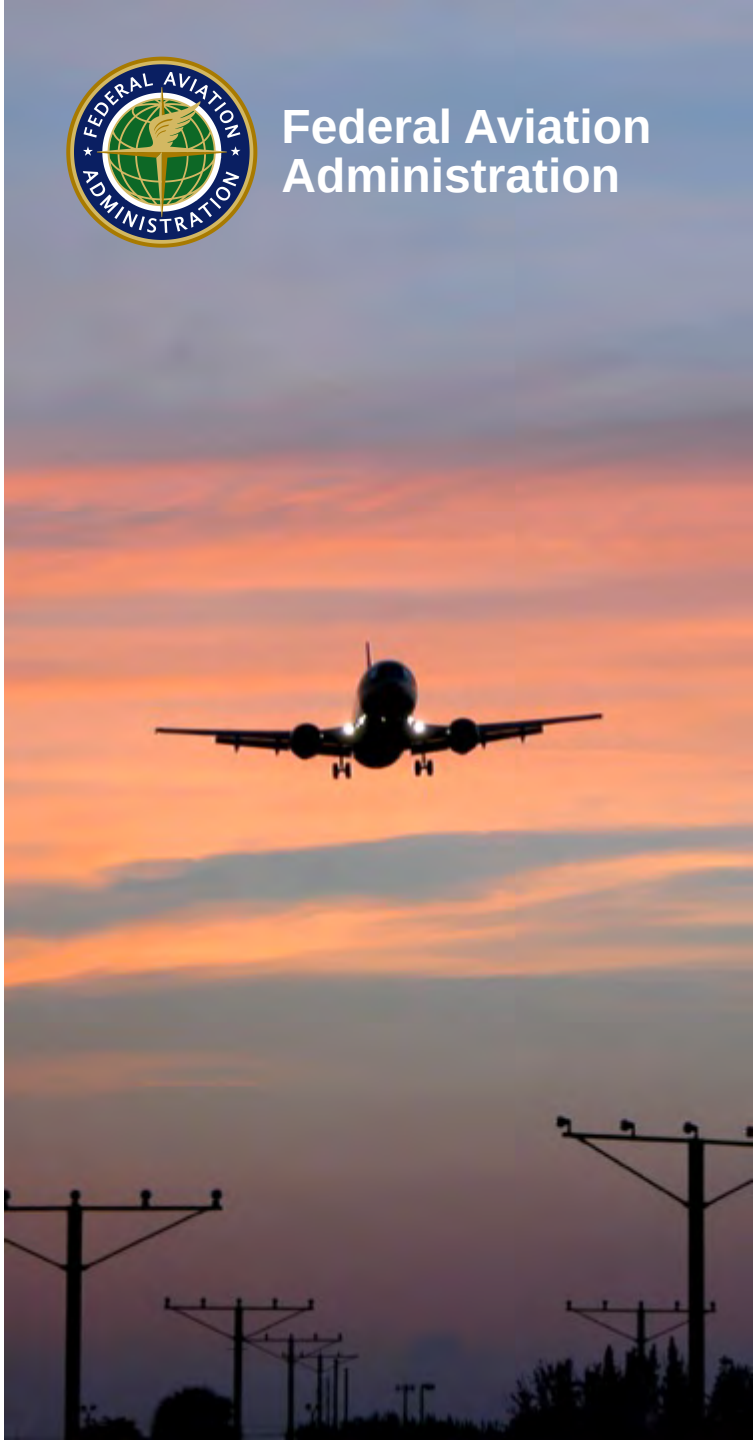
SWIM, Services & SWIFT (SWIM Industry-FAA Team)

FAA SWIM Program

Communications, Information and Network Programs

February 26th , 2020

Federal Aviation Administration



Welcome to FedEx - UOM

- **Internet Access Credentials:**
  - *Network: ftc-conf*
  - *Password: fedex-conf*

SWIFT Collaborative Workshop #9 Day 2

February 26, 2020 – Memphis, TN

- Sign in 8AM – 8:30
- FedEx – Welcome and Logistics, FedEx, Felisa White, Josh Gustin, Rob Goldman
- SWIFT Updates: General Updates, David Almeida
- Special Topic: Data Governance: FAA Data Strategy – Governance, Natesh Manikoth
- Producer Briefing: Traffic Flow Management System: TFMS Request/Reply, Steve Lewandowski
- **BREAK: 10:10 – 10:30**

- Flight and Flow for an Information Collaborative Environment (FF-ICE), Ray Ahlberg
- SWIM Capability: SWIFT Portal, Damon Thomas
- **LUNCH: 12:00 – 13:00**

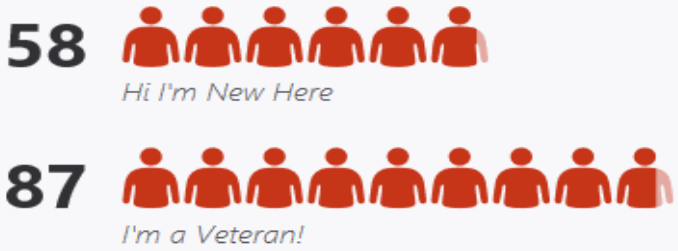
- Focus Group Summary (Ops Context, Analytics/Development, Operational), Ray Mitchell, Chris Gottlieb, and Erin Cobbett
- Special Topic: Ops Context for TBFM, Xavier Pratt
- Special Topic: Machine Learning & Time Based Flow Metering Service by NASA, Al Capps
- **BREAK: 14:25 – 14:50**

- Case Study: SWIFT Flight Information Widget by L3Harris, Doug Harvey
- Producer Program Data: SWIM Flight Data Publication Service (SFDPS), Ross Skiles
- Producer Program Update: Aeronautical Common Service & NOTAMS by AIMM, Davy Andrew
- Wrap up: 1625 – 1630

Who is Sitting Next to You at SWIFT #9?

Attendee Organizations

Attended a SWIFT Meeting Before?



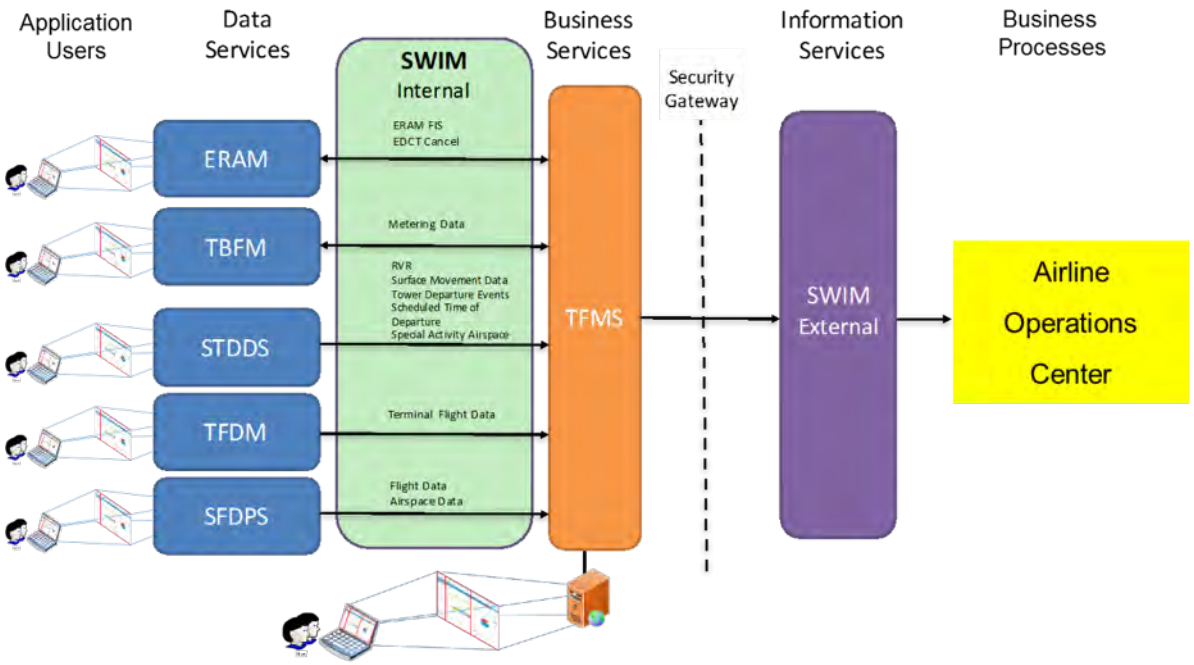
145Attendees

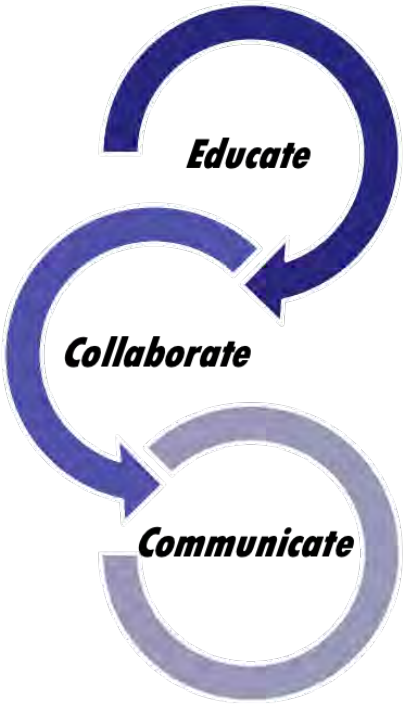
SWIFT

SWIFT Stakeholders

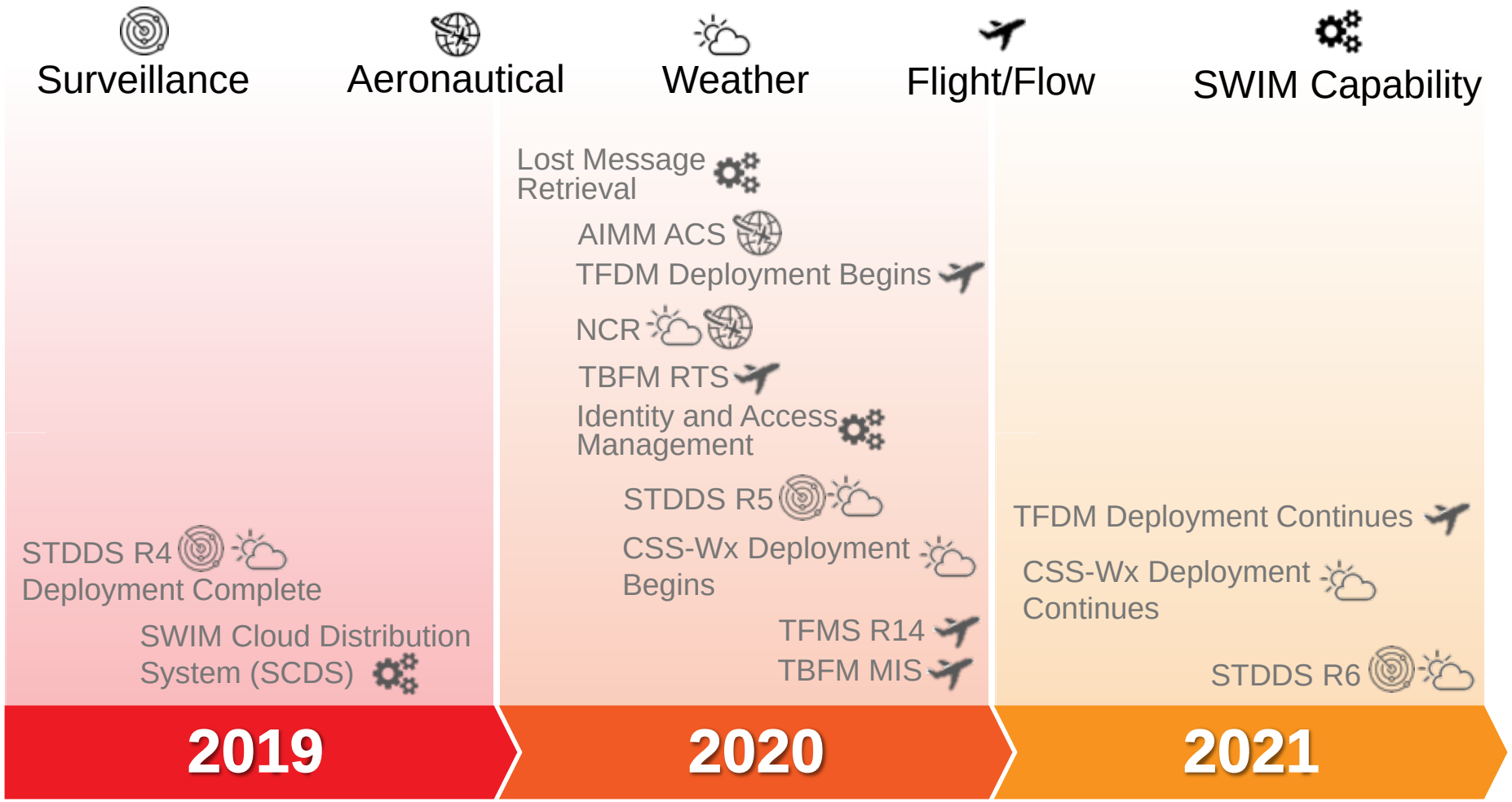
SWIM Industry FAA Team (SWIFT)

- **SWIFT addresses industry recommendation to:**
  - Establish a community forum that acts as a single environment for collaborative engagement around NAS information and data sharing
  - **Educate**: Synchronize community on information services
  - **Collaborate**: Discuss issues most relevant to community
  - **Communicate**: Inform community about SWIM & NAS programs





SWIM Planned Deployment Roadmap



*Calendar year dates, subject to change

SWIM Cloud Distribution Service (SCDS) User Survey

During the Break

If you have not yet filled out the survey, please take a few minutes to take our quick SCDS User Survey. This survey will help us to plan for future growth, better understand user needs and help us continually improve SWIM services.

Note: This survey and other SCDS communications are sent from SCDS@FAA.GOV please ensure emails from this address are not going to your spam folder.

FAA Data Strategy

Governance

SWIFT Meeting Feb 26th 2020

Federal Data Strategy

M-19-18 Federal Data Strategy – A Framework for Consistency
Released 6/4

- 10 year vision with goals for a 5 -10 year time horizon
- 10 Principles organized in 3 categories
  - Ethical Governance (Principles 1-3)
  - Conscious Design (Principles 4-7)
  - Learning Culture (Principles 8-10)
- 40 best practices organized in 3 categories
  - Building a Culture that Values Data and Promotes Public Use (Practices 1-10)
  - Governing, Managing, and Protecting Data (Practices 11-26)
  - Promoting Efficient and Appropriate Data Use (27-40)

FAA Data Strategy

Addresses the data challenges to create a transformed future state

Current state

- **Lack of integrated data**
- **Lack of timely access to data**
- **Lack of documented data models**
- **Lack of access to big-data tools**
- **Limited ability to analyze unstructured data**

ACTIONS/INITIATIVES

Data Access & Controls
- Data Stewardship Communities
- FAA Data Governance Center
- Geospatial and Analytics COPs
- 1375.1 Data Policy Revision

Technology Platforms
- Cloud based Enterprise Data Platform
- Integrated data sets from across the enterprise

Continuous Innovation
- Enabling data sharing within and outside FAA
- ML/AI tools and training
- Data Challenges to drive innovation

Future state

Data available to all based on roles

Shorten time to make decisions through ready access to all relevant data.

- **More effective use of data**

Ability to identify and understand anomalies (e.g. behavior, events). Predictive use of data.

- **Transformed work process**

Data driven decisions. ML/AI broadly applied. Data services to support industry innovation and external research.

-

Federal Data Strategy Action Plan Status

In response to the Federal Data Strategy's 2020 Action Plan published earlier this year, the Chief Data Office conducted a crosswalk of the six agency actions against FAA's data maturity to baseline progress. Based on the findings, the FAA is well underway in meeting the 2020 targets, with 7 out of the 18 milestones already completed. The Chief Data Office will continue to collaborate with lines of businesses and staff offices to complete the outstanding actions within the established timeline.

In progress	**ACTION 1. Identify Data Needs to Answer Priority Agency Questions**
In progress	**ACTION 2. Constitute a Diverse Data Governance Body**
Complete	**ACTION 3. Assess Data and Related Infrastructure Maturity**
In progress	**ACTION 4. Identify Opportunities to Increase Staff Data Skills**
In progress	**ACTION 5. Identify Priority Data Assets for Agency Open Data Plans**
In progress	**ACTION 6. Publish and Update Data Inventories**

The purpose of governance is to control, influence or change behavior. Period.

Gartner Analyst, Dave Mayer
Basics of Data Governance, Aug 2019

Improve business outcomes

Data Governance (DG) is defined as the exercise of authority and control (planning, monitoring, and enforcement) over the management of data assets. All organizations make decisions about data, regardless of whether they have a formal Data Governance function.
- *DAMA-DMBOK*

The specification of **decision rights** and an **accountability framework** to ensure the **appropriate behavior** in the valuation, creation, consumption and control of data and analytics.
- *Gartner*

What should be governed?

Who should govern?

How should it be governed?

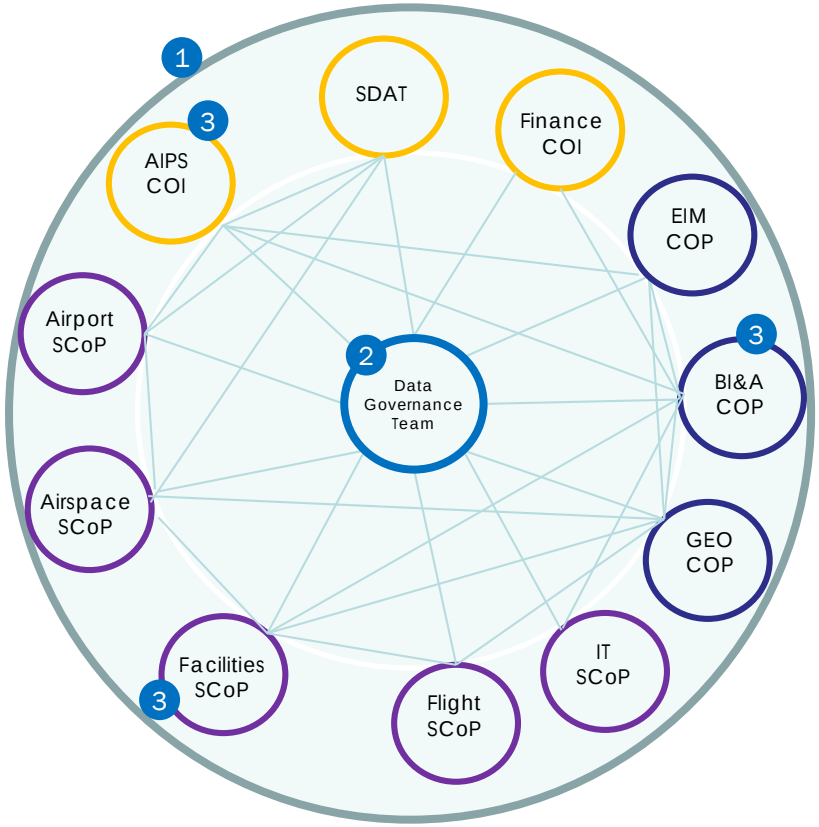
Data Governance

A federated data governance model with LOBs/SOs to drive the agenda

1. **Overall Governance** –EIM Steering Committee provides overall direction and guidance for data governance activities (as well as platform evolution). Architectural impacts of data quality improvement recommendations are reviewed and approved by the FAA Enterprise Architecture Board.

2. **Centralized Governance Team** – Central team helps run the various communities. The central team runs the FAA Data Governance Center and monitors various working groups and data quality improvement initiatives.

3. **Communities** –Communities of interest (COI) for various business domains, data stewardship communities of practice (SCoP) for various data domains and practitioners in technical areas (Communities of Practice - COP) such as analytics and geospatial data form the backbone of FAA's distributed data governance strategy.



ENABLING | ***Engagement***

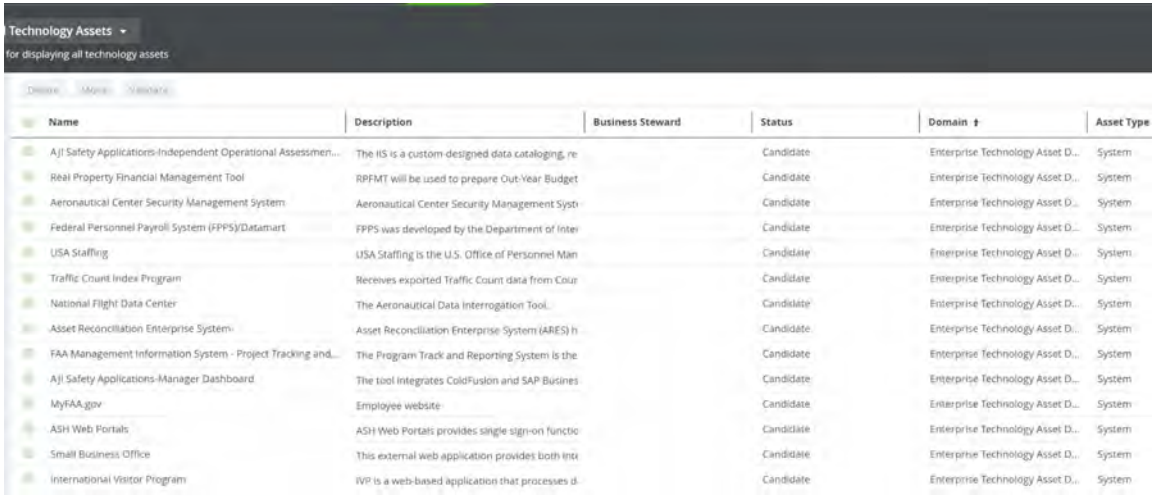
- Engage FAA employees through multiple channels.
- Conduct employee outreach & engagement.
- Continue to provide Data Governance Center training, demos, and brown bags.
- Implement multi-phase data governance enhancements.

AUTHORITATIVE | ***Governance***

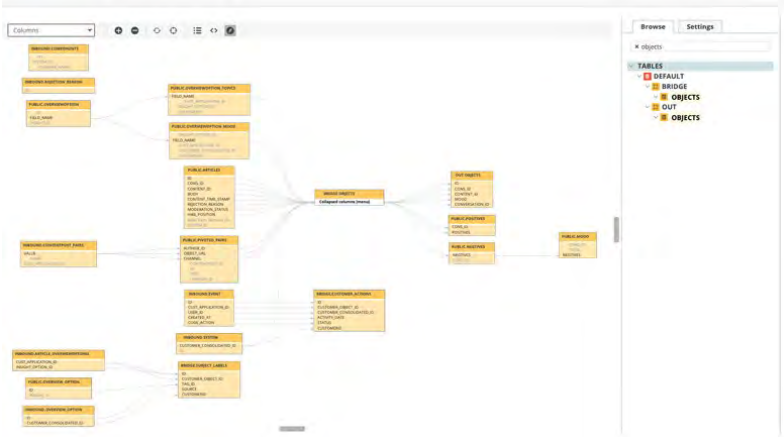
- Support the SCoPs in implementing their strategic plan and prioritizing activities.
- Standardize and distribute best practice tools and templates from COIs and SCoPs.
- Update 1375.1E Data/Information Order.
- Develop a Data Governance Framework.

ACCELERATE | ***Technology***

- Collaborate with COIs and SCoPs to catalog 50 trusted assets in Data Governance Center.
- Initiate data cataloging for all LOBs/Sos.
- Provide provenance and lineage information.


Technology Assets
for displaying all technology assets
Name
Description
Business Steward
Status
Domain
Asset Type
AJI Safety Applications-Independent Operational Assessmen...
The IIS is a custom-designed data cataloging, re
Candidate
Enterprise Technology Asset D...
System
Real Property Financial Management Tool
RPFMT will be used to prepare Out-Year Budget
Aeronautical Center Security Management System
Aeronautical Center Security Management Syst
Federal Personnel Payroll System (FPPS)/Datamart
FPPS was developed by the Department of Inter
USA Staffing
USA Staffing is the U.S. Office of Personnel Man
Traffic Count Index Program
Receives exported Traffic Count data from Cour
National Flight Data Center
The Aeronautical Data Interrogation Tool.
Asset Reconciliation Enterprise System
Asset Reconciliation Enterprise System (ARES) h
FAA Management Information System - Project Tracking and...
The Program Track and Reporting System is the
AJI Safety Applications-Manager Dashboard
The tool integrates ColdFusion and SAP Busines
MyFAA.gov
Employee website
ASH Web Portals
ASH Web Portals provides single sign-on functio
Small Business Office
This external web application provides both inte
International Visitor Program
IVP is a web-based application that processes d


ENT CONTROLLED AIRSPACE
FAA Order JO 7400.11C Subpart C
ENT CLASS C
MDL Airspace Type Logical Model
NASR DB


Browse
Settings
TABLES
DEFAULT
BRIDGE
OBJECTS
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OBJECTS

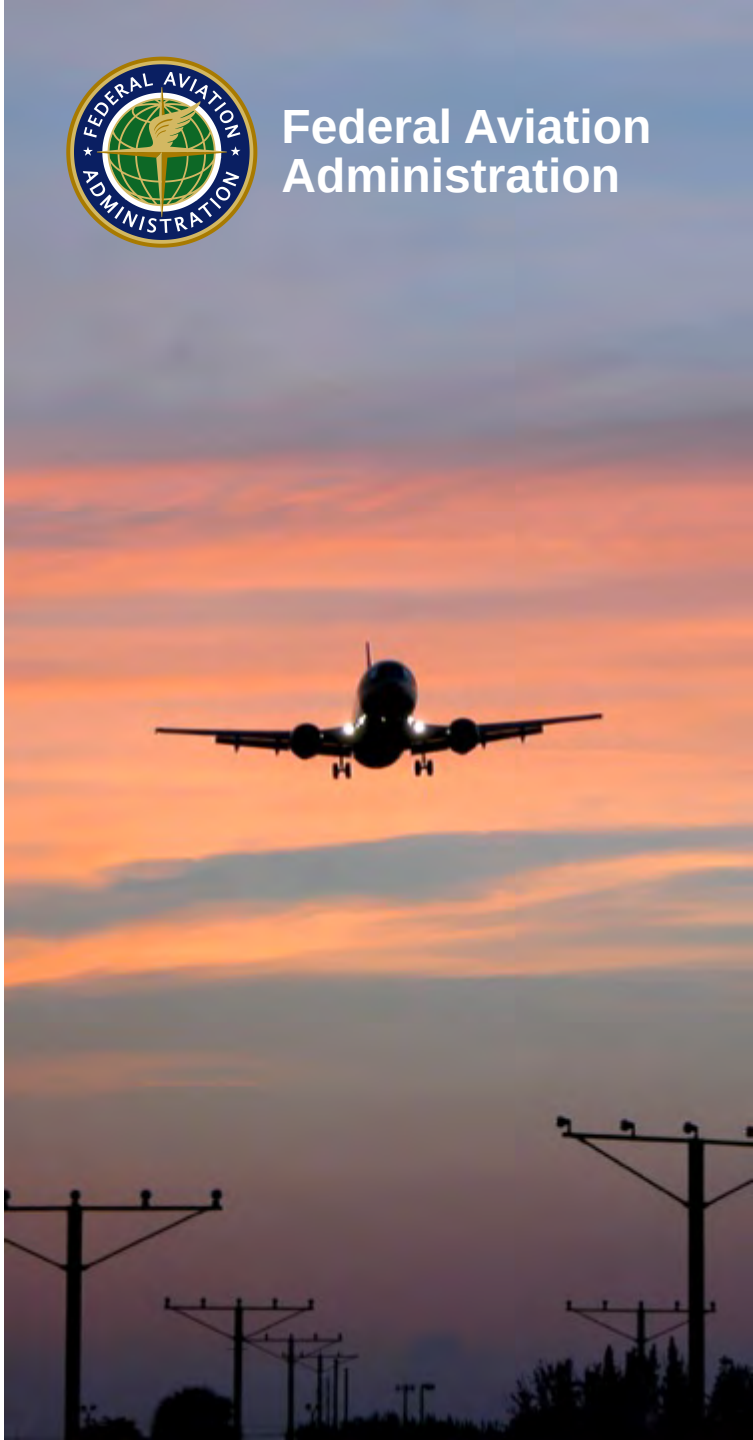
SWIFT #9
TFMS

Airport Monitor and TMI Flight Lists

By: Steve Lewandowski, CSRA

Date: February 26th, 2020

Federal Aviation Administration



Airport Monitor and TMI Flight Lists – Exercise Objectives

- **Part 1: Airport Monitoring**
  - Introduction of the Airport Monitoring Request.
    - Conceptual background, request options, message sequences, and responses.
    - Request message contents.
    - Reply message and Flow Information message details.
  - Example: Issue a Airport Monitoring Registration and evaluate the responses.
    - Issue a Airport Monitoring Registration request.
    - Evaluate the TFMS Monitoring Reply and the Flight Monitoring Updates.

- **Part 2: TMI List Request**
  - Introduction of TMI list requests.
    - Walk through the 2-step process and message flow to obtain a TMI Flight List.
    - Discuss the TMI List request and TMI Definition request contents.
    - Walk through the responses for each of the requests.
  - Example: Issue TMI List and TMI Definition requests.
    - Issue a TMI List request.
    - Evaluate the TMI Index response.
    - Issue a TMI Definition request – utilizing previously obtained index information.
    - Evaluate the TMI definition response, including associated flight lists.

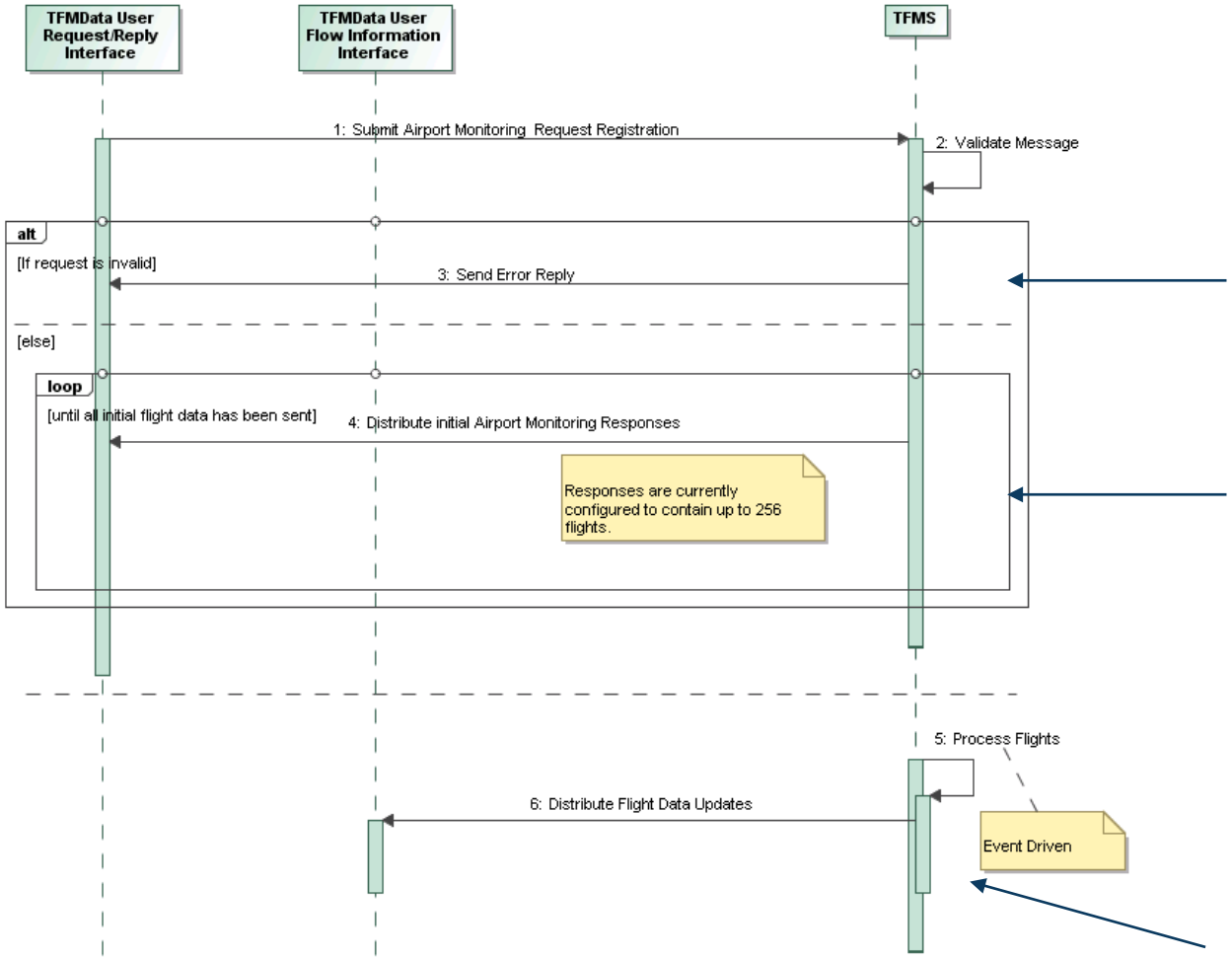
Part 1:
Airport Monitoring

Airport Monitoring Request

- **Conceptual Background**
  - Allows users to subscribe to flight data information updates for flights that are arriving or departing from specified airports.
  - Airport Monitoring requests and replies are handled over the TFMData Request/Reply interface.
  - Users will receive the initial full set of flight information in the response to a successful registration request.
    - TFMS allows only one Airport Monitoring Request every **60 (sixty)** minutes per user and airport.
  - Future flight updates are provided asynchronously via the TFMData FlowInformation interface.
  - TFMS does NOT send a notification when the registration expires.

- **Request Options**
  - Register: Register for flight information from one or more airports.
    - Subscription period is limited to 24 hours.
    - Registration must specify the monitoring type: arrivals, departures, or both.
  - Renew: Renew one or more existing airport registrations.
    - Purpose is to maintain a continuous subscription by programmatically renewing an existing registration before expiration.
    - Renewals must match the airport and monitoring type (arrivals, departures, or both) of the initial registration.
  - Deregister: Cancel existing subscription for one or more existing airport registrations.
    - Deregistrations must match the airport and monitoring type of the initial registration.

Airport Monitoring Request – Message Sequence



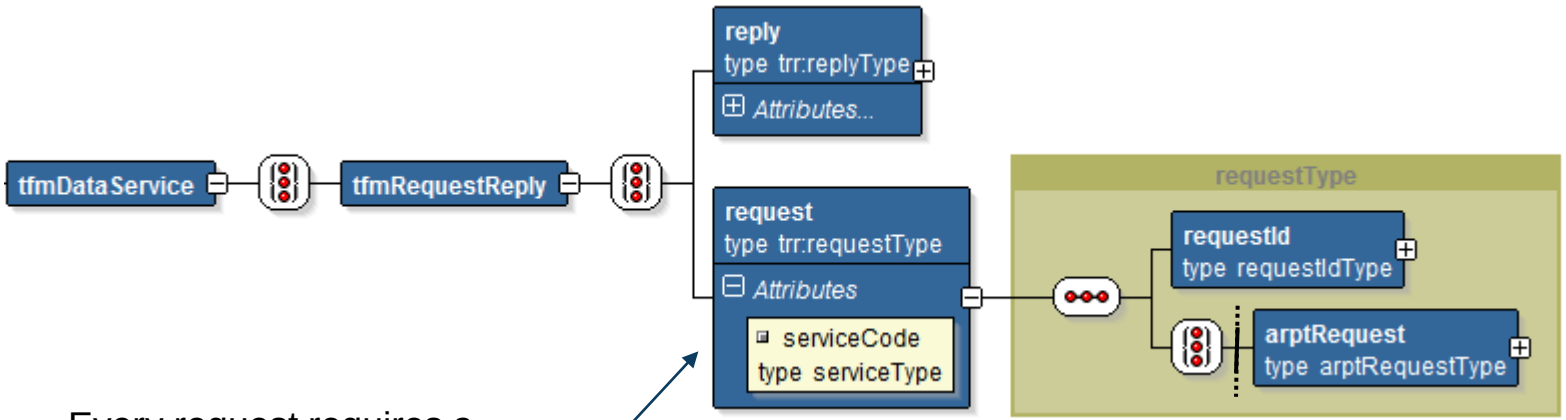
Request can be a registration, renewal, or de-registration request. Diagram depicts the registration process.

ERROR Path.

For successful registration requests, the initial flight list is provided in one or more response messages.

Flight data that changes due to events external and internal to TFMS is distributed over the Flow Information feed.

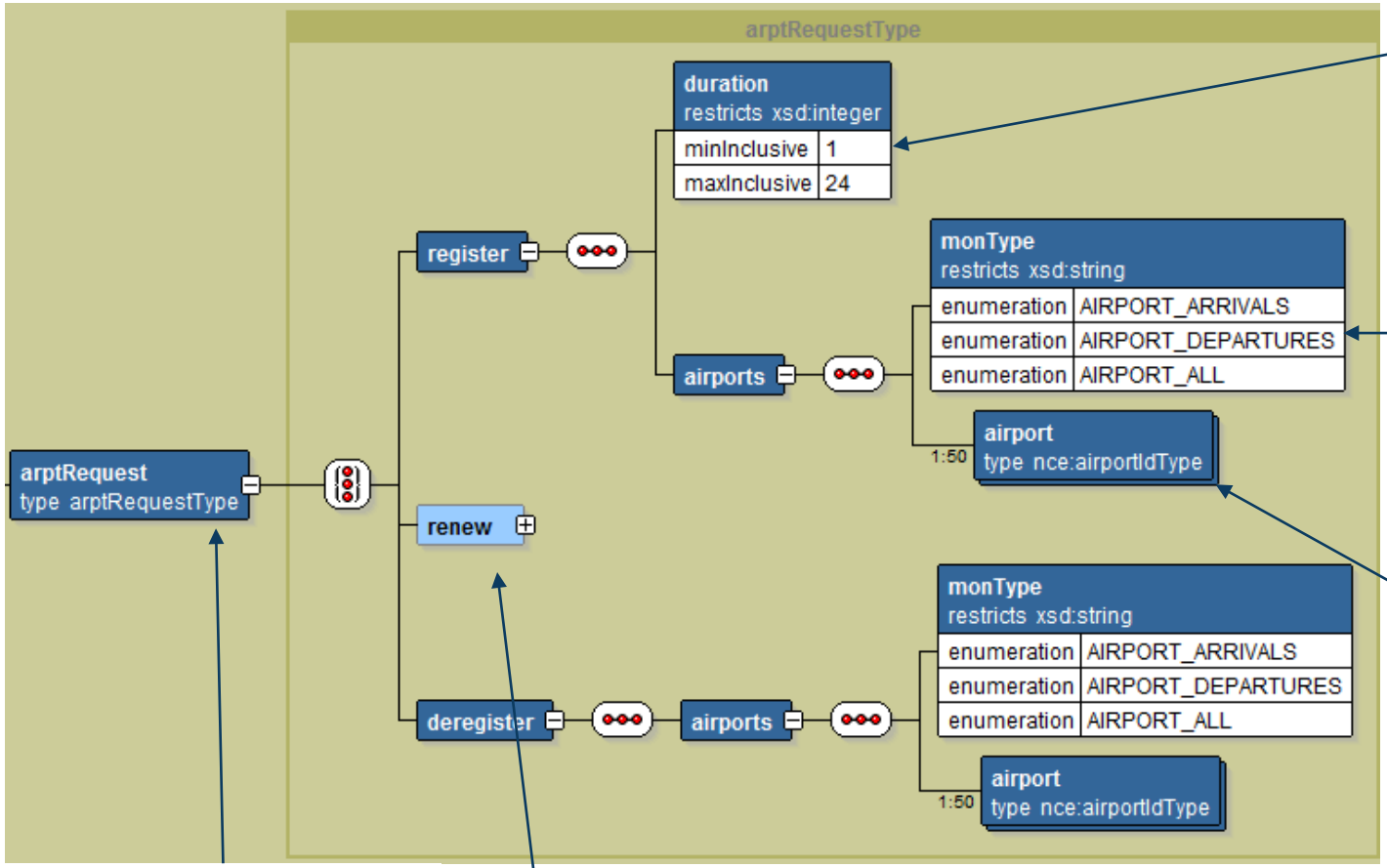
Airport Monitoring Request – TFMData Service Schema Location



Every request requires a service code.
The Airport Monitoring Request is coded **“ARPTM”**.

arptRequest element is further defined in the following slides.

Airport Monitoring Request – arptRequest Message Structure



Allows to register for airport flight information up to 24 hours into the future.

User can register for departure or arrival flight information, or both.
The specified monitoring type applies to all specified airports.

Though the schema allows for 50, TFMS currently limits up to 7 airports that can be registered in a single request.

arptRequest allows to register, de-register or renew airport flight data.

Renew option is structurally identical to register.

Airport Monitoring Request – ArptRequest Message Structure (Cont.)

```
<?xml version="1.0" encoding="UTF-8"?>
<tx:tfmDataService xmlns="urn:us:gov:dot:faa:atm:tfm:tfmrequestreplytypes"
xmlns:ax="http://www.fixm.aero/tfm/3.1"
xmlns:fdm="urn:us:gov:dot:faa:atm:tfm:flightdata"
xmlns:frt="urn:us:gov:dot:faa:atm:tfm:rapttimeline"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xmlns:tx="urn:us:gov:dot:faa:atm:tfm:tfmdataservice"
xmlns:fim="urn:us:gov:dot:faa:atm:tfm:flowinformation"
xmlns:fcm="urn:us:gov:dot:faa:atm:tfm:ficommonmessages"
xmlns:fce="urn:us:gov:dot:faa:atm:tfm:ficommondatatypes"
xmlns:fm2="urn:us:gov:dot:faa:atm:tfm:ficommonmessages2"
xmlns:nxce="urn:us:gov:dot:faa:atm:tfm:tfmdatacoreelements"
xmlns:nxcm="urn:us:gov:dot:faa:atm:tfm:flightdatacommonmessages">
  <tx:tfmRequestReply>
    <tx:request serviceCode="ARPTM">
      <requestId>
        <requestor>
          <fm2:center>TFM</fm2:center>
          <fm2:requestorId>TFM0001</fm2:requestorId>
        </requestor>
        <uniqueMsgId>4f65856f-8d75-4509-9af4-999991100332</uniqueMsgId>
        <replyOption>SUCC_OR_ERR_OR_WARN</replyOption>
      </requestId>
      <arptRequest>
        <register>
          <duration>1</duration>
          <airports>
            <monType>AIRPORT_DEPARTURES</monTyp>
            <airport>DEN</airport>
          </airports>
        </register>
      </arptRequest>
    </tx:request>
  </tx:tfmRequestReply>
</tx:tfmDataService>
```

User “TFM” registers for Flight updates during the next hour that depart from Denver airport.

Airport Monitoring Request – Response Message Structure

- **Airport Monitoring Request Reply**

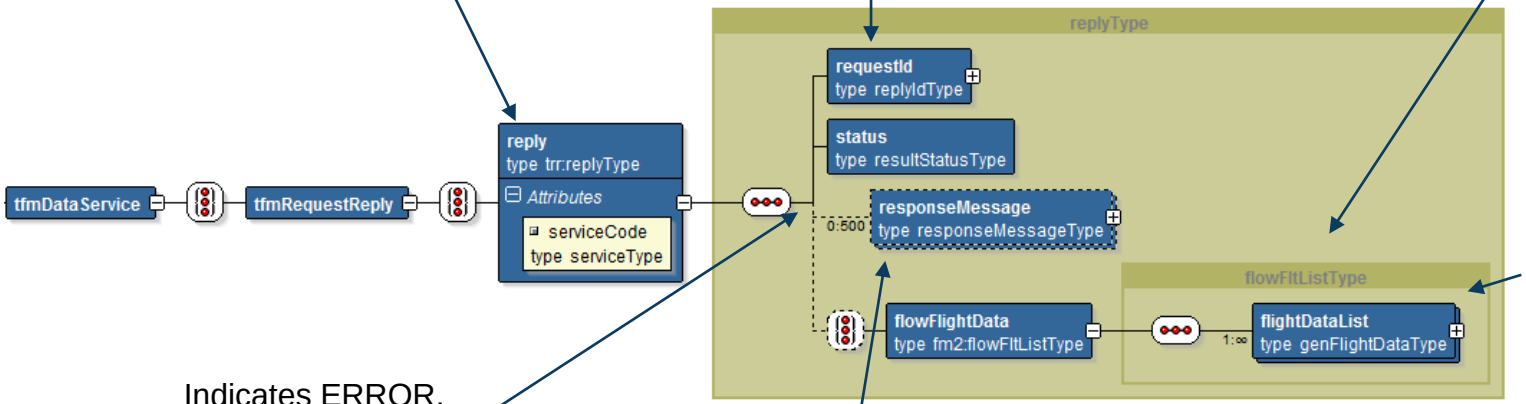
The serviceCode is also set to “ARPTM”.

The RequestId information issued in the request is mirrored back in the reply, to allow users to correlate the reply to the response.

FlightDataLists are returned when a valid monitoring request has been received.

Though the schema allows for infinite number of flights, TFMS currently limits them to 128.

Uses the generic flight data Type discussed in earlier exercises.



Indicates ERROR, PROCESSING, or SUCCESS.

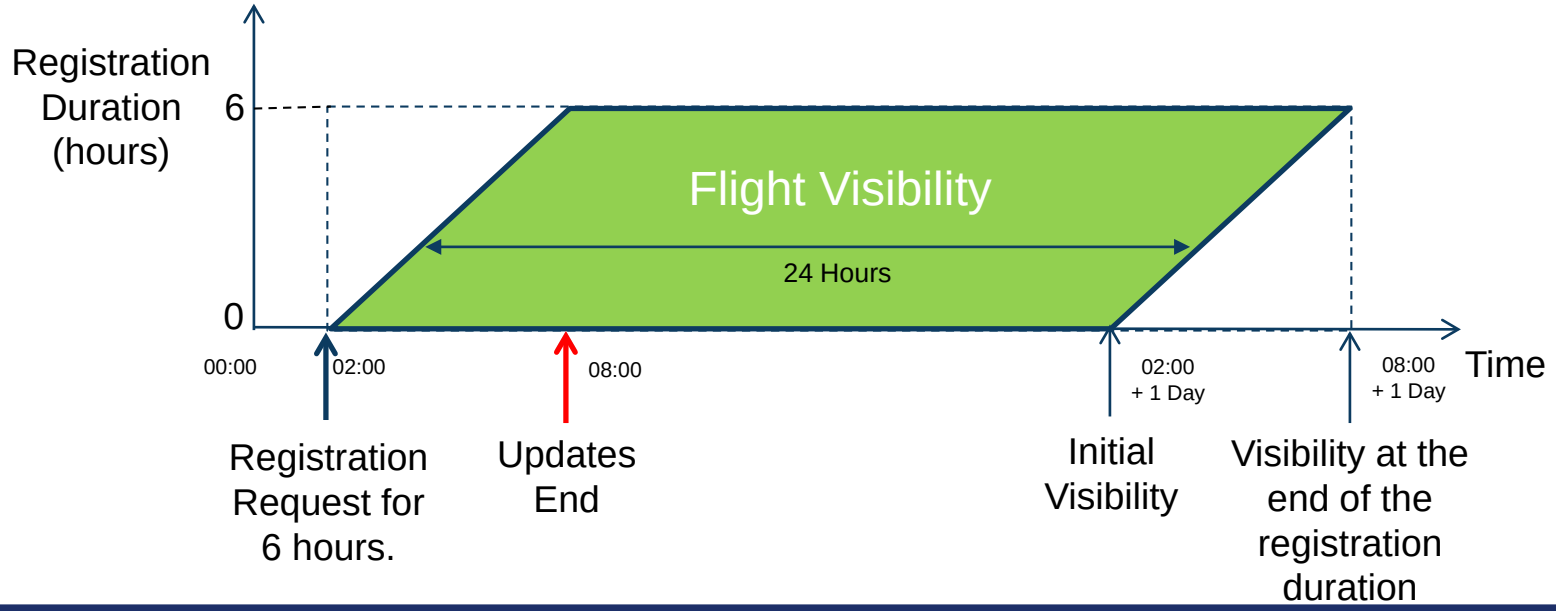
The optional “responseMessage” is only included in the response when an ERROR occurred. It provides a detailed description of the error.

Examples:

- Logical error: `“Airport ZZZ is not adapted.”`
- Validation error : “`The TFMData Request failed to process. Reason: cvc-pattern-valid: Value 'PHLxxx' is not facet-valid with respect to pattern '[a-zA-Z0-9]{3,5}[ ]{0,1}' for type 'airportIdType'.`”
  - Includes the original message in the reply.

Airport Monitoring Request – Flow Information Updates

- **Flow Information Updates**
  - Are being distributed during the registration duration.
  - Users receive updates for flights that:
    - Meet the user's registration criteria (airport, departure/arrival mode).
    - Are eligible for the user to receive (sensitivity, user access).
    - Fall into the 24-hour moving window ahead of the registration period.



Airport Monitoring Request – Flow Information Updates (Cont.)

- **Flow Information Updates**
  - Are issued when a flight change occurs.
  - Flow Information Updates are mainly driven by the following:
    - Events (external to TFMS) such as flight plan updates from the FAA or airlines.
    - New or amended Traffic Management Initiatives (TMIs).
    - Remodeling of Flight Trajectories.
    - Scheduled events such as OAG flight creation.
  - Flow Information Updates messages can contain multiple flights, but most likely will only contain data for a single flight due to the event-based nature of the interface.
    - User implementations have to assume that multiple flights are present in the message.

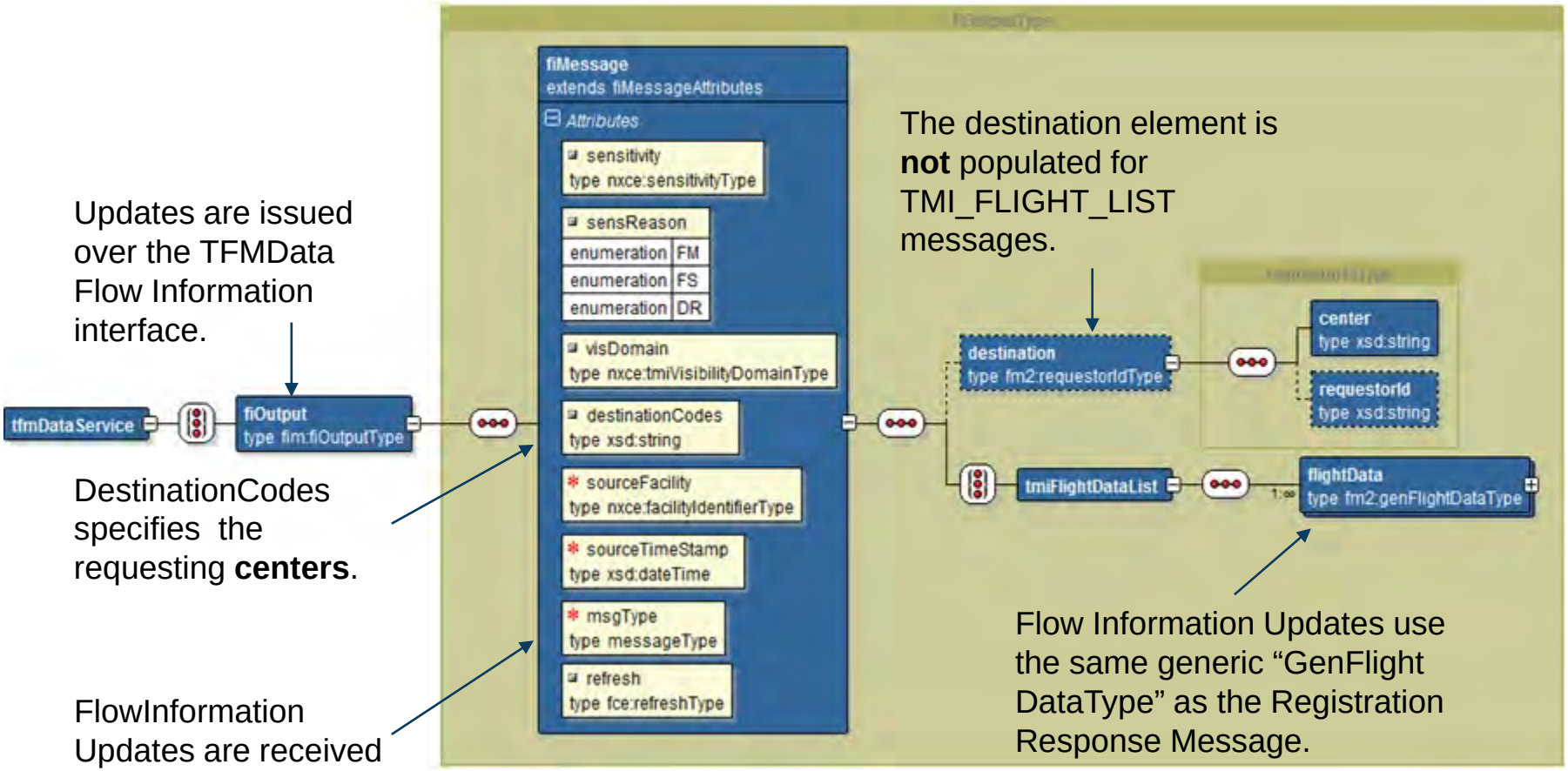
Airport Monitoring Request – Flow Information Updates (Cont.)

- **Flow Information Updates – Schema location**

Updates are issued over the TFMData Flow Information interface.

DestinationCodes specifies the requesting **centers**.

FlowInformation Updates are received with message type "**TMI_FLIGHT_LIST**".



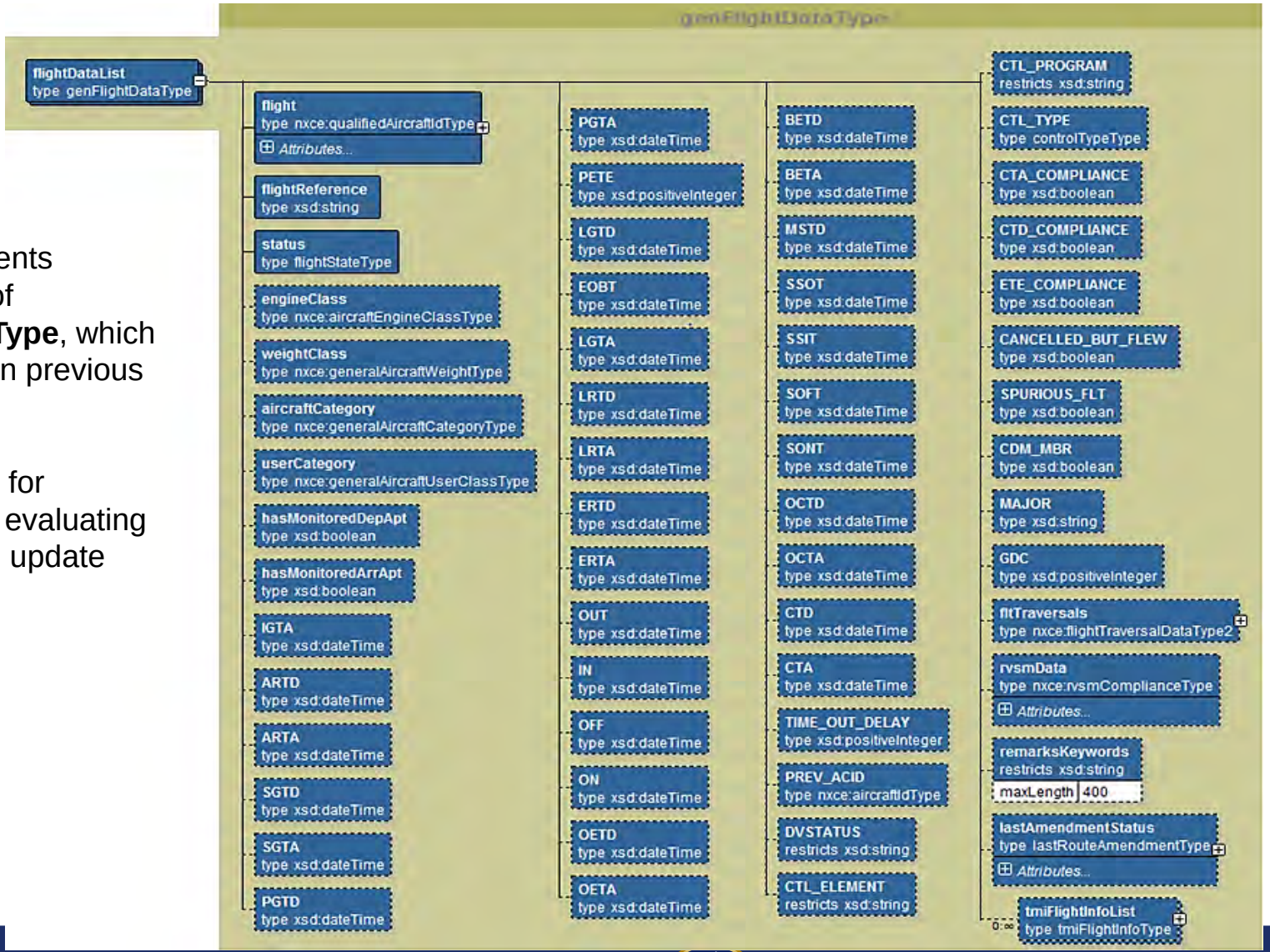
The destination element is **not** populated for TMI_FLIGHT_LIST messages.

Flow Information Updates use the same generic "GenFlight DataType" as the Registration Response Message.

Airport Monitoring Request – Response Message Structure

Note: The elements distributed are of **genFlightDataType**, which was discussed in previous exercises.

It is shown here for reference when evaluating actual reply and update messages.



Example Airport Monitoring Request/Response(s)

Airport Monitoring Request

- **Example: Sending the Airport Monitoring Request**
  - Objective
    - Issue a Airport Monitoring request JFK, requesting updates for all arriving and departing flights in the next 5 hours.
    - Examine reply information returned by TFMS.

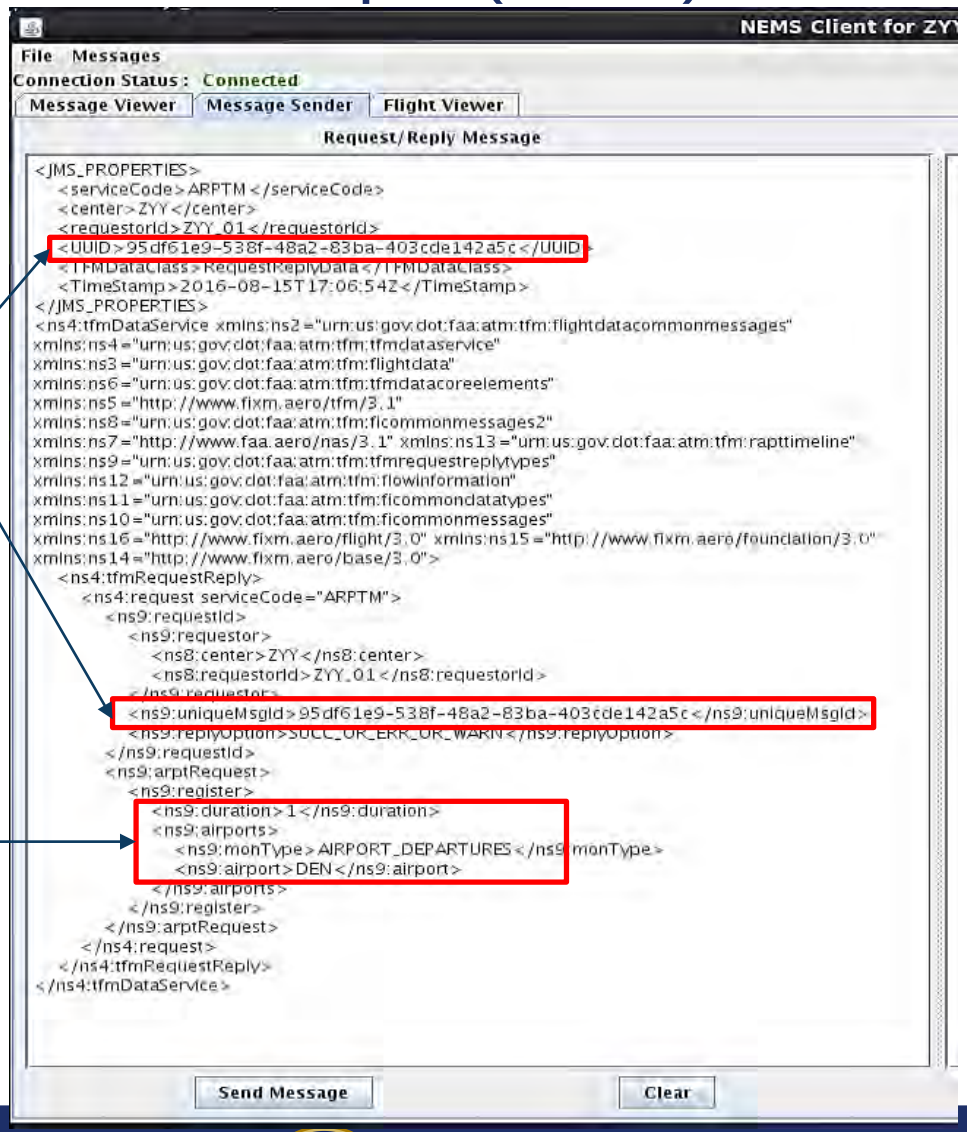
Airport Monitoring Request – Example (Cont.)

- An example Airport Monitoring Request Message is pictured.

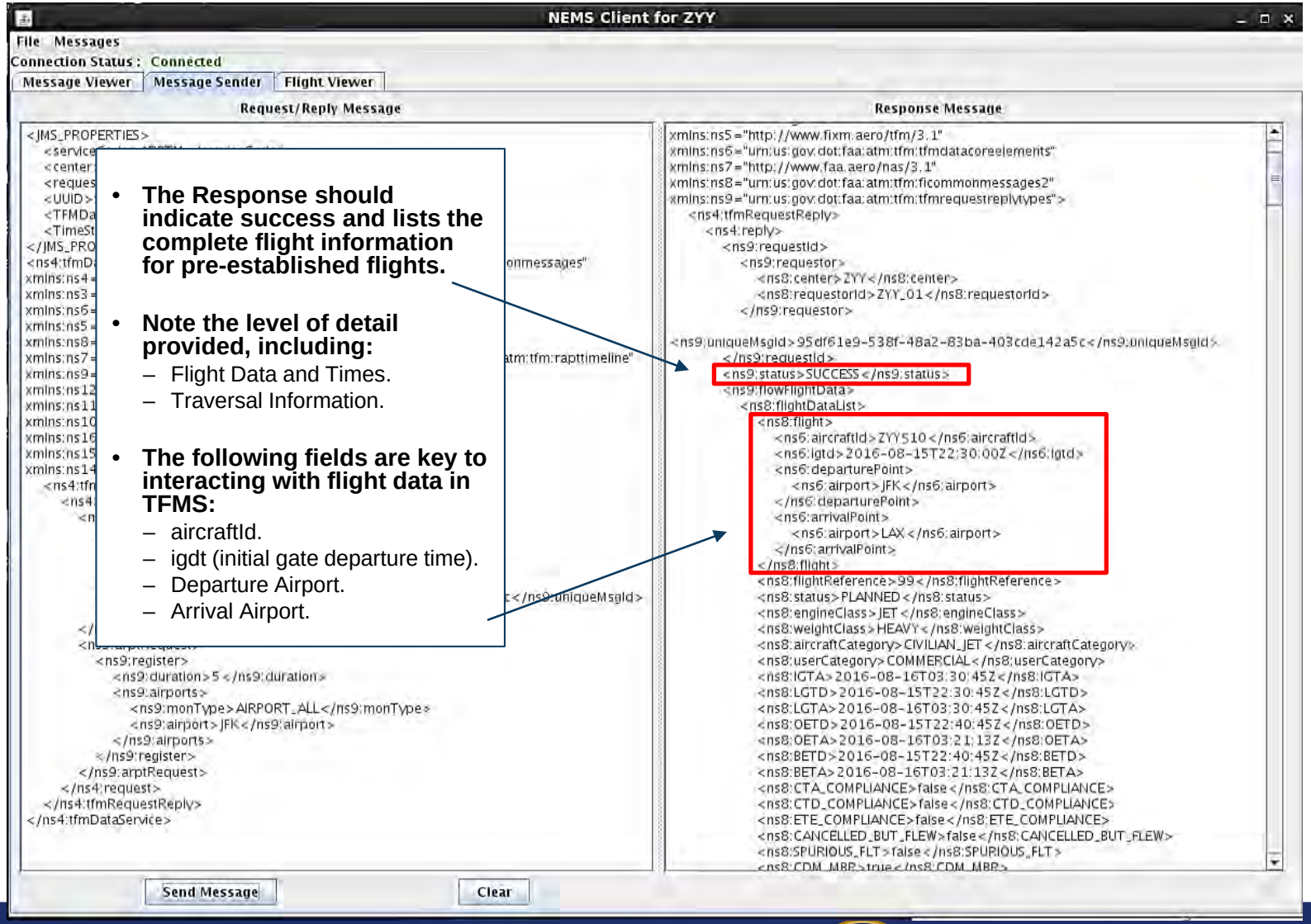
- The **UUID** in the JMS properties must match the value in the **uniqueMsgId** element within the message.
  - The UUID must be different for each request submitted.

- Assume the following changes from the shown template:
  - Registration **duration** to **5** (hours)
  - The **monType** to **AIPORT_ALL**
  - The **airport** to **JFK**

  in the message



Airport Monitoring Request – Example (Cont.)

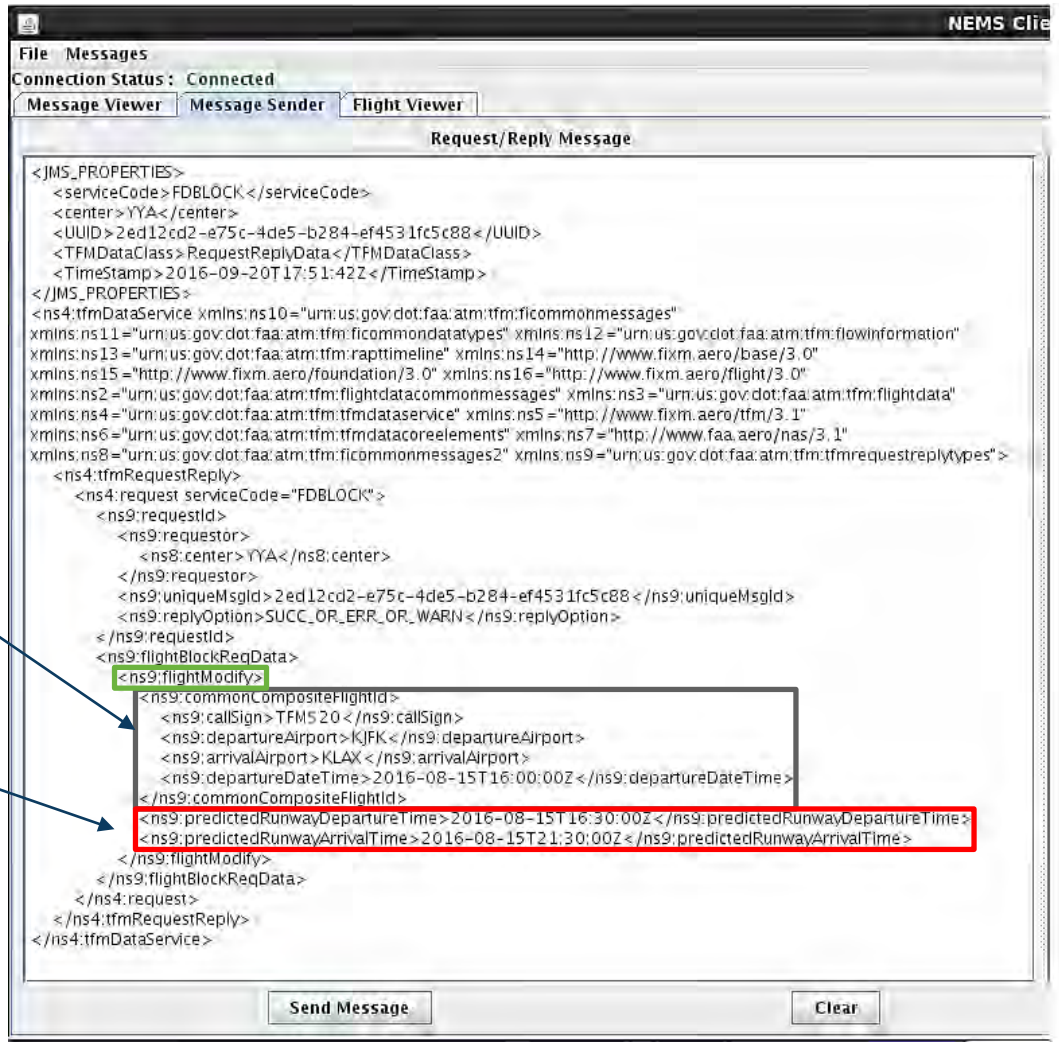


Airport Monitoring Request – Example (Cont.)

- **Example: Flow Information Updates triggered by Airline Input**
  - Objective
    - Verify that flight data updates are being distributed to the user over the flow information interface.
  - Test Setup
    - Change the departure time for one of the received flights, to initiate the re-distribution of the flight.
      - Use FlightModify Request/Reply interface.

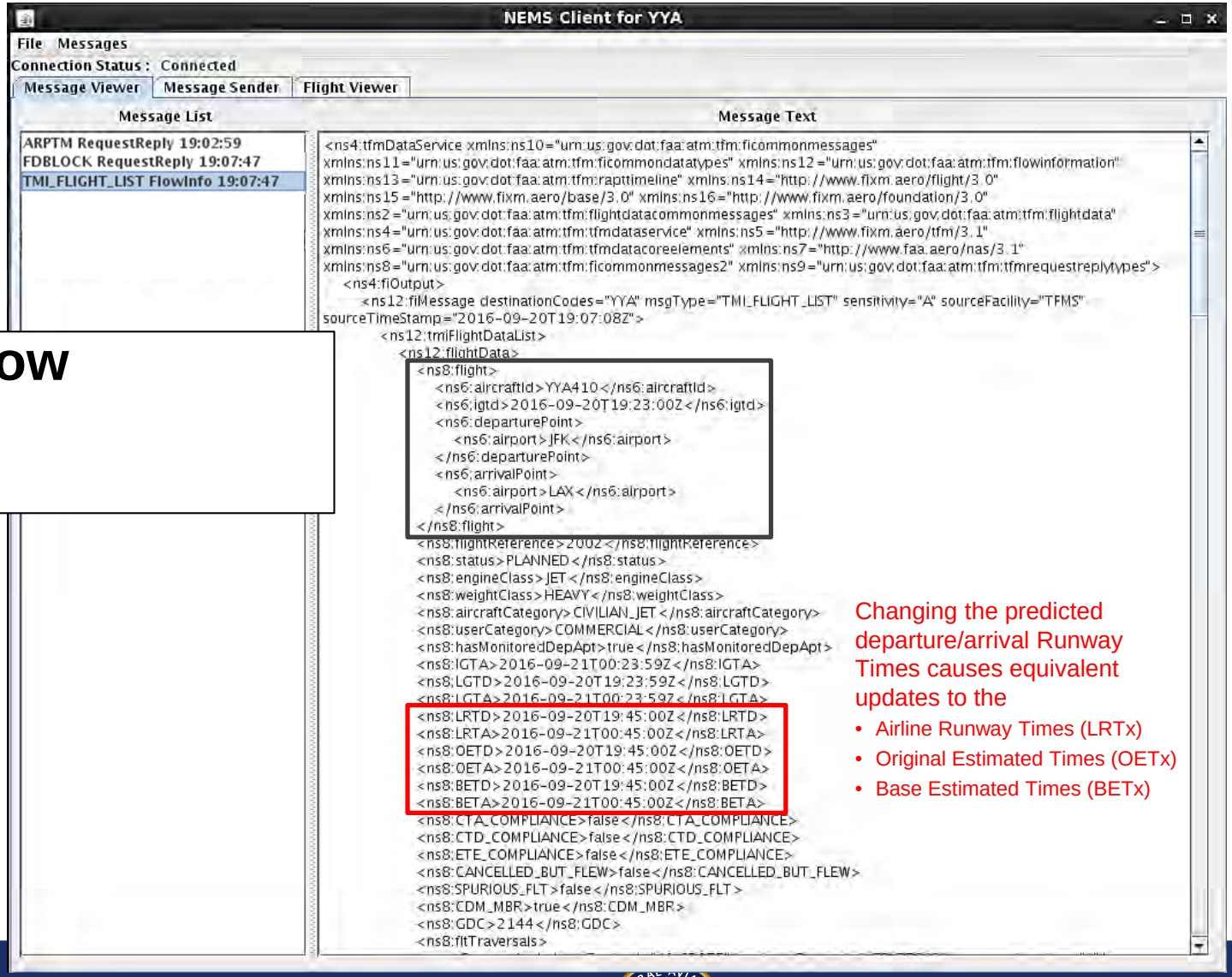
Airport Monitoring Request – Example (Cont.)

- An Example Request/Reply FlightModify Request message is pictured.
- Assume the use of Flight 510 data that was recorded in the previous slide.
  - Change the flight's:
    - Callsign
    - Departure Airport
    - Arrival Airport
    - DepartureDateTime (IGTD)
- Issue predicted runway times for Flight 510.



Airport Monitoring Request – Example (Cont.)

- **Resulting Flow Information Distribution.**

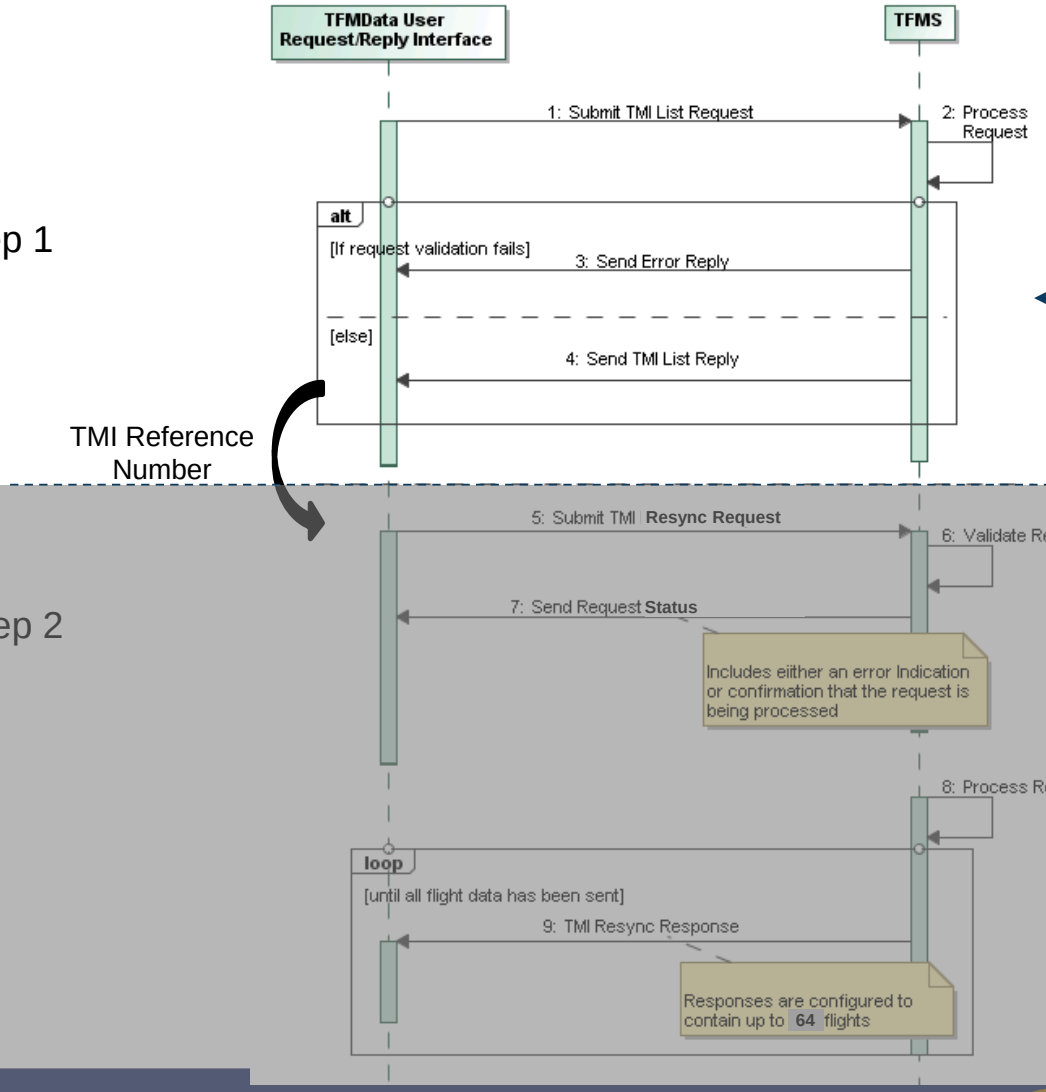


Part 2:
TMI List Requests

TMI List Request

- **Conceptual Background**
  - TMI Flight Lists are obtained in a two step process.
    - **Step 1**: If not already available at the users site, reference information for the TMIs needs to be gathered via a **TMI List Request**.
      - The TMI List reply returns a simple index structure for the TMI types specified in the request.
    - **Step 2**: Using the references received in the TMI List reply, the user can issue a **TMI Resync request** to obtain the flight information related to a specific TMI.
      - TFMS responds with multiple reply messages.
        - » A status message, indication that the request was invalid or is being successfully processed.
        - » Data message(s) after the request was fully processed and the data was gathered.
  - TMI Resync requests
    - Allows users to specify whether associated flight data should be returned.
    - TFMS restricts the number of resync requests.
      - Services up to **5 (five) concurrent** TMI Resync requests. Additional requests are queued.
      - A user can only issue a TMI Resync Request for a specific TMI only every **60 (sixty)** minutes.

TMI List Request – Sequence



Step 1

Obtaining TMI Index information.

Step 2

TFMS first validates the TMI Resync Request and replies with a status response.

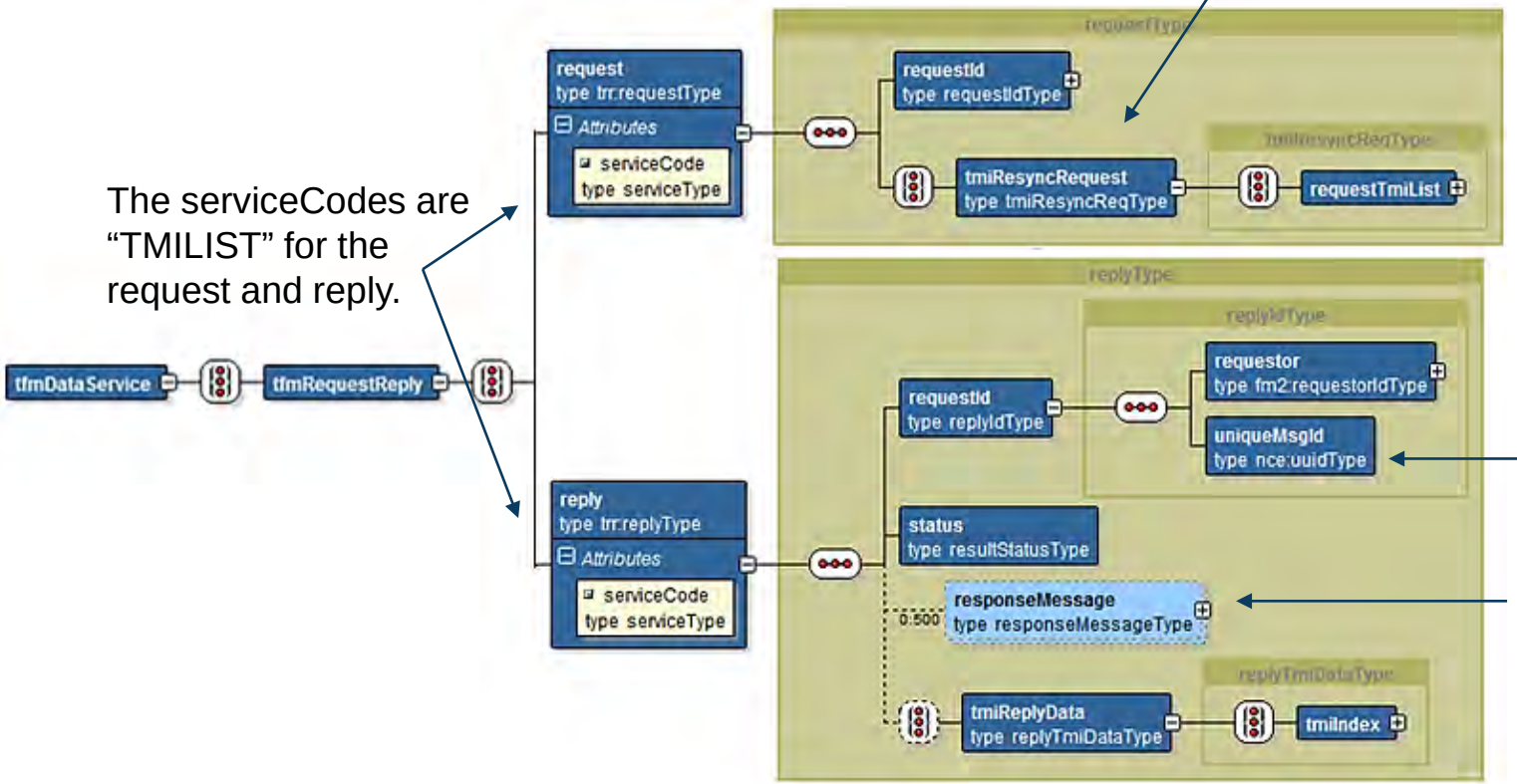
The flight data is returned once TFMS gathers the pertinent flight data for the request.
Flight data may be returned in one or more messages.

TMI List Request

- **TMI List Request/Reply Structure**

TMI List Request is part of the TMI Resync Request.

The serviceCodes are "TMILIST" for the request and reply.

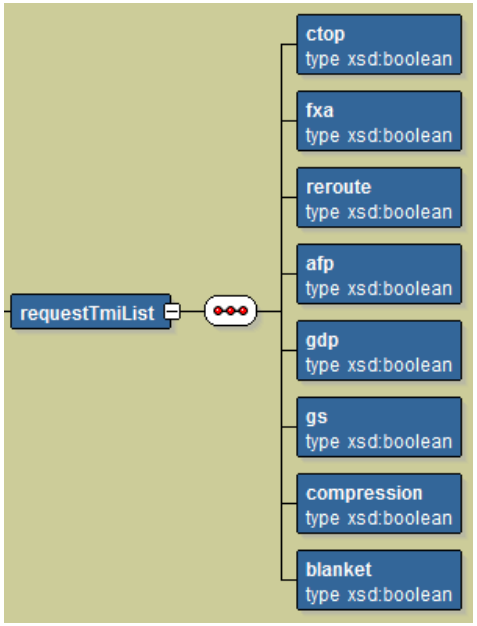


RequestId information is mirrored in the response.

A response Message is returned instead of the TmiIndex when an error situation is detected.

TMI List Request

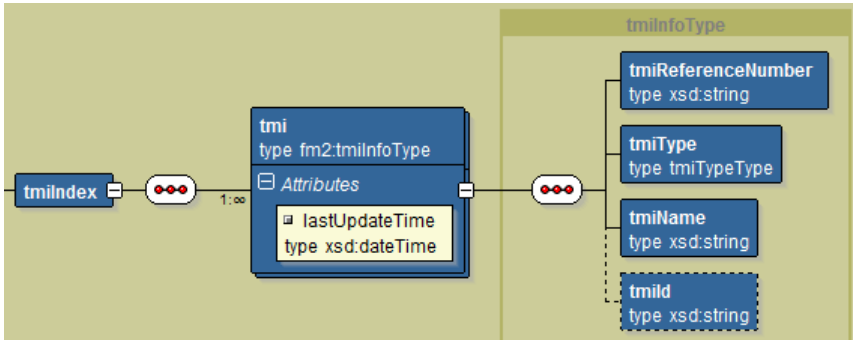
- **Schema Detail and Example Message**




```
1  <?xml version="1.0" encoding="UTF-8"?>
2  <ns4:tfmDataService xmlns:ns2="urn:us:gov:dot:faa:atm:tfm:flightdatacommonmessages"
3     .....
4  xmlns:ns15="http://www.fixm.aero/foundation/3.0" xmlns:ns14="http://www.fixm.aero/base/3.0">
5      <ns4:tfmRequestReply>
6          <ns4:request serviceCode="TMILIST">
7              <ns9:requestId>
8                  <ns9:requestor>
9                      <ns8:center>ZYA</ns8:center>
10                     <ns8:requestorId>ZYA-01</ns8:requestorId>
11                 </ns9:requestor>
12                 <ns9:uniqueMsgId>89f900f0-051f-4353-9963-b595eac809cc</ns9:uniqueMsgId>
13             </ns9:requestId>
14             <ns9:tmiResyncRequest>
15                 <ns9:requestTmiList>
16                     <ns9:ctop>true</ns9:ctop>
17                     <ns9:fxa>true</ns9:fxa>
18                     <ns9:reroute>true</ns9:reroute>
19                     <ns9:afp>true</ns9:afp>
20                     <ns9:gdp>true</ns9:gdp>
21                     <ns9:gs>true</ns9:gs>
22                     <ns9:compression>true</ns9:compression>
23                     <ns9:blanket>true</ns9:blanket>
24                 </ns9:requestTmiList>
25             </ns9:tmiResyncRequest>
26         </ns4:request>
27     </ns4:tfmRequestReply>
28 </ns4:tfmDataService>
```

TMI List Response

- **Schema Detail**



tmiIndex contains a list of all available TMIs that match the requested types.

Every TMI element include the lastUpdateTime of the TMI as an attribute.

tmiReferenceNumber needed to request the actual TMI definition in the next step.

```
<ns4:tfmDataService xmlns:ns16="http://www.fixm.aero/flight/3.0"
  .....
xmlns:ns3="urn:us:gov:dot:faa:atm:tfm:flightdata">
    <ns4:tfmRequestReply>
        <ns4:reply serviceCode="TMILIST">
            <ns9:requestId>
                <ns9:requestor>
                    <ns8:center>ZMA</ns8:center>
                    <ns8:requestorId>lxstn01</ns8:requestorId>
                </ns9:requestor>
                <ns9:uniqueMsgId>4cc58ccf-8d75-4509-9af4-cab7ceca0001</ns9:uniqueMsgId>
            </ns9:requestId>
            <ns9:status>SUCCESS</ns9:status>
            <ns9:tmiReplyData>
                <ns9:tmiIndex>
                    <ns9:tmi lastUpdateTime="2016-07-29T14:31:39Z">
                        <ns8:tmiReferenceNumber>6000101</ns8:tmiReferenceNumber>
                        <ns8:tmiType>CTOP</ns8:tmiType>
                        <ns8:tmiName>CTPCT</ns8:tmiName>
                        <ns8:tmiId>CTP001</ns8:tmiId>
                    </ns9:tmi>
                    <ns9:tmi lastUpdateTime="2016-07-29T14:29:35Z">
                        <ns8:tmiReferenceNumber>13001101</ns8:tmiReferenceNumber>
                        <ns8:tmiType>FXA</ns8:tmiType>
                        <ns8:tmiName>FCA002</ns8:tmiName>
                        <ns8:tmiId>FCA002</ns8:tmiId>
                    </ns9:tmi>
                </ns9:tmiIndex>
            </ns9:tmiReplyData>
        </ns4:reply>
    </ns4:tfmRequestReply>
</ns4:tfmDataService>
```

TMI Resync Request – Example

- **Example: Sending the TMI List Request**
  - Objective:
    - Issue a TMI List request to obtain TMI reference information.
    - View the replies that are returned by TFMS.

TMI List Request – Example

- Pictured is an example TMI List Request which would request information about all TMIs currently active in TFMS.

TMI List Response – Example

- The tmiReferenceNumber is used to request TMI Definitions and flight lists in a subsequent request.

Note:
When none of the requested TMIs are present in the system, TFMS returns a warning.

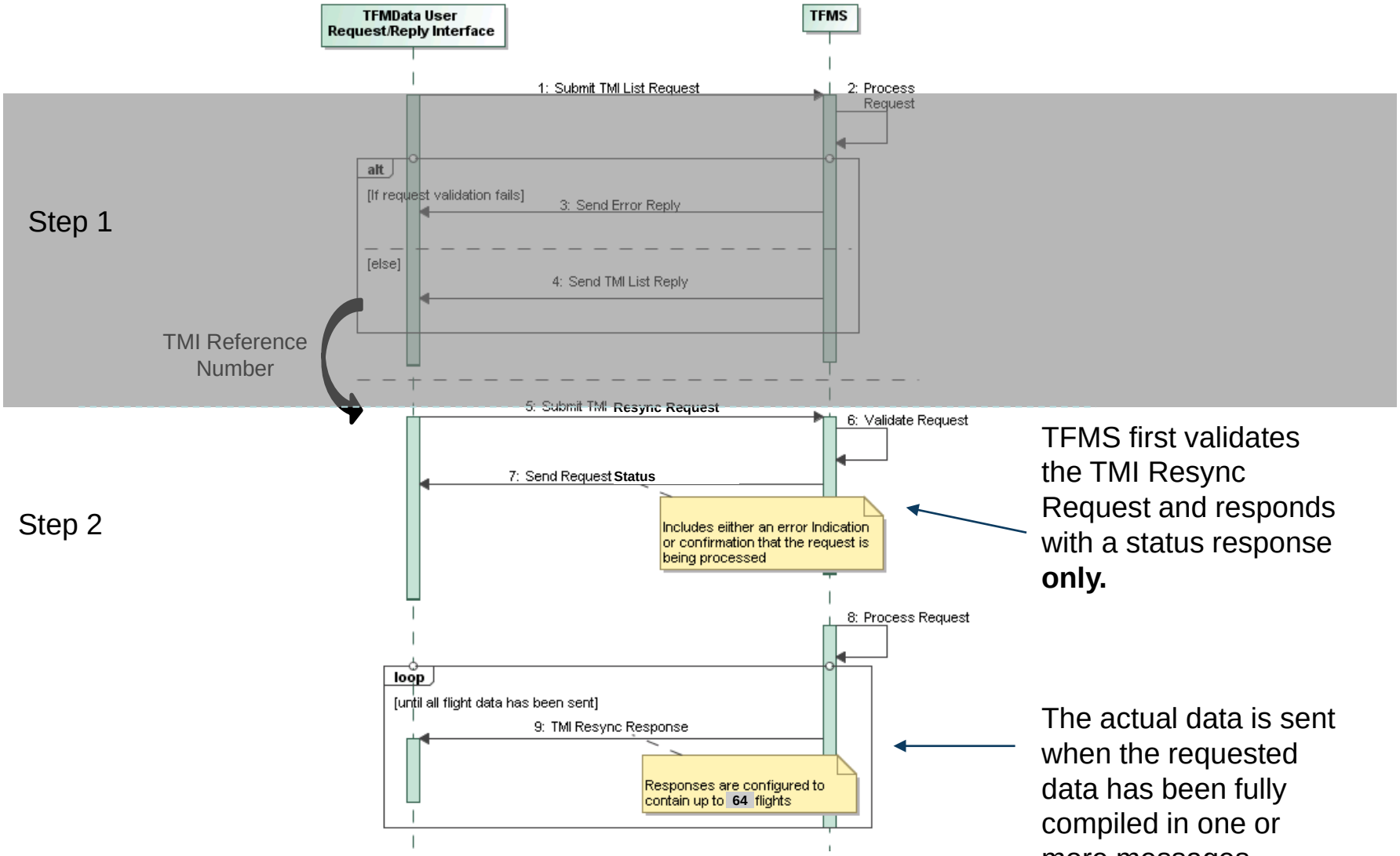
```
<ns4:tfmRequestReply>
  <ns4:reply serviceCode="TMILIST">
    <ns9:requestId>
      <ns9:requestor>
        <ns8:center>YYZ</ns8:center>
        <ns8:requestorId>YYZ_01</ns8:requestorId>
      </ns9:requestor>
      <ns9:uniqueMsgId>bf91a551-2dd9-4d29-9a75-f3d368df29ff</ns9:uniqueMsgId>
    </ns9:requestId>
    <ns9:status>WARNING</ns9:status>
    <ns9:responseMessage>
      <ns9:description>There are no TMIs to include in the TMI Resync List
request.</ns9:description>
    </ns9:responseMessage>
  </ns4:reply>
</ns4:tfmRequestReply>
</ns4:tfmDataService>
```

Response Message

```
<ns4:tfmDataService xmlns:ns10="urn:us:gov:dot:faa:atm:tfm:ficommonmessages"
xmlns:ns11="urn:us:gov:dot:faa:atm:tfm:ficommondatatypes"
xmlns:ns12="urn:us:gov:dot:faa:atm:tfm:flowinformation"
xmlns:ns13="urn:us:gov:dot:faa:atm:tfm:rapttimeline"
xmlns:ns14="http://www.fixm.aero/base/3.0"
xmlns:ns15="http://www.fixm.aero/foundation/3.0"
xmlns:ns16="http://www.fixm.aero/flight/3.0"
xmlns:ns2="urn:us:gov:dot:faa:atm:tfm:flightdatacommonmessages"
xmlns:ns3="urn:us:gov:dot:faa:atm:tfm:flightdata"
xmlns:ns4="urn:us:gov:dot:faa:atm:tfm:tfmdataservice"
xmlns:ns5="http://www.fixm.aero/tfm/3.1"
xmlns:ns6="urn:us:gov:dot:faa:atm:tfm:tfmdatacoreelements"
xmlns:ns7="http://www.faa.aero/nas/3.1"
xmlns:ns8="urn:us:gov:dot:faa:atm:tfm:ficommonmessages2"
xmlns:ns9="urn:us:gov:dot:faa:atm:tfm:tfmrequestreplytypes">
  <ns4:tfmRequestReply>
    <ns4:reply serviceCode="TMILIST">
      <ns9:requestId>
        <ns9:requestor>
          <ns8:center>YYX</ns8:center>
          <ns8:requestorId>YYX_01</ns8:requestorId>
        </ns9:requestor>

<ns9:uniqueMsgId>4fcd95cc-0315-4387-9a96-93c930ceb38a</ns9:uniqueMsgId>
      </ns9:requestId>
      <ns9:status>SUCCESS</ns9:status>
      <ns9:tmiReplyData>
        <ns9:tmiIndex>
          <ns9:tmi lastUpdateTime="2016-08-17T13:13:08Z">
            <ns8:tmiReferenceNumber>3</ns8:tmiReferenceNumber>
            <ns8:tmiType>FXA</ns8:tmiType>
            <ns8:tmiName>FCA002</ns8:tmiName>
            <ns8:tmiId>FCA002</ns8:tmiId>
          </ns9:tmi>
          <ns9:tmi lastUpdateTime="2016-08-17T12:57:41Z">
            <ns8:tmiReferenceNumber>2</ns8:tmiReferenceNumber>
            <ns8:tmiType>FXA</ns8:tmiType>
            <ns8:tmiName>FCA001</ns8:tmiName>
            <ns8:tmiId>FCA001</ns8:tmiId>
          </ns9:tmi>
          <ns9:tmi lastUpdateTime="2016-08-17T15:00:05Z">
            <ns8:tmiReferenceNumber>4</ns8:tmiReferenceNumber>
            <ns8:tmiType>FXA</ns8:tmiType>
            <ns8:tmiName>FCA003</ns8:tmiName>
            <ns8:tmiId>FCA003</ns8:tmiId>
          </ns9:tmi>
        </ns9:tmiIndex>
      </ns9:tmiReplyData>
    </ns4:reply>
  </ns4:tfmRequestReply>
</ns4:tfmDataService>
```

TMI List Request – Sequence



TFMS first validates the TMI Resync Request and responds with a status response **only.**

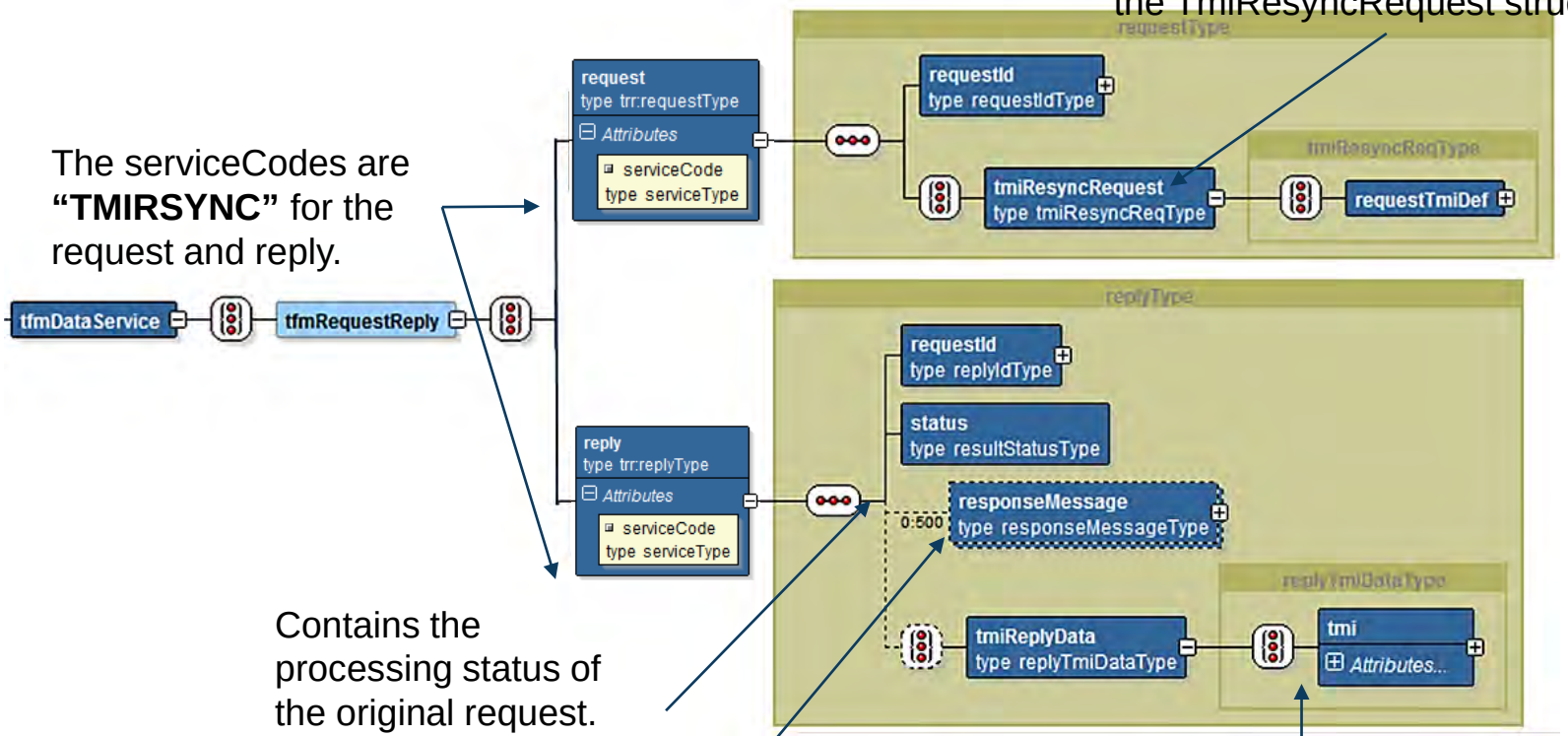
The actual data is sent when the requested data has been fully compiled in one or more messages.

TMI Resync Request

- **TMI Resync Request/Reply Structure**

TMI Definition Request is part of the TmiResyncRequest structure.

The serviceCodes are **"TMIRSYNC"** for the request and reply.



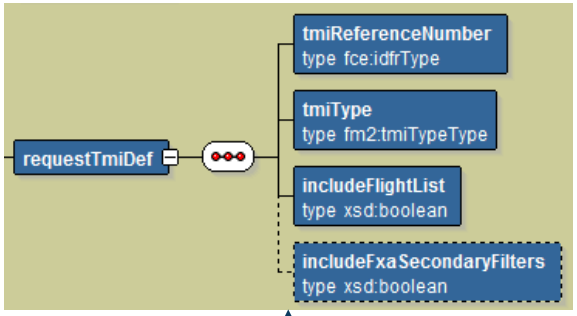
Contains the processing status of the original request.

Initial Response Message is issued to acknowledge that the request is being processed, or that an error was encountered.

Provides the TMI definition details and related flight information, if requested.

TMI Resync Request – Request TMI Definition

- **Schema Detail**



Allows to request secondary Filter information.

TMIReferenceNumber from previous request.

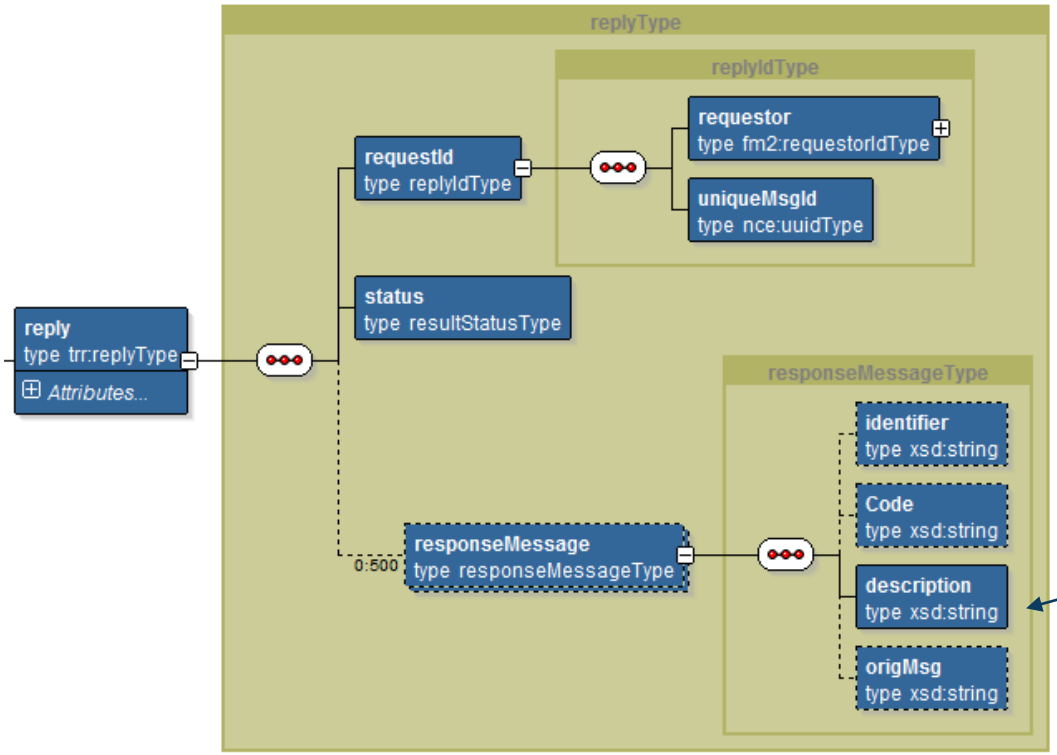
Option to request the associated Flight list and secondary filter information.

Sample Message

```
1  <?xml version="1.0" encoding="UTF-8"?>
2  <ns4:tfmDataService xmlns:ns2="urn:us:gov:dot:faa:atm:tfm:flightdatacommonmessages"
3    .....
4  xmlns:ns14="http://www.fixm.aero/base/3.0">
5      <ns4:tfmRequestReply>
6          <ns4:request serviceCode="TMIRSYNC">
7              <ns9:requestId>
8                  <ns9:requestor>
9                      <ns8:center>YYA</ns8:center>
10                     <ns8:requestorId>YYA_01</ns8:requestorId>
11                 </ns9:requestor>
12                 <ns9:uniqueMsgId>c66524a5-7caf-42c5-bfcd-e87dc5ee37df</ns9:uniqueMsgId>
13             </ns9:requestId>
14             <ns9:tmiResyncRequest>
15                 <ns9:requestTmiDef>
16                     <ns9:tmiReferenceNumber>13001101</ns9:tmiReferenceNumber>
17                     <ns9:tmiType>FXA</ns9:tmiType>
18                     <ns9:includeFlightList>true</ns9:includeFlightList>
19                     <ns9:includeFxaSecondaryFilters>true</ns9:includeFxaSecondaryFilters>
20                 </ns9:requestTmiDef>
21             </ns9:tmiResyncRequest>
22         </ns4:request>
23     </ns4:tfmRequestReply>
24 </ns4:tfmDataService>
```

TMI Resync Request – TMI Definition Responses

1st Reply Message : Status



If an **invalid** request was issued or TFMS encountered an error during processing one reply message is returned to the client with:

- status set to ERROR.
- responseMessage provides a detailed description of the error.

Every TMI Definition Request receives a status reply that contains:

- RequestId to correlate the reply to the response (uniqueMsgId).
- Processing Status Indicator.
- Response Message.

If TFMS was able to successfully process, the request:

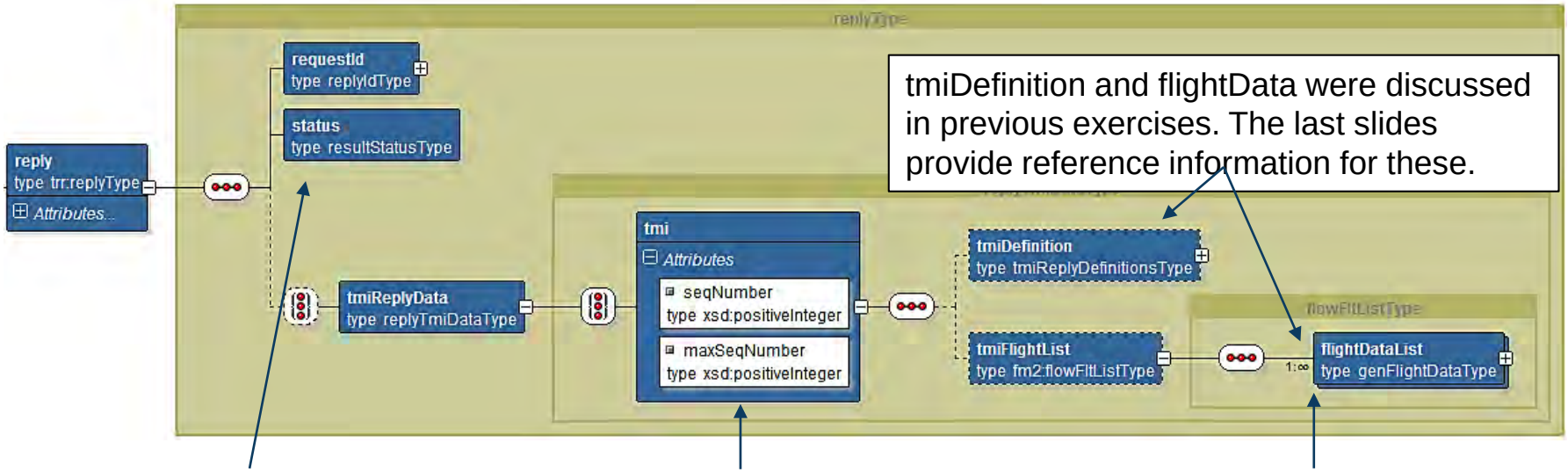
- Status is set to PROCESSING.
- The description in the responseMessage is set to

"TMI Resync request has been received, validated, and queued. Resynchronization processing will begin as soon as TFMS resources allow."

TMI Resync Request – TMI Definition Responses (Cont.)

2nd – Final Response Message(s): Data

Every successfully processed TMI Definition Request causes at least one ***data*** reply, which contains the TMI definition, and if requested , the associated flight data information.



Status values:

- SUCCESS in the last reply message,
- PROCESSING in all but the last reply message.

Client processing should utilize

- uniqueMsgId in the requestId to correlate the reply to the request.
- seqNumber and maxSeqNumber attributes to track progress.

Note: Messages may not be received in sequence.

Though the schema allows an infinite number of flights in a reply message, TFMS currently limits the number of flights per message to 64. Additional reply messages will then only contain tmiflightList information (the tmiDefinition is not repeated).

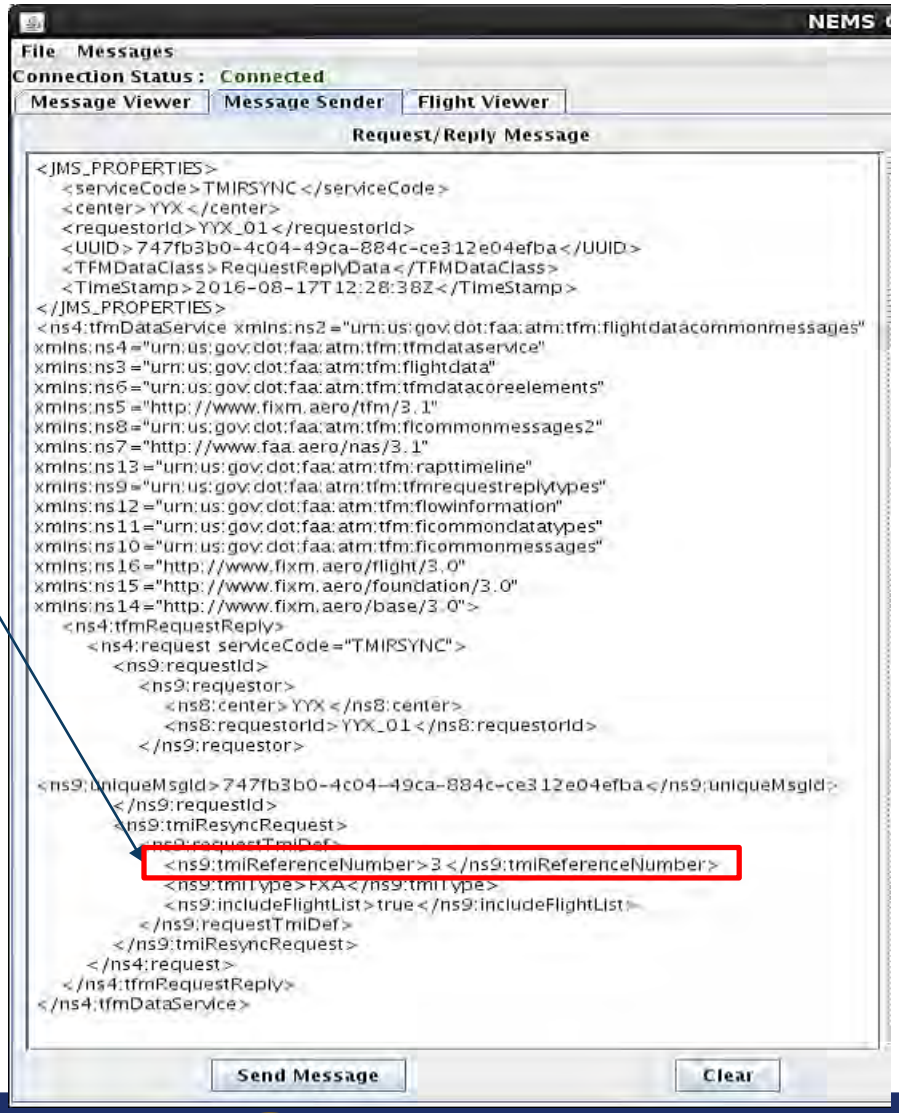
TMI Resync Request – Example

- **Example: Sending the TMI Resync Request**
  - Objective:
    - Issue a TMI Resync request to obtain TMI definitions and associated flight lists.
    - View the replies that are returned by TFMS.

TMI Resync Request – Example

- tmiReferenceNumber returned by the list response is used to identify TMIs to resync.

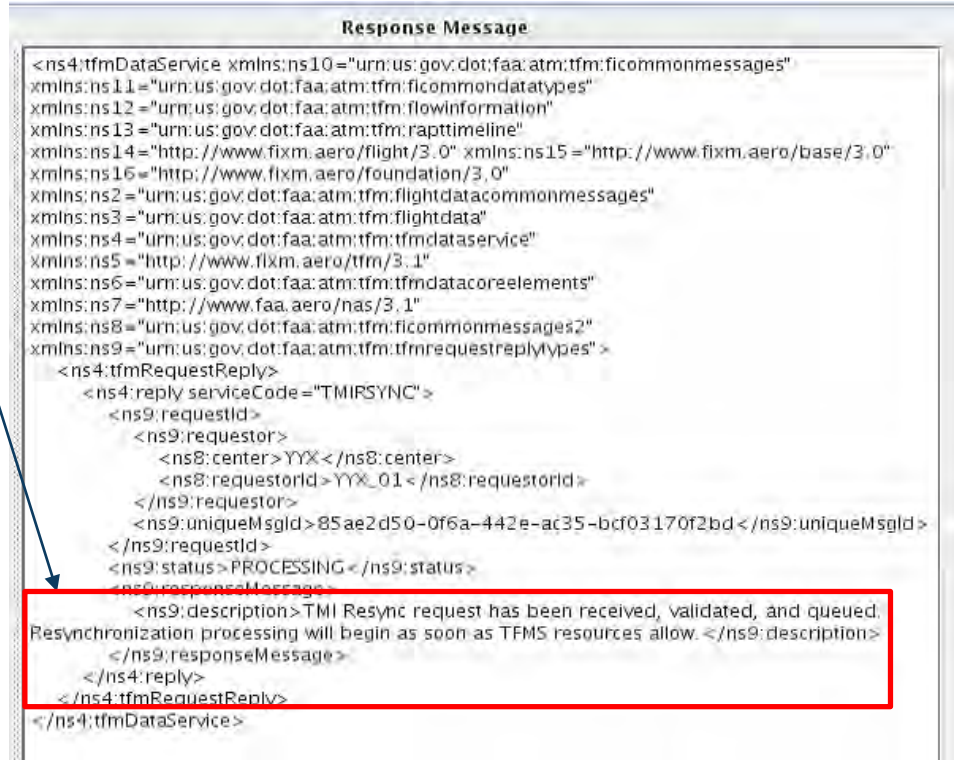
- What to expect:
  - Two reply messages will be returned
    - Status.
    - Resync Data Message(s).



TMI Resync Responses – Example

- The initial Resync reply message confirms the receipt of a valid TMIResyncRequest.
- Note: If the request was invalid the initial TMI reply contains the error information, indicating that TFMS aborted the processing for this request, and no further messages will be published.

Response Message



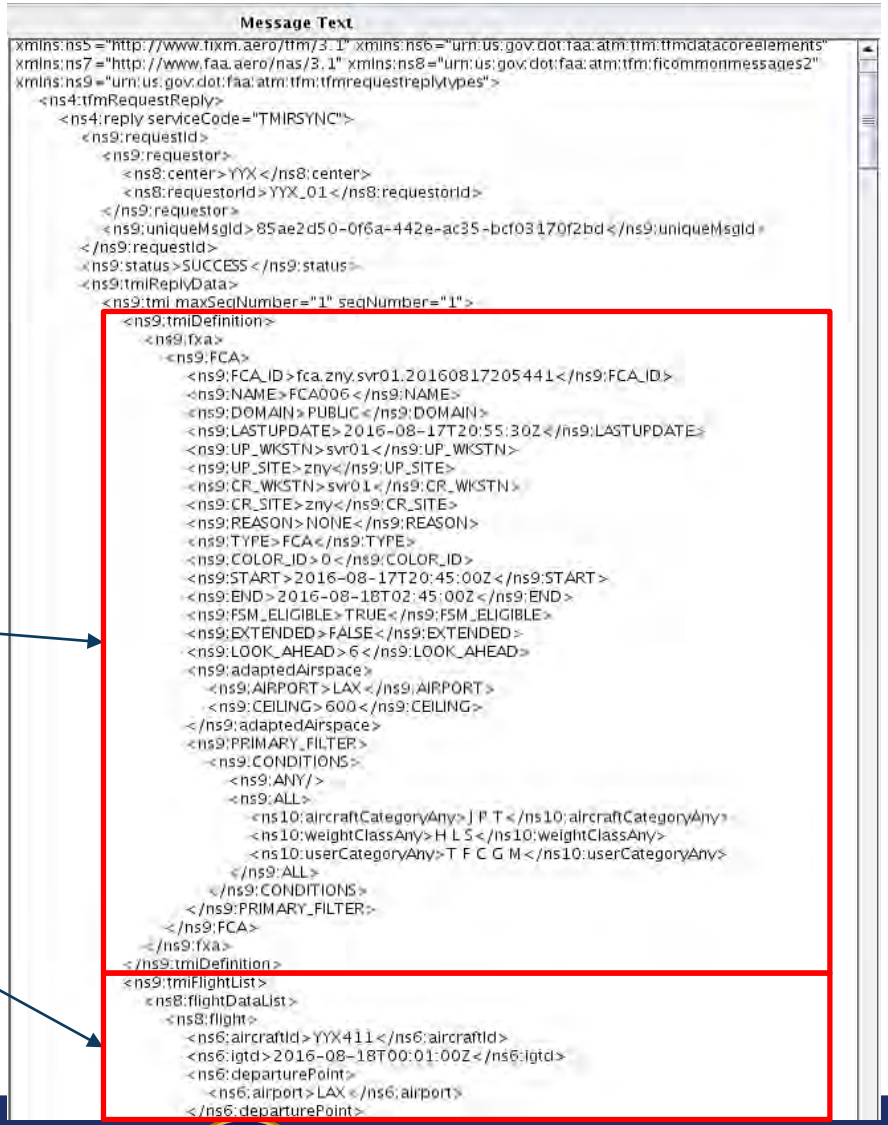
```
<ns4:tfmDataService xmlns:ns10="urn:us:gov:dot:faa:atm:tfm:ficommonmessages"
xmlns:ns11="urn:us:gov:dot:faa:atm:tfm:ficommondatatypes"
xmlns:ns12="urn:us:gov:dot:faa:atm:tfm:flowinformation"
xmlns:ns13="urn:us:gov:dot:faa:atm:tfm:rapttimeline"
xmlns:ns14="http://www.fixm.aero/flight/3.0" xmlns:ns15="http://www.fixm.aero/base/3.0"
xmlns:ns16="http://www.fixm.aero/foundation/3.0"
xmlns:ns2="urn:us:gov:dot:faa:atm:tfm:flightdatacommonmessages"
xmlns:ns3="urn:us:gov:dot:faa:atm:tfm:flightdata"
xmlns:ns4="urn:us:gov:dot:faa:atm:tfm:tfmdataservice"
xmlns:ns5="http://www.fixm.aero/tfm/3.1"
xmlns:ns6="urn:us:gov:dot:faa:atm:tfm:tfmdatacoreelements"
xmlns:ns7="http://www.faa.aero/nas/3.1"
xmlns:ns8="urn:us:gov:dot:faa:atm:tfm:ficommonmessages2"
xmlns:ns9="urn:us:gov:dot:faa:atm:tfm:tfmrequestreplytypes">
   <ns4:tfmRequestReply>
      <ns4:reply serviceCode="TMIRSYNC">
         <ns9:requestId>
            <ns9:requestor>
               <ns8:center>YYX</ns8:center>
               <ns8:requestorId>YYX_01</ns8:requestorId>
            </ns9:requestor>
            <ns9:uniqueMsgId>85ae2d50-0f6a-442e-ac35-bcf03170f2bd</ns9:uniqueMsgId>
         </ns9:requestId>
         <ns9:status>PROCESSING</ns9:status>
         <ns9:responseMessage>
            <ns9:description>TMI Resync request has been received, validated, and queued.
Resynchronization processing will begin as soon as TFMS resources allow.</ns9:description>
         </ns9:responseMessage>
      </ns4:reply>
   </ns4:tfmRequestReply>
</ns4:tfmDataService>
```

```
<ns4:tfmRequestReply>
   <ns4:reply serviceCode="TMIRSYNC">
      <ns9:requestId>
         <ns9:requestor>
            <ns8:center>YYX</ns8:center>
            <ns8:requestorId>YYX_01</ns8:requestorId>
         </ns9:requestor>
         <ns9:uniqueMsgId>747fb3b0-4c04-49ca-884c-ce312e04efb5</ns9:uniqueMsgId>
      </ns9:requestId>
      <ns9:status>ERROR</ns9:status>
      <ns9:responseMessage>
         <ns9:description>There was no FXA associated with reference number 10.</ns9:description>
      </ns9:responseMessage>
   </ns4:reply>
</ns4:tfmRequestReply>
```

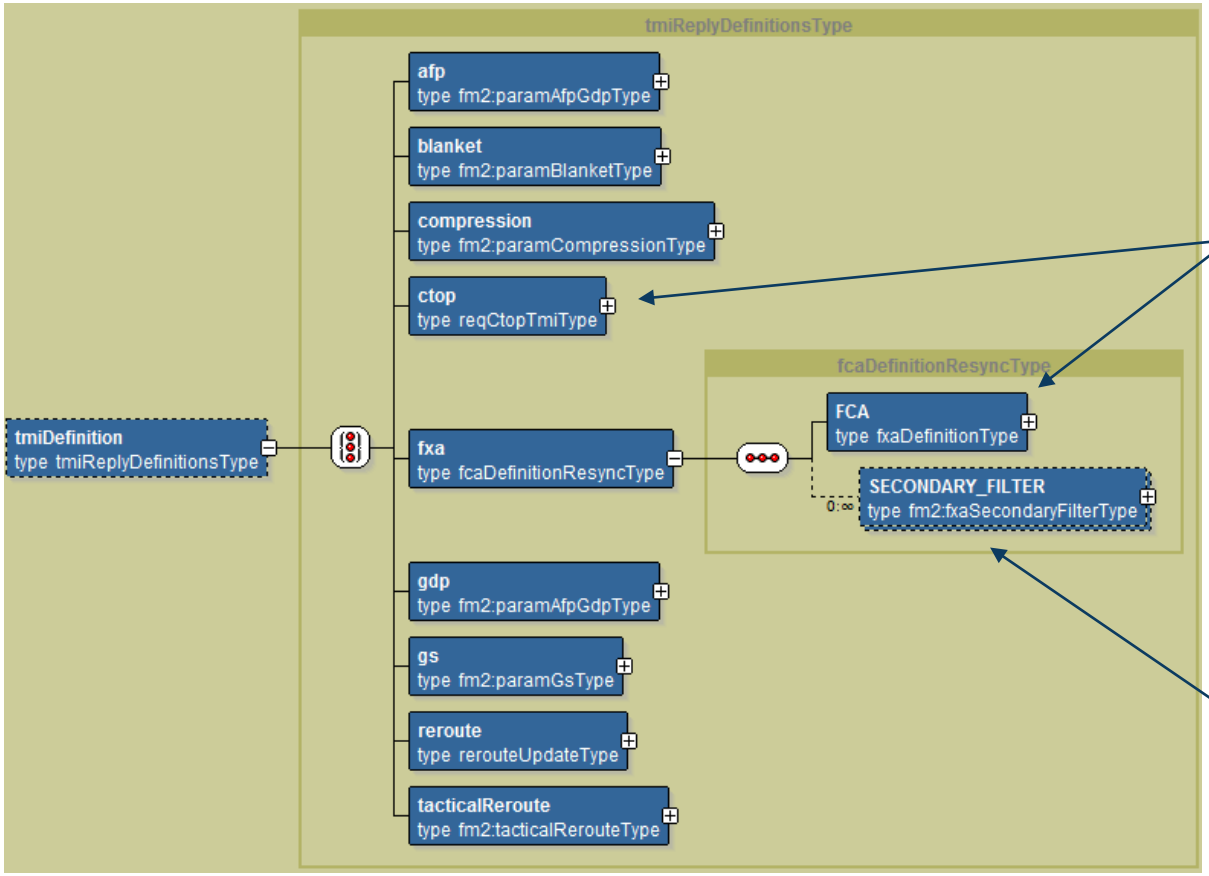
TMI Resync Responses – Example(Cont.)

- The Resync Data reply can consist of multiple messages if the number of impacted flights exceeds 64.

- The reply includes:
  - The complete TMI definition (only in the first data reply).
  - All flights impacted by the TMI, identify the intersection information with the TMI.



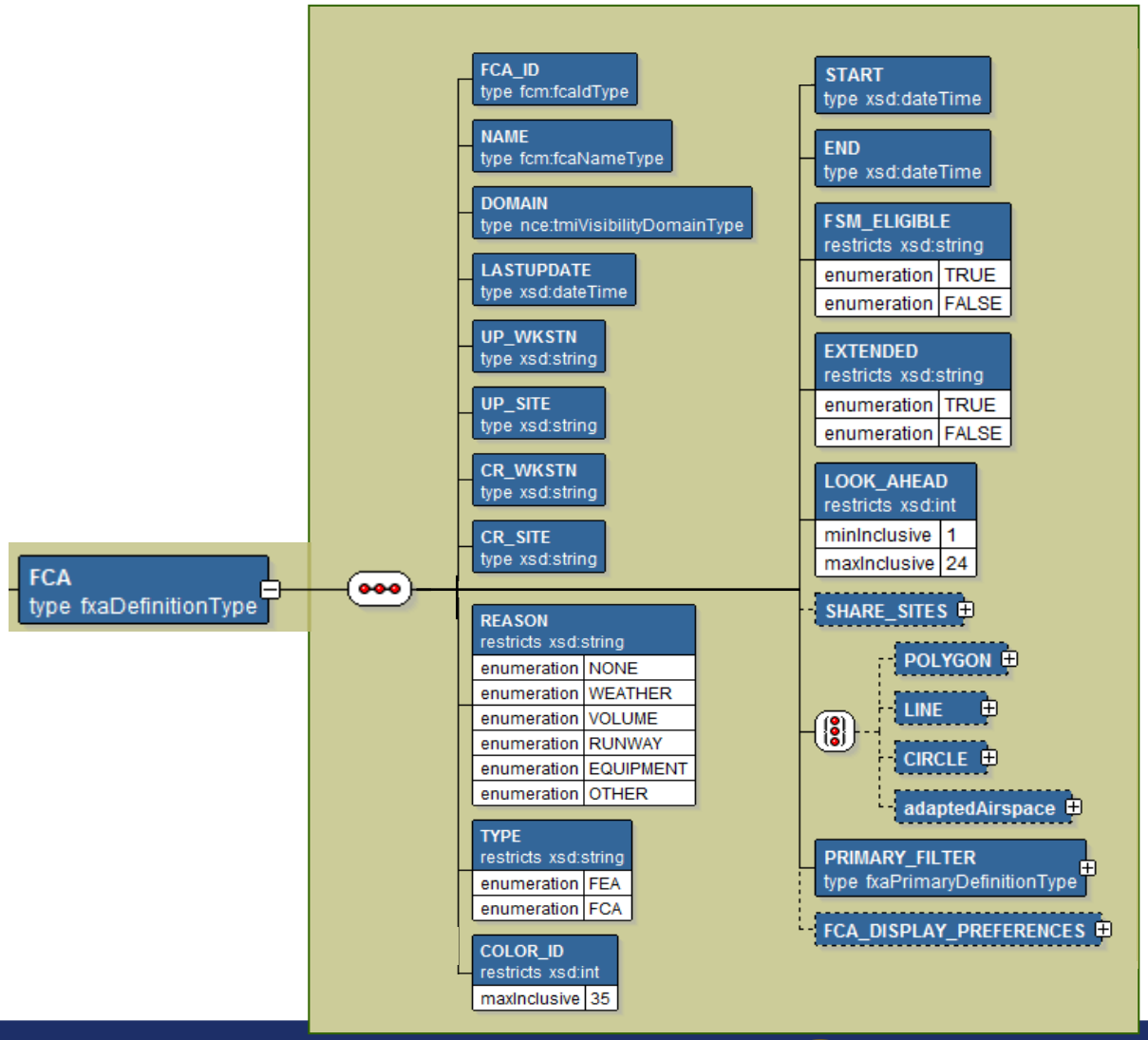
TMI Resync Reply – Schema Detail



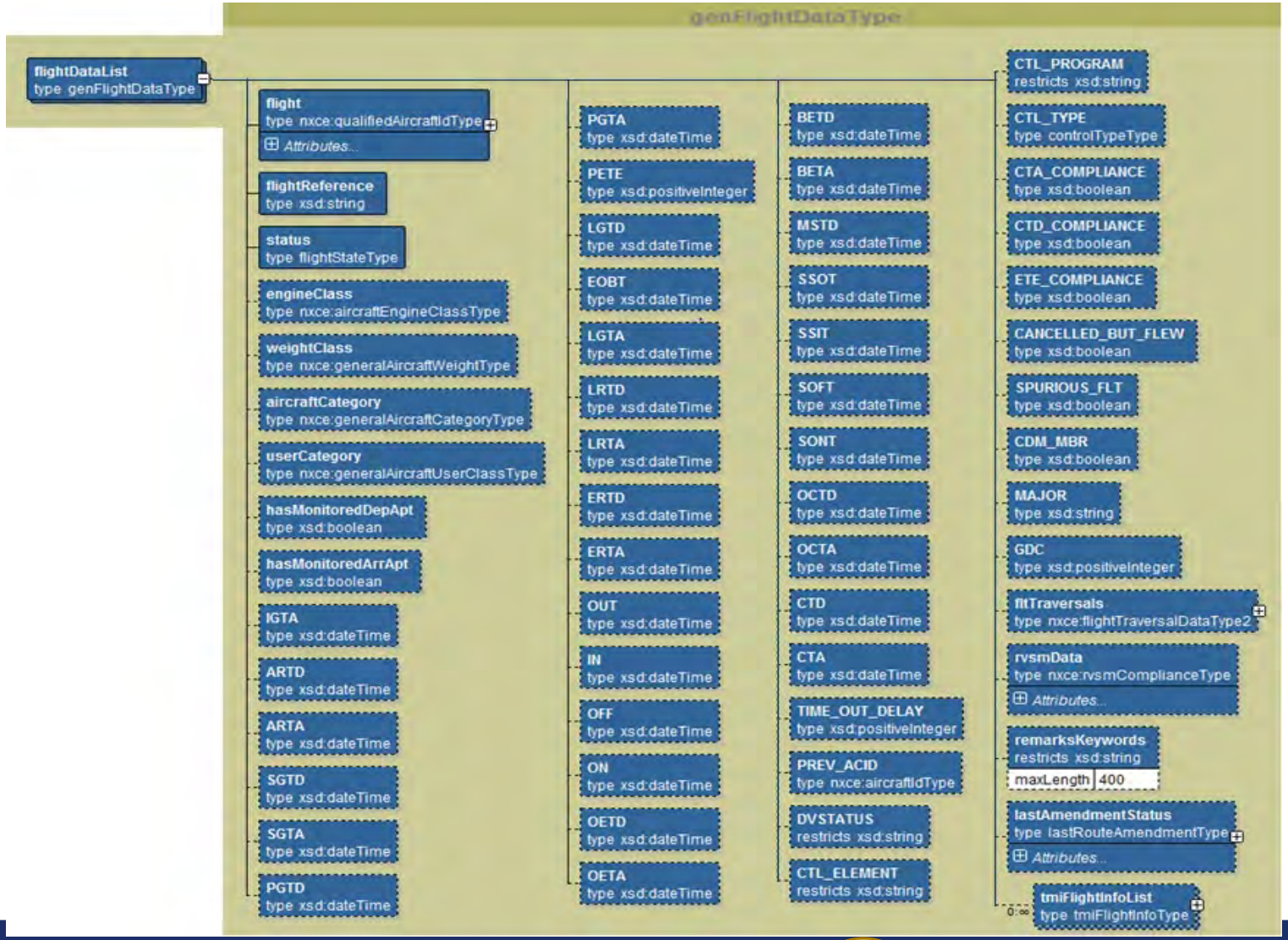
FXA definitions are depicted in more detail in the following slide.

FXAs may include secondary filter definitions. These were discussed in Exercise 1 and are not be repeated here.

TMI Resync Reply – Schema Detail (Cont.)



TMI Resync Reply – Schema Detail (Cont.)



BREAK

FF-ICE

Flight and Flow Information for a Collaborative Environment

Presented to: SWIFT Meeting

By: Ray Ahlberg, FAA, AJV-S

Date: February 26th , 2020

Federal Aviation Administration

Outline

- **Introduction- background**
- **Overview- what is FF-ICE?**
- **Details- a peek at how it will work**

FF-ICE background

- **Current shortfalls in flight planning data**
  - AFTN and teletype message limitations
    - Size limits
    - Difficulty in adding needed new data to exchanges
  - Lack of integration between ATC and ATFM
    - ATFM/CDM exchanges have been developed specific to service providers
  - Inability to exchange data needed in a TBO environment

FF-ICE background

- **ICAO Doc. 9965 presents a concept for a collaborative flight planning environment**
  - The key goal is that all participants have consistent information, and sufficient information for optimal decision making
  - FF-ICE does not define the applications that will use the data

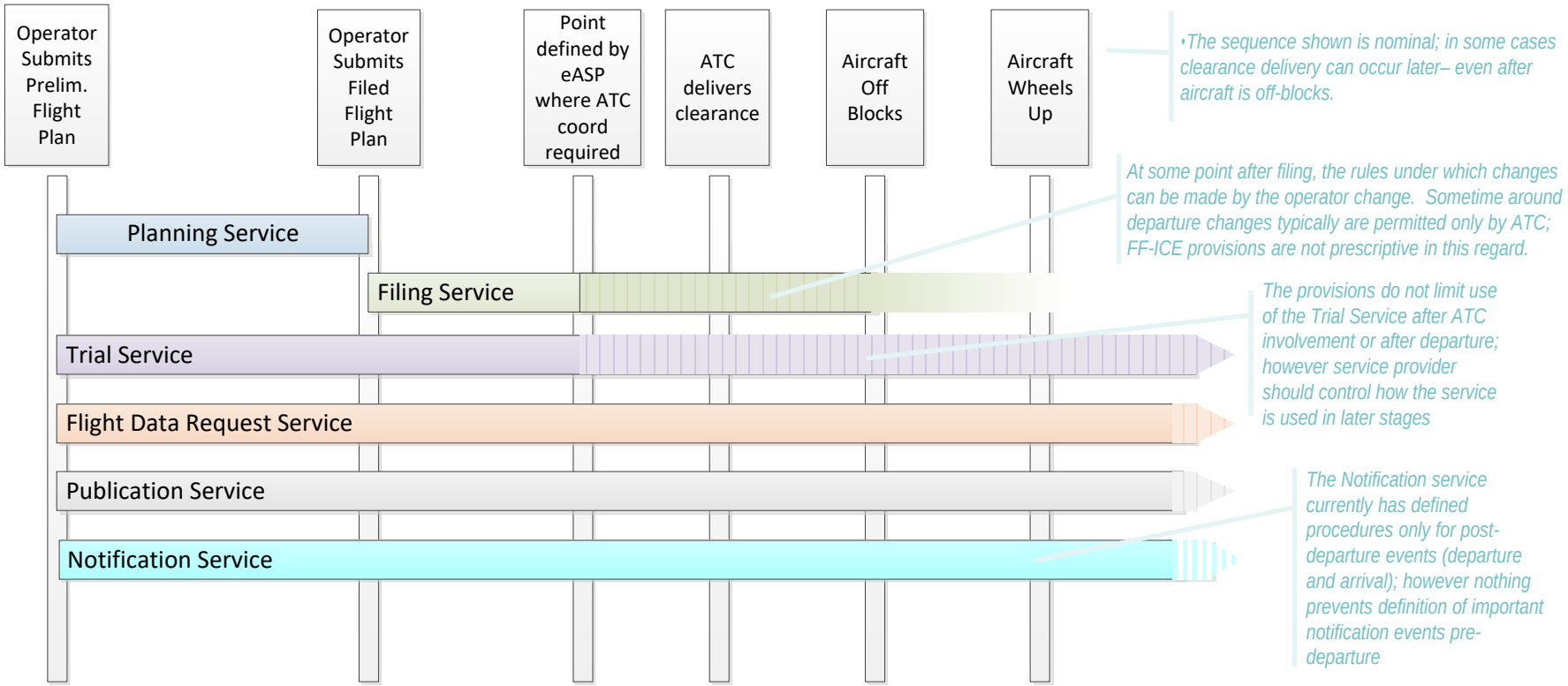
FF-ICE background

- **Implementation details for a first increment of FF-ICE are being developed**
  - Will address mainly pre-departure flight planning
  - Will address exchanges to support ATFM planning; ATC flight plan filing in a collaborative fashion
  - Will use XML-based data exchanges
- **Amendments to ICAO documents, and an implementation guidance manual are in process**

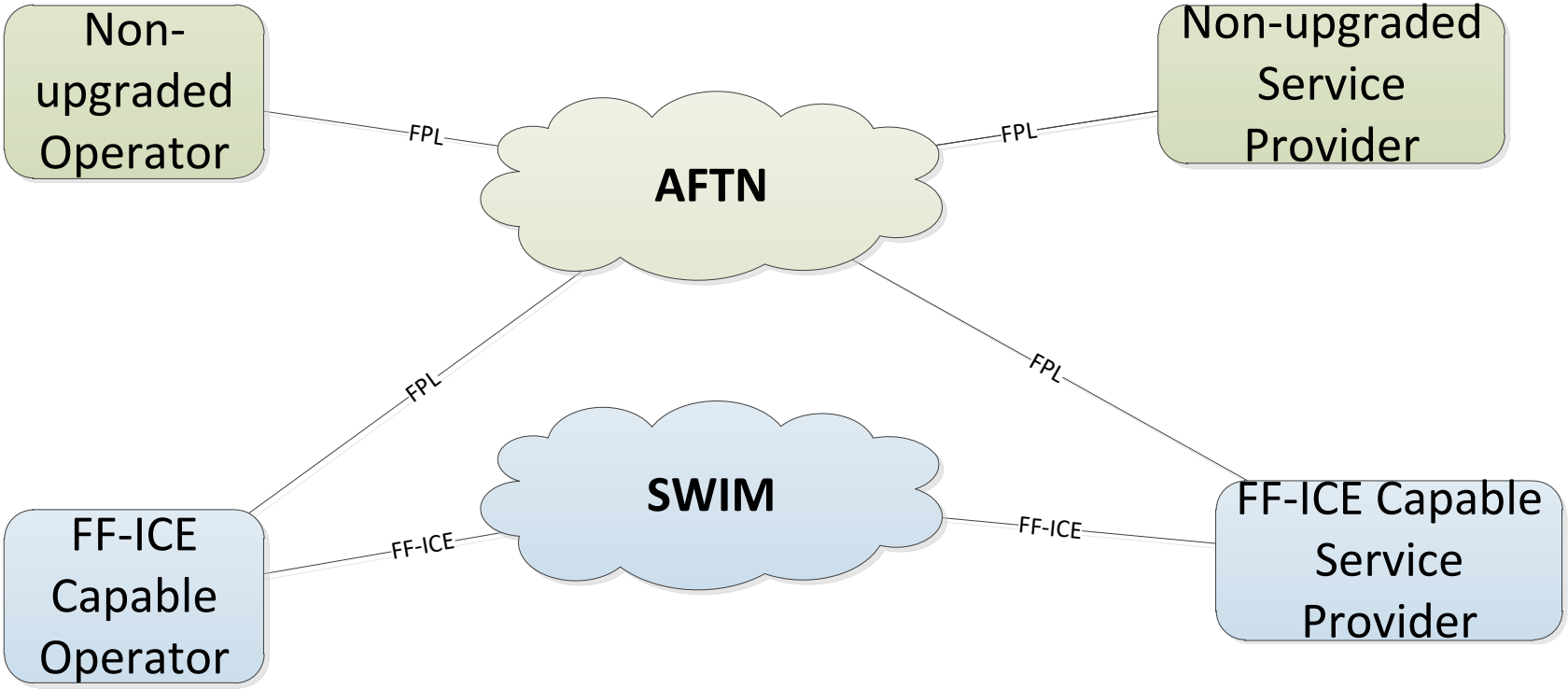
FF-ICE Details

- **FF-ICE environment**
  - Scope
  - Overview of the mixed environment
- **FF-ICE components**
  - Services, Processes, Messages
- **Sample information exchanges**
  - Preliminary flight plan
  - Flight data request
- **Flight Information Exchange Model (FIXM)**

Scope of the FF-ICE/r1 Services



The FF-ICE Environment



FF-ICE Components

- **Each FF-ICE service provides a complete capability that is implementable. FF-ICE services are either mandatory or optional. All mandatory services must be implemented to be considered FF-ICE capable.**
  - These services are introduced in PANS-ATM 17.1.
- **Each FF-ICE procedure is a lower-level set of actions, usually involving a specific data exchange. Each service employs one or more procedures, and procedures can (and do) support more than one service.**
  - Requirements for FF-ICE procedures are in PANS-ATM 17.3.
- **Each FF-ICE message defines a specific data exchange associated with a procedure. Each procedure has one or more associated messages and a message my be used by more than one procedure.**
  - FF-ICE message high-level requirements are in PANS-ATM 17.2; details are in Appendices B and C of Doc. 9965 Part II.
  - Note: A “message” is a computer to computer exchange of information. This exchange may be via modern technologies (e.g. a web service) or a traditional message routing system. FF-ICE does defines messages at an operational level, and is agnostic to the method of exchange.

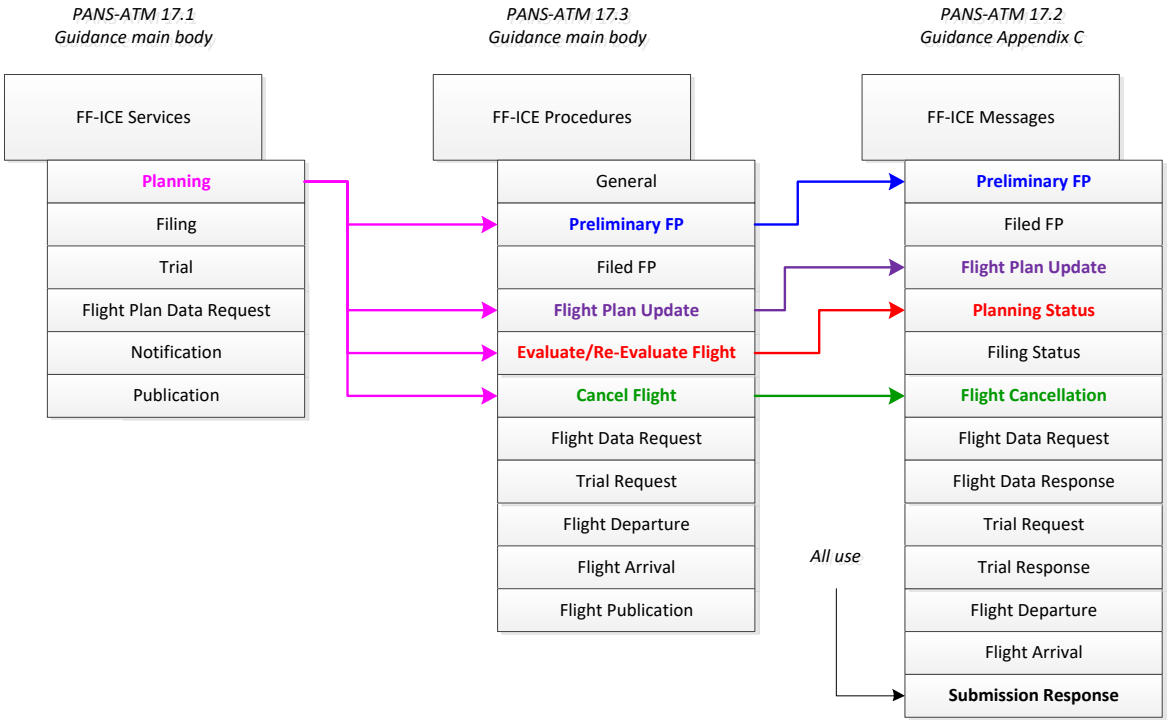
FF-ICE/r1 Services

Service	Description
Planning Service	Submission of a Preliminary Flight Plan to obtain constraint information from relevant ATM Service Providers (ASPs) and improve ATM resource planning. *(New- Like an early intent flight plan but with feedback from the service provider)*
Filing Service ***(Required for anyone implementing FF-ICE)***	Filing of an ATS Flight Plan (using eFPL) with relevant eASPs. *(Replaces use of FPL, SPL, CHG, DLA, and CNL)*
Trial Service	Submission of a potential change to a Preliminary or Filed Flight Plan to explore the impacts of the change before committing to it. *(New)*
Flight Data Request Service ***(Required for service providers implementing FF-ICE)***	A request for information regarding a specific flight, e.g. the flight plan, search and rescue data, or status information. *(Replaces use of RQP and RQS)*
Notification Service	Notification of certain flight events to required recipients, e.g. departure and arrival notification. *(Replaces use of DEP and ARR)*
FF-ICE Data Publication Service	General publication of flight and flow information by an ASP to authorized subscribers. *(Intended to standardize data sharing)*

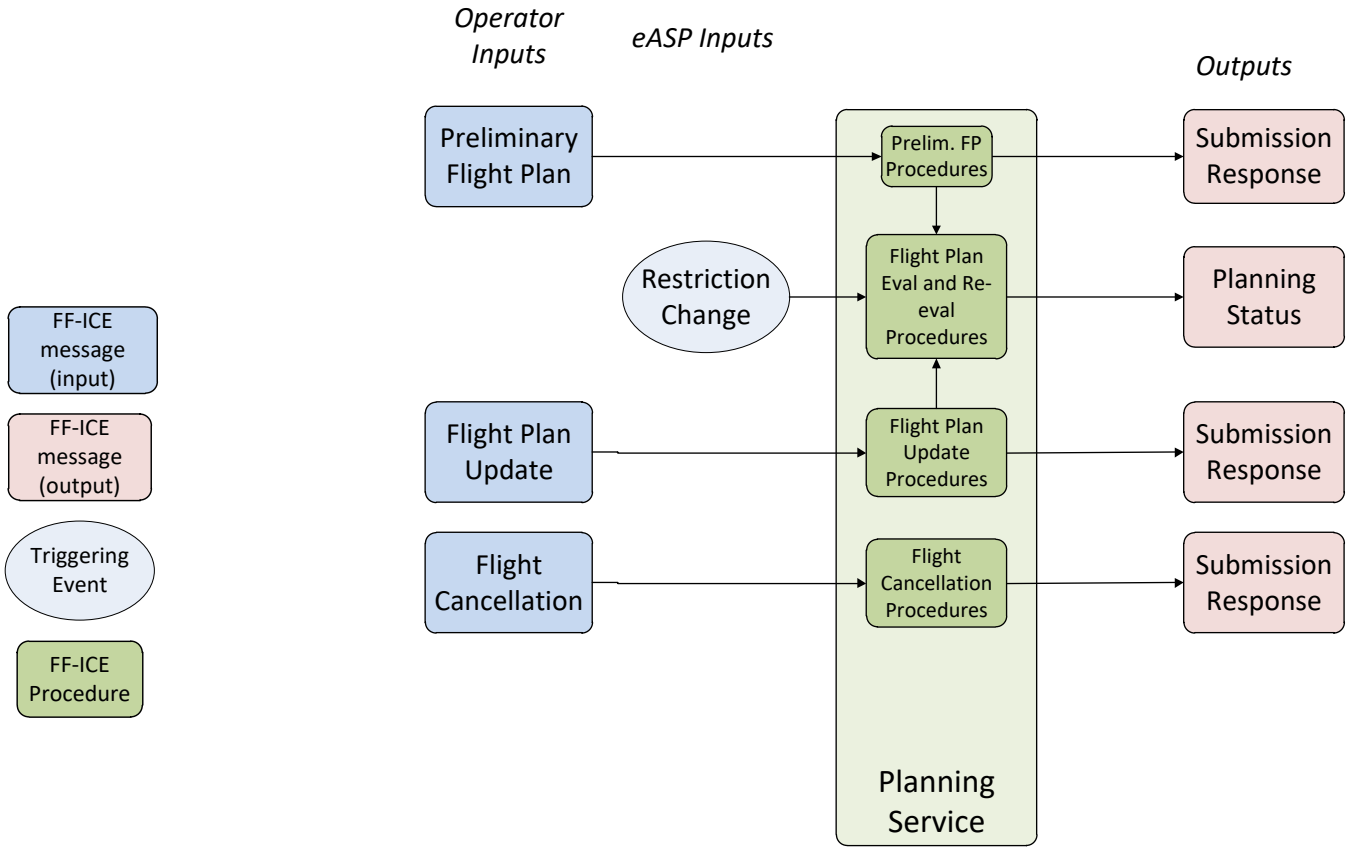
Example FF-ICE components

- *This diagram shows all of the FF-ICE services, procedures, and messages. The highlighted items trace the procedures and messages relevant to the Planning Service.*

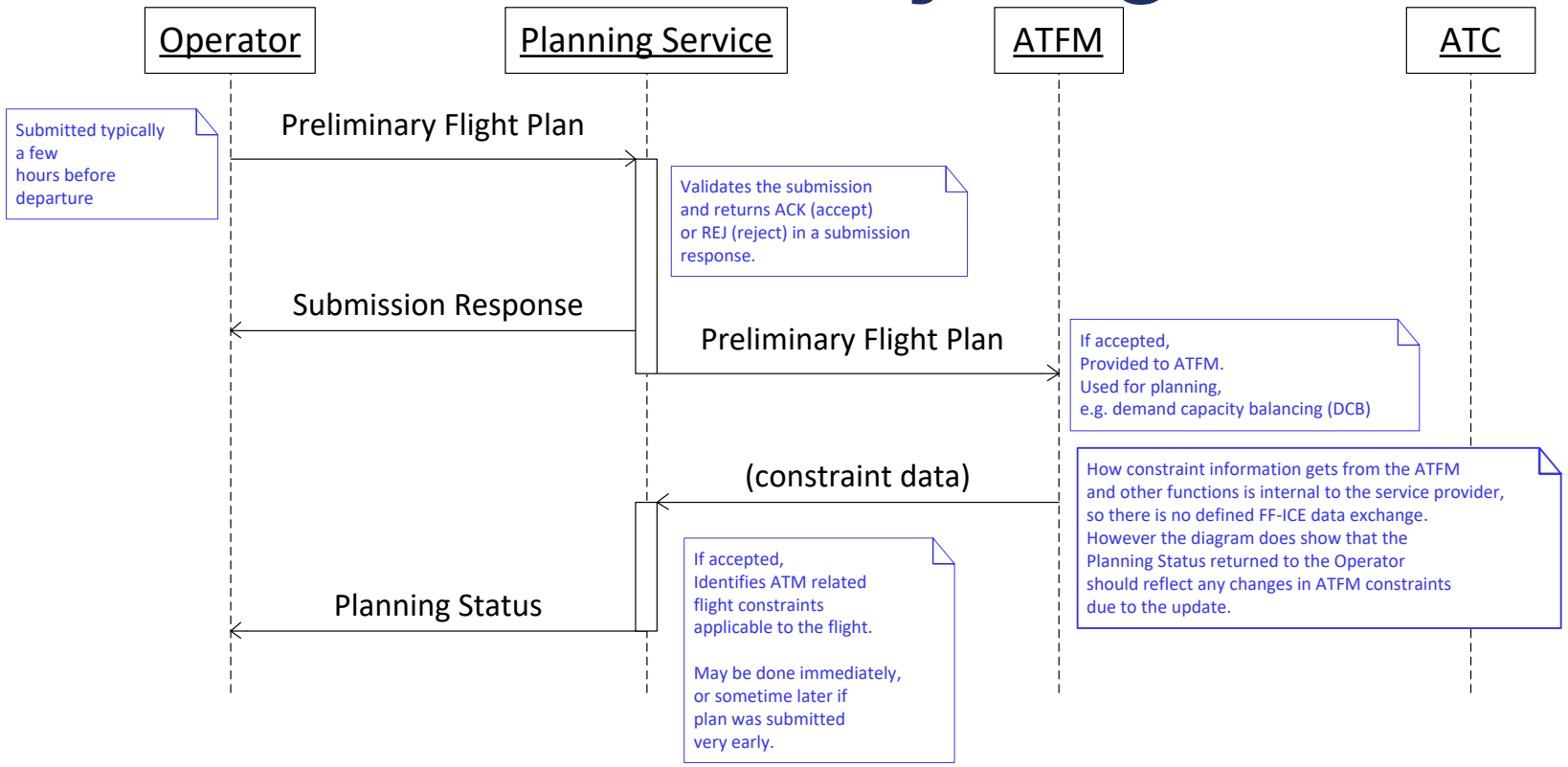
- *Diagrams for the other FF-ICE services are found in the reference material at the end.*



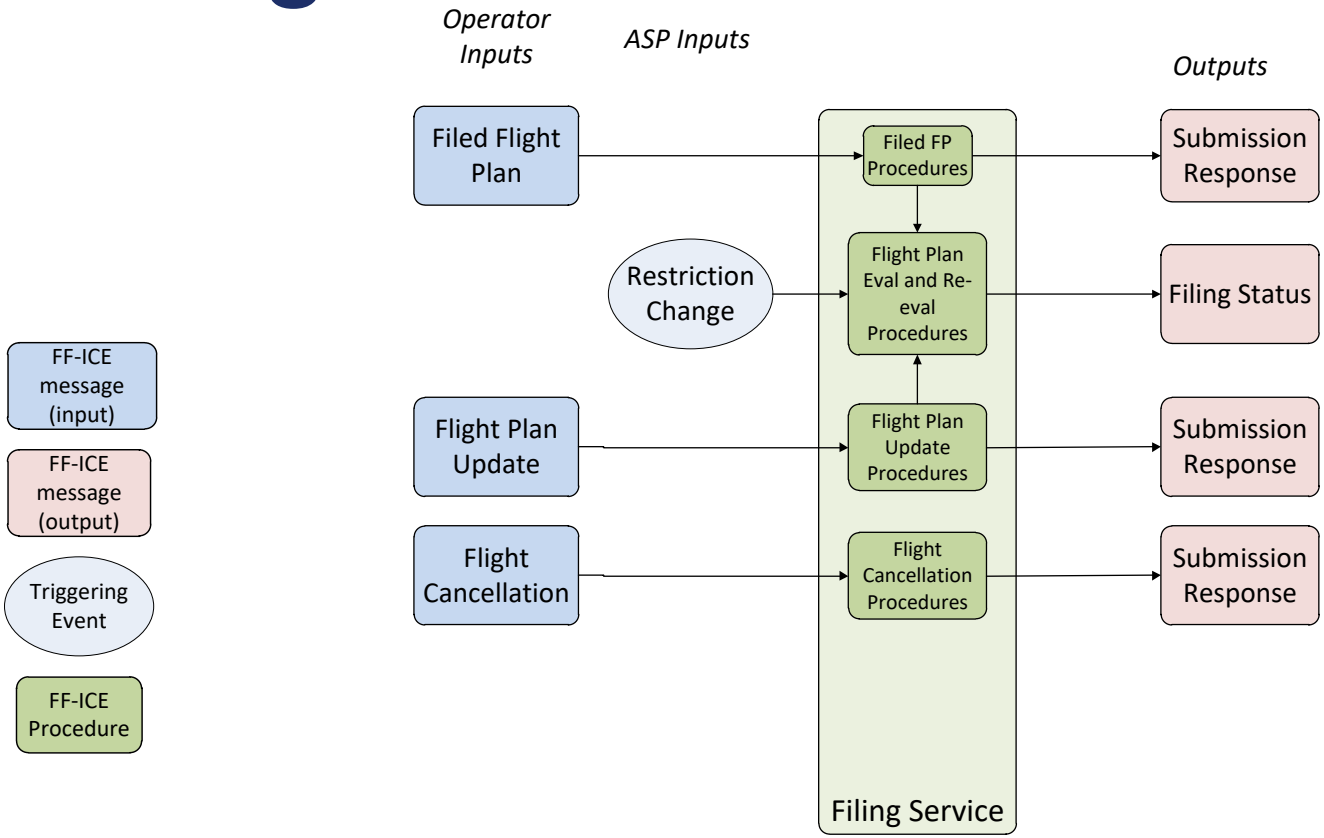
Planning Service Overview



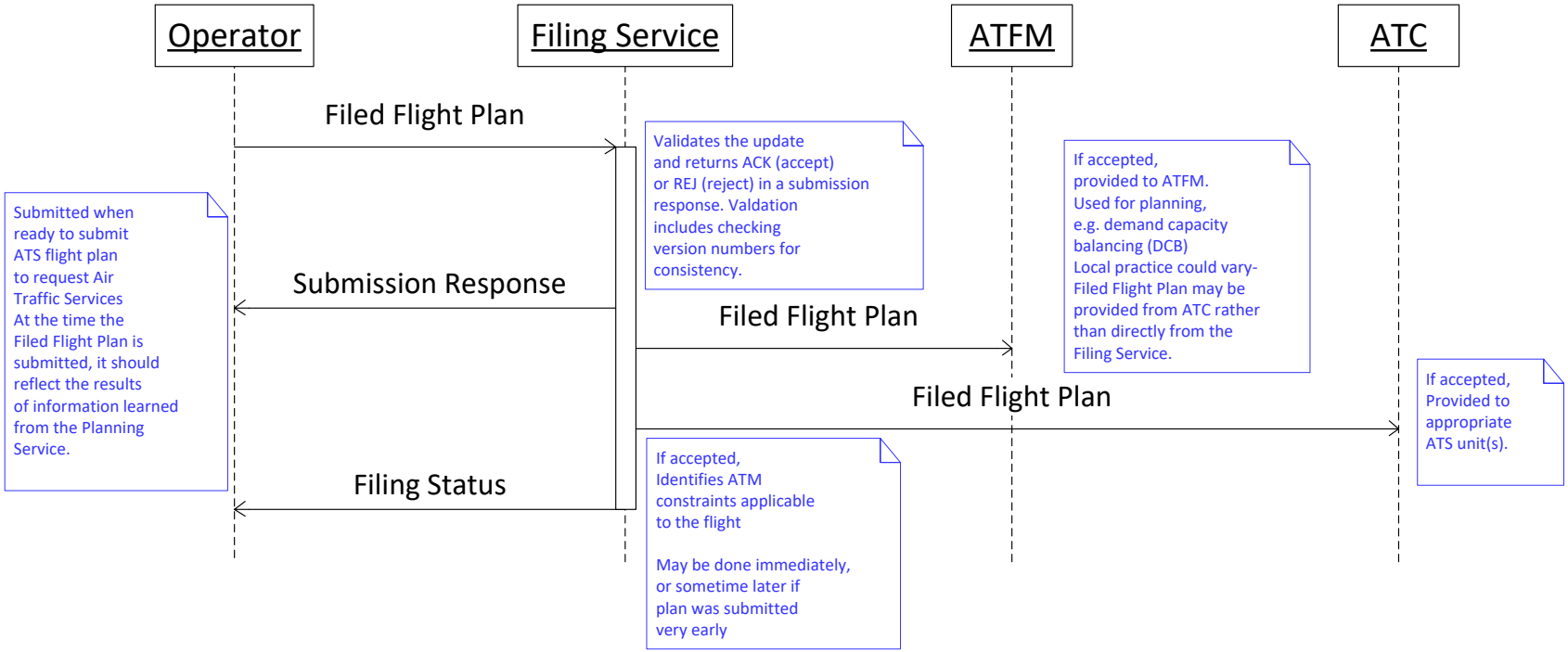
Submit Preliminary Flight Plan



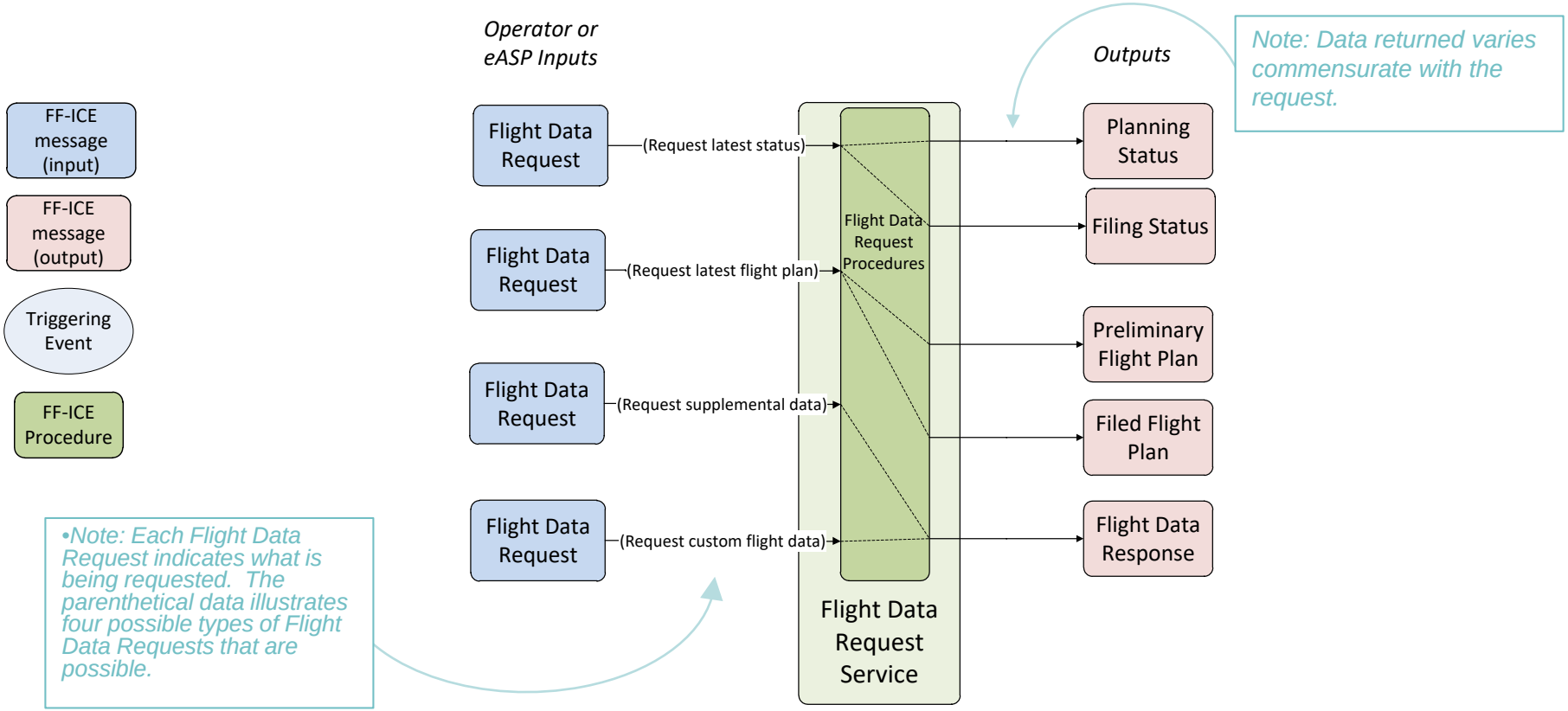
Filing Service Overview



Submit Filed Flight Plan



Flight Data Request Overview



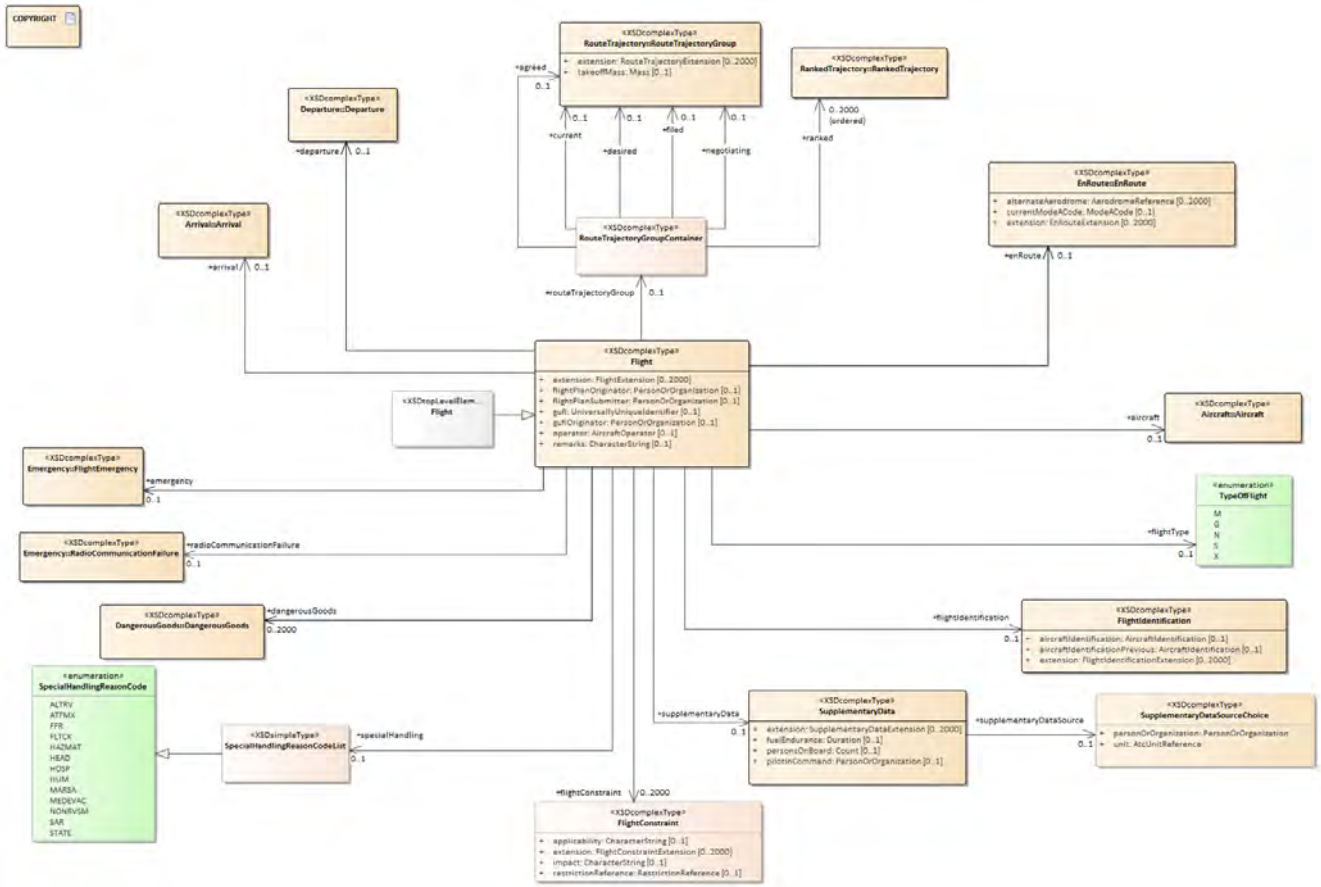
Flight Data in FIXM

- **XML schema**
- **Logical model and schema available at http://www.fixm.aero**
  - Can directly view logical model at https://fixm.aero/releases/FIXM-4.2.0-RC/doc/logical_model_documentation/index.htm
- **FIXM CCB addresses all data items called for in the FF-ICE guidance manual**
- **Current release is 4.1; Release 4.2 draft is out for review**

Next Steps

- **Common Support Services Flight Data (CSS-FD)**
  - Near term investment activities include initial investment analysis for early adoption focusing on FF-ICE/r1 FPL
    - Common portal to file FF-ICE/r1 via SWIM
    - XML schema for flight data in FIXM standards (current release 4.1, draft release for review 4.2)
  - Ongoing evaluation includes service analysis and strategic planning for Trial Planning that support US domestic flights
    - Identification and development of capabilities
    - Analysis of potential architecture alternatives

That's all- questions?

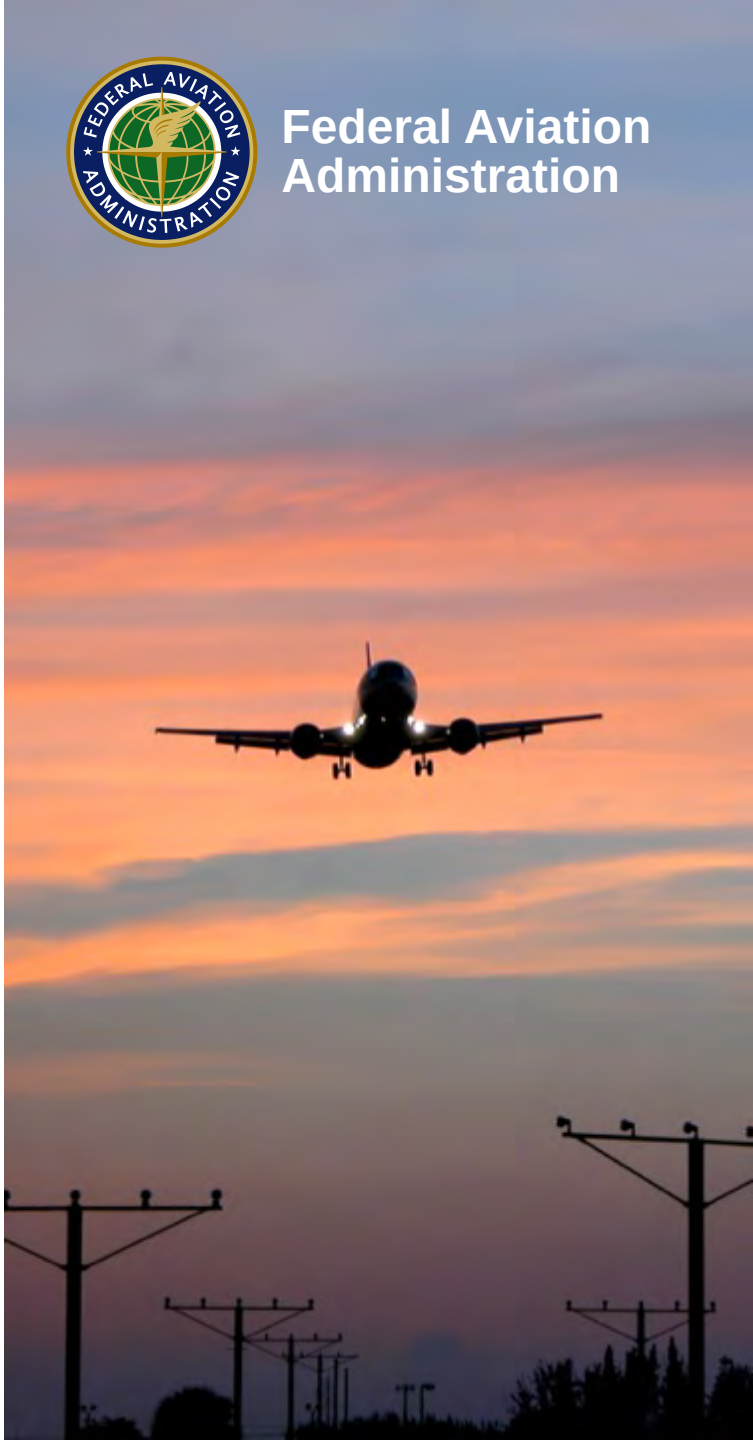


SWIM Cloud Distribution Service (SCDS) / Portal Update

SWIFT Meeting

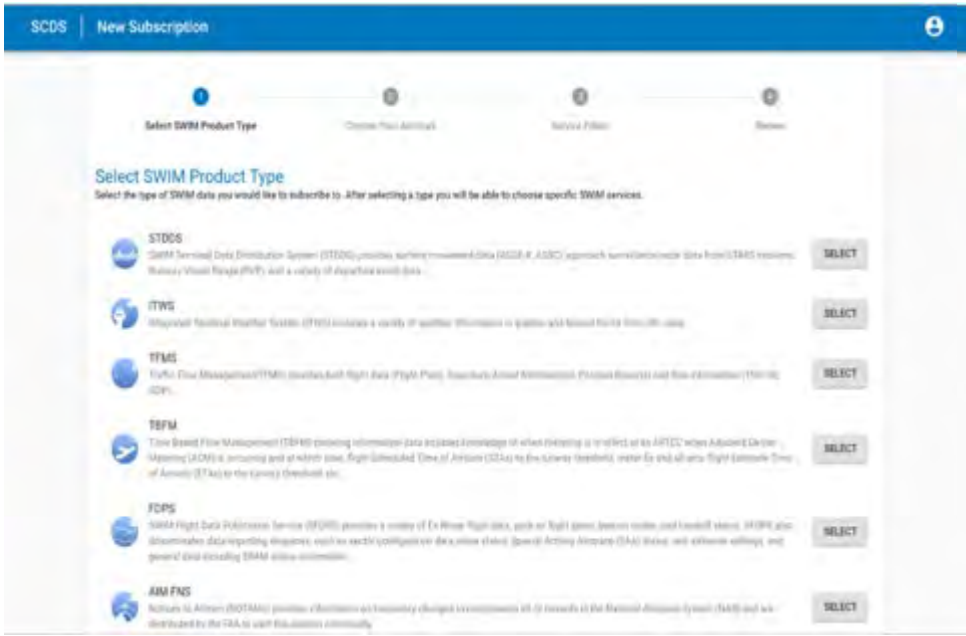
Damon Thomas, FAA, AJM-316

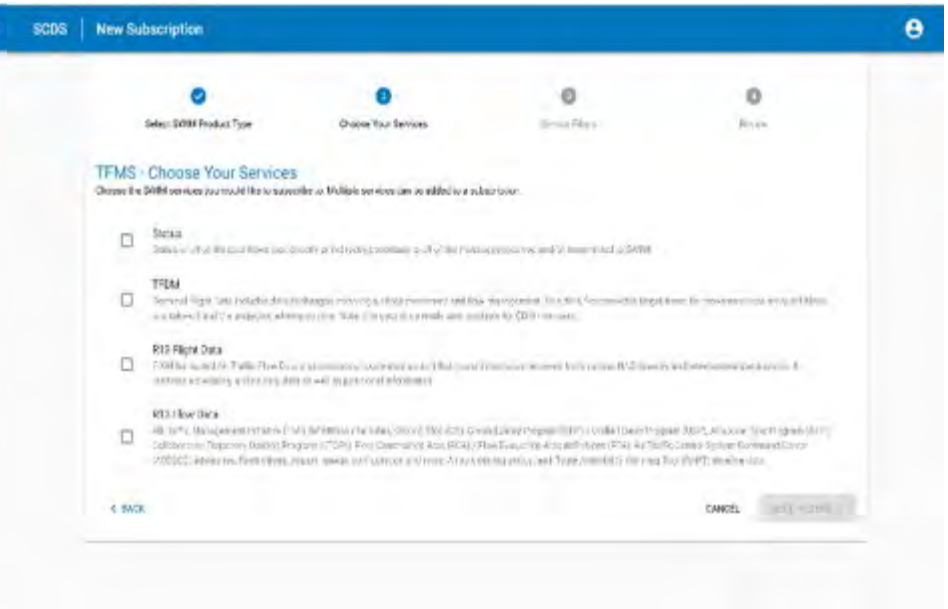
February 26th, 2020



SWIM Cloud Distribution Service (SCDS)

SCDS is a publicly accessible cloud-based infrastructure dedicated to providing real-time SWIM data to the public via Solace JMS messaging. This service will include access to the same publicly available data that is currently offered via the NAS Enterprise Service Gateway (NESG) SWIM implementation.





Why SCDS?

1. Primary SWIM Access Mechanism

SCDS is the new SWIM Service for external consumers that provides access to the same publicly available data on the NESG

2. Improved User Experience

SCDS provides an enhanced user experience offering self-registration, self-provisioning and advanced filtering capabilities

3. Additional Benefits

SCDS provides benefits such as newly available metrics/statistics and provides security through standard encryption (and therefore does not require a VPN connection) or service acceptance testing

SCDS Experience

Self-service Provisioning: Ability to create connections in real time

Help Desk Support: Dedicated Help Desk

Service Management: Fine-grained filtering ability

Managed Failover: Redundant connections and cloud technology, to create a reliable environment

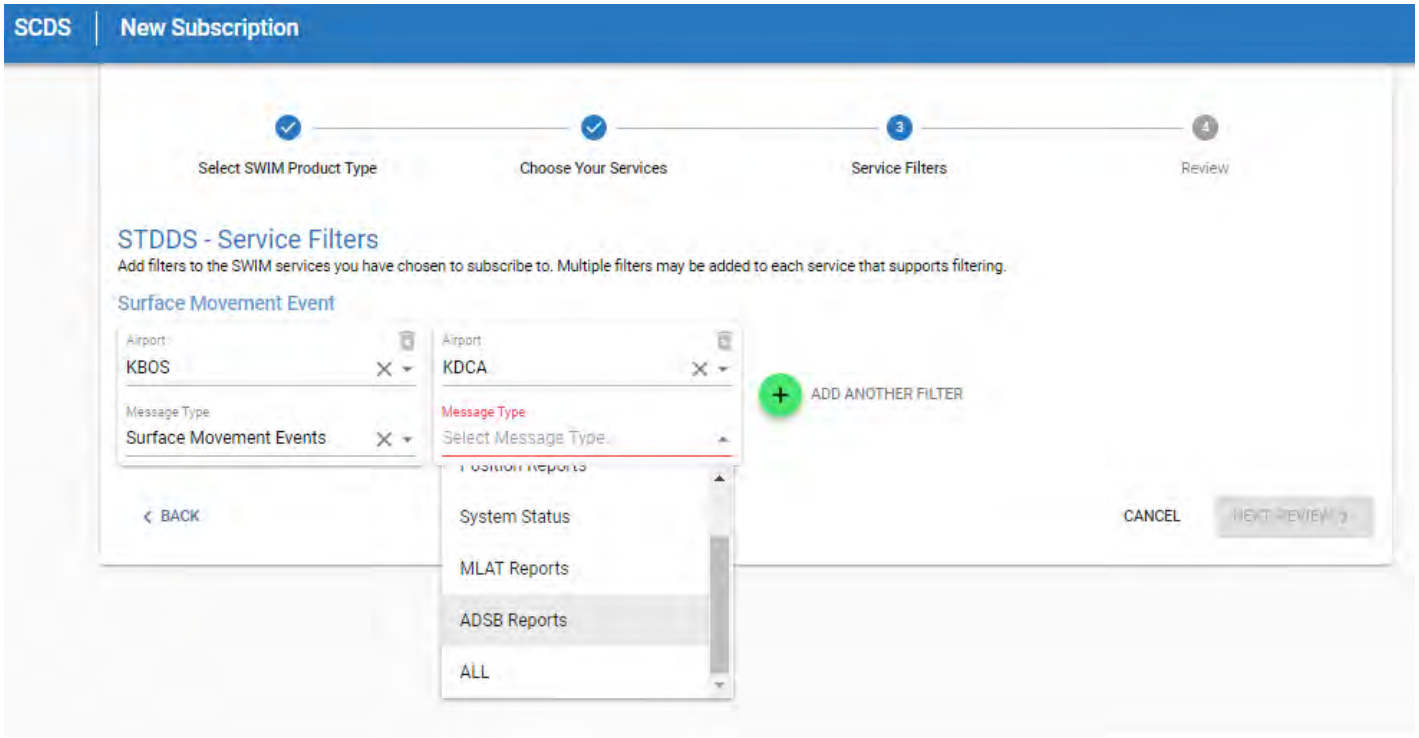
Subscription Level Metrics: Detailed view of message rates, bandwidth and other metrics

Security Controls: Utilizes TLS connection technology

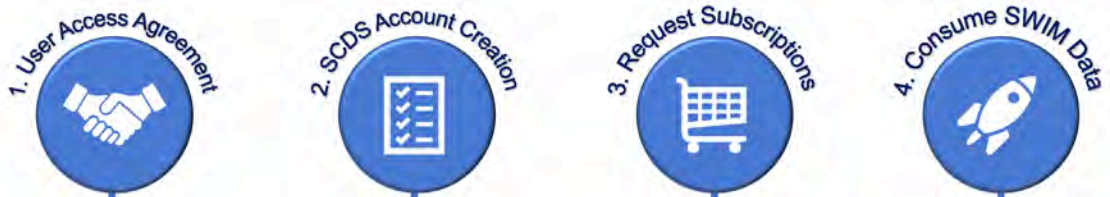
SCDS Filtering Capability

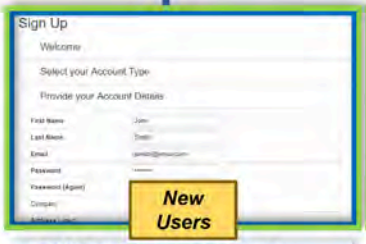
SCDS provides the capability to set up service filters for each subscription, allowing the user to request only the data that they need instead of receiving the entire feed and only using parts of what was received.

- Multiple filters can be added to each new subscription
- Filters are available for most services

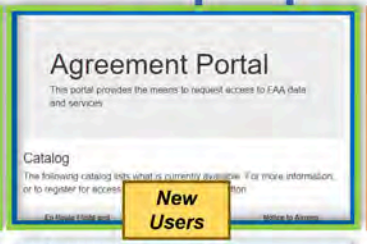


On-Boarding Process for SCDS Users

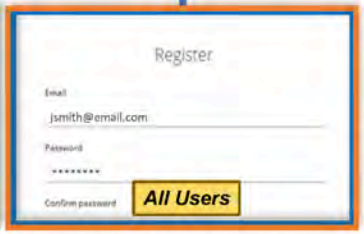




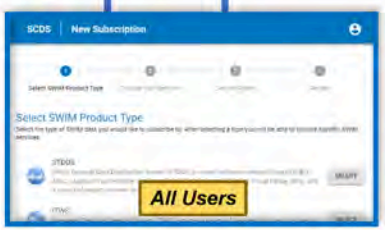
- **FAA Data Access Account** Create an account on the FAA agreement portal https://data.faa.gov/data/register.jsf



- **Access Agreements** Complete the Access Agreements for the SWIM JMS services to be consumed via SCDS https://data.faa.gov/



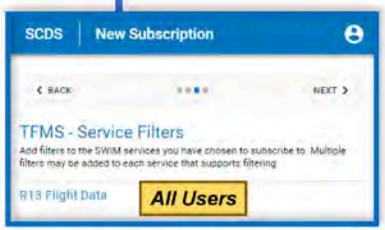
- **Create an SCDS account** https://scds.swim.faa.gov
- **Registration** Complete the form and click "REGISTER."
- **Update your account information** then click "SUBMIT."
- **Email verification** An email will be sent to the address provided on the previous page. Please validate the email address and click "SIGN IN."
- **Email confirmation** You will be taken to a page notifying you your email has been verified. Click "Back to Application."



- **Subscriptions** Once logged in, you will be taken to the subscriptions page. From here, you can create new subscriptions and view subscription metrics.

Subscriptions will only be approved for those services that have a corresponding signed Access Agreement.

- **Current NESG Users Migrating to SCDS** Create your subscriptions based on the list of your current NESG subscriptions provided to you at the beginning of your on-boarding



- **Filters** Set up your data filters, multiple filters can be applied for one feed
- **Approvals** Subscription requests are reviewed, approved within 72 hours of request and then provisioned automatically
- **Consume SWIM Data** Connect your consumer application to your approved SCDS subscription(s) and consume SWIM data

New Users: 90 Day window for on-boarding

New Users of SWIM data must start at Step 1 "User Access Agreement"

Current Users: 90 Day window to on-board and disconnect from NESG

Current NESG Users migration to SCDS begin on Step 2 "SCDS Account Creation"

SWIM SCDS Helpdesk Contact Information

- Enterprise Control Center (ECC) Contact Information:
- 855-FAA-NEMC (855-322-6362)
- Use option 3 for Enterprise Services then 1 for SWIM Services (24/7/365)
- 9-ATO-SECC-OPS@faa.gov

Please identify yourself as an SCDS user

Note: The FAA recommends Chrome or Firefox when accessing SCDS

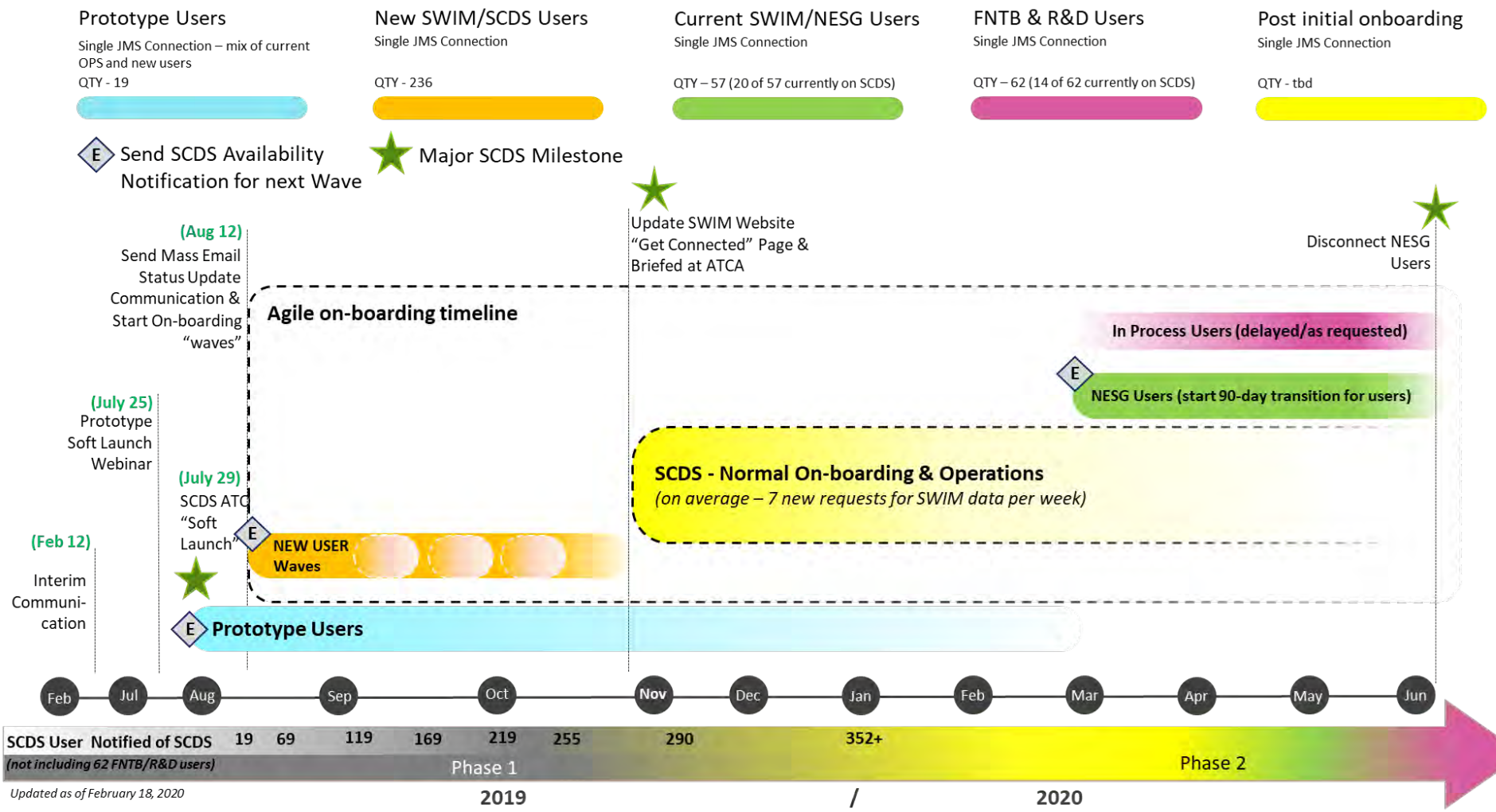
SCDS Governance

The FAA has developed an SCDS policy to preserve system resources and maintain accurate information on system usage.

This policy addresses the following:

- **Subscriptions Pending Approval**
  - Subscriptions in the “pending approval” status for more than 30 days will be deleted
  - Notification at 15 and 30 days, deleted after 1 additional week
- **Unused Approved Subscriptions**
  - Approved subscriptions that have not been connected in 60 or more days will be removed
  - Notification at 30 and 60 days, deleted 1 additional week
    - Contact the SCDS on-boarding team (scds@faa.gov) if you plan to use a subscription
    - **Note:** If you have any subscriptions that are used as backup, please label your subscription as “backup”
    - If your planned use of SCDS is limited to a few times a year, please label your subscription as “occasional use”

SCDS Agile On-Boarding Plan



NESG user transition to SCDS

Reminder:

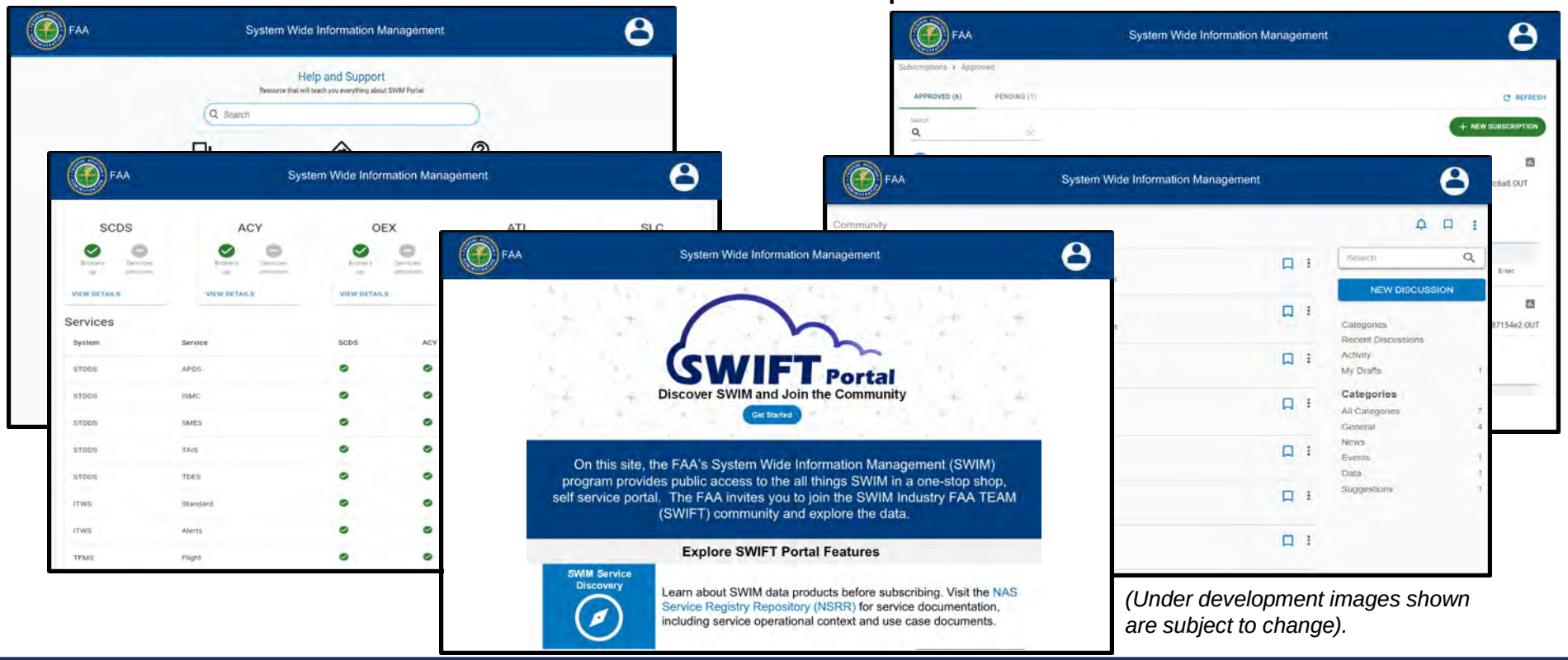
Existing NESG Users that are designated to transition will be notified the week of March 15, 2020. All communications will come from SCDS@faa.gov

- Users will have 90-days to set up SCDS connections prior to being disconnected from the NESG.
- Upon request your SWIM SE POC can provide a list of data subscriptions that you are currently subscribed to. This should be the same data that you request on SCDS (requests to any new data sets will require you to sign the corresponding Access Agreements).

SWIM Industry-FAA Team (SWIFT) Portal

SWIFT Portal is a publicly accessible cloud-based infrastructure bringing new capabilities built upon SCDS.

This service will include Service Discovery, Service Status, Community Forum, Cloud Distribution Service and self-service Help Desk



(Under development images shown are subject to change).

Why SWIFT Portal?

1. Portal Vision

SWIFT Portal is the new one-stop shop, self-service Portal that provides public access to all things SWIM

2. Improved User Experience

SWIFT Portal provides an enhanced user experience offering self-registration, self-provisioning and access to current status of SWIM Services

3. Additional Benefits

SWIFT Portal provides the ability to connect with the SWIM Community to share knowledge and ideas, as well as a self-service help desk with various ways of finding solutions (help guides, ticketing tool, chat etc..)

SWIFT Portal Experience

Self-service Provisioning: Ability to register & create/control your own subscriptions

Self-service support: Online guides, ticketing, and chat support

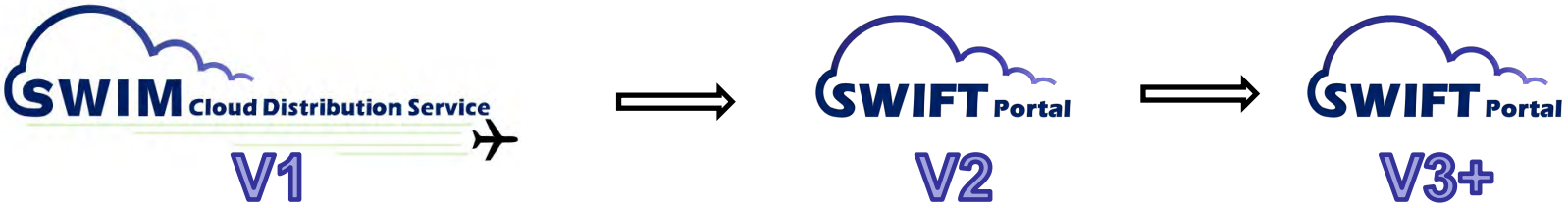
Live Service Status: Current status on SWIM services

Managed Failover: Redundant connections & cloud technology, to create a reliable environment

Data Subscription Metrics: Data bandwidth, connections, queue lengths & expired message count

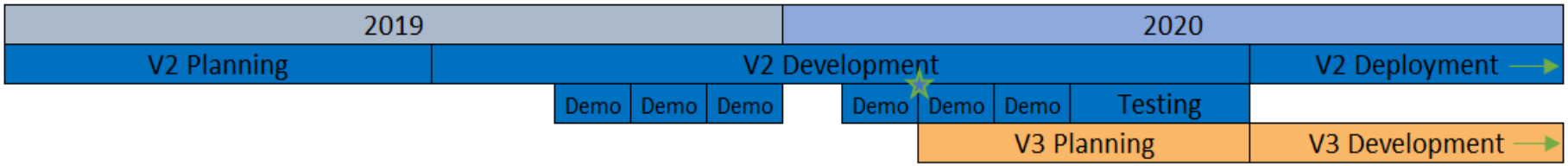
Community Forum: Discuss ideas, share SWIM knowledge, learn about latest news & events

SWIFT Portal Development



SWIFT Portal built upon SCDS
+50% development done

Additional features/improvements planned as part of V3+ (TBD)



Contact Information

For information on SWIM, visit the SWIM website:

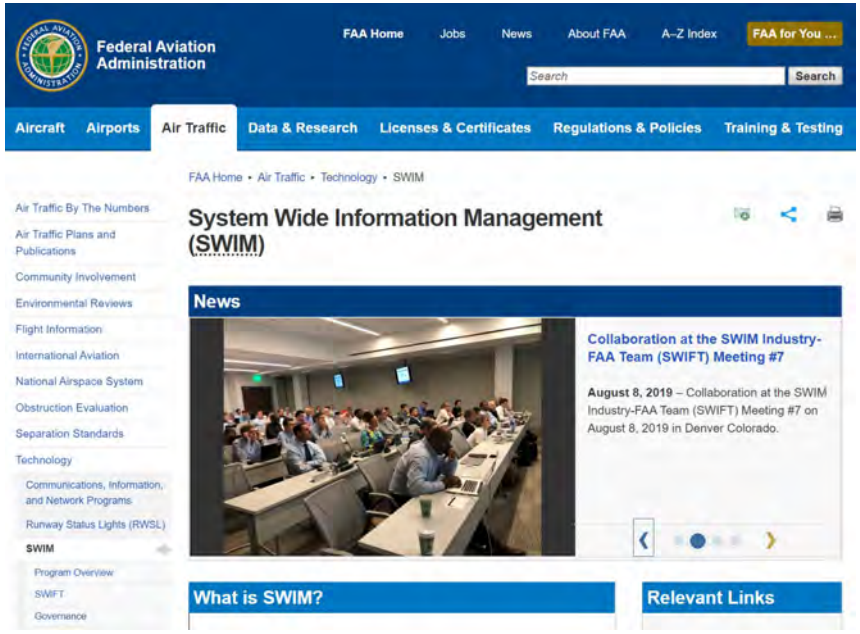
https://www.faa.gov/air_traffic/technology/swim/

Register for our next SWIM Users Forum:

https://www.faa.gov/air_traffic/technology/swim/users_forum/

Register for our next SWIFT:

SWIFT 10



Or contact us via email:

General SWIM Questions

SWIM@faa.gov

SCDS Specific Questions

SCDS@faa.gov

LUNCH

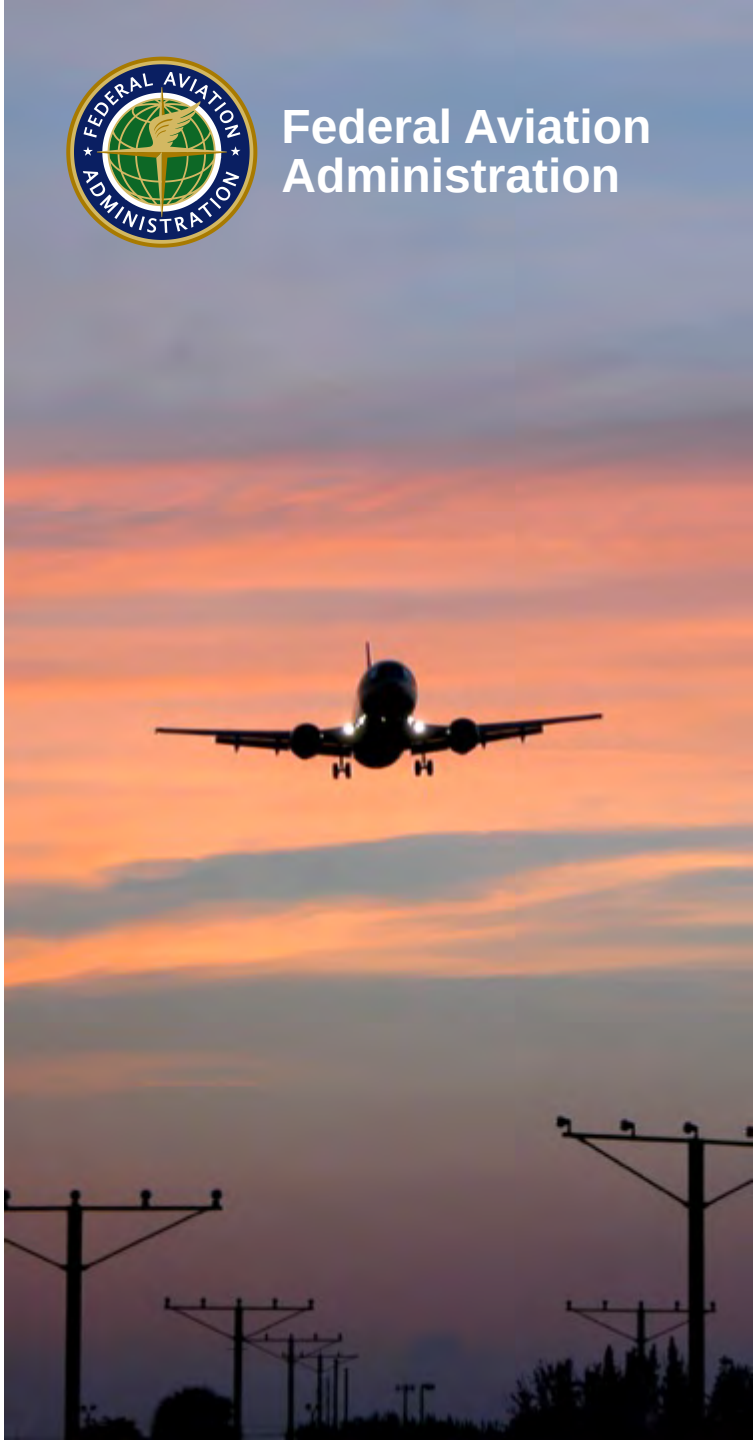
SWIFT Focus Group: Operational Context & Use Case Documents

Update on Focus Group

Ray Mitchell, LS Technologies

February 26th , 2020

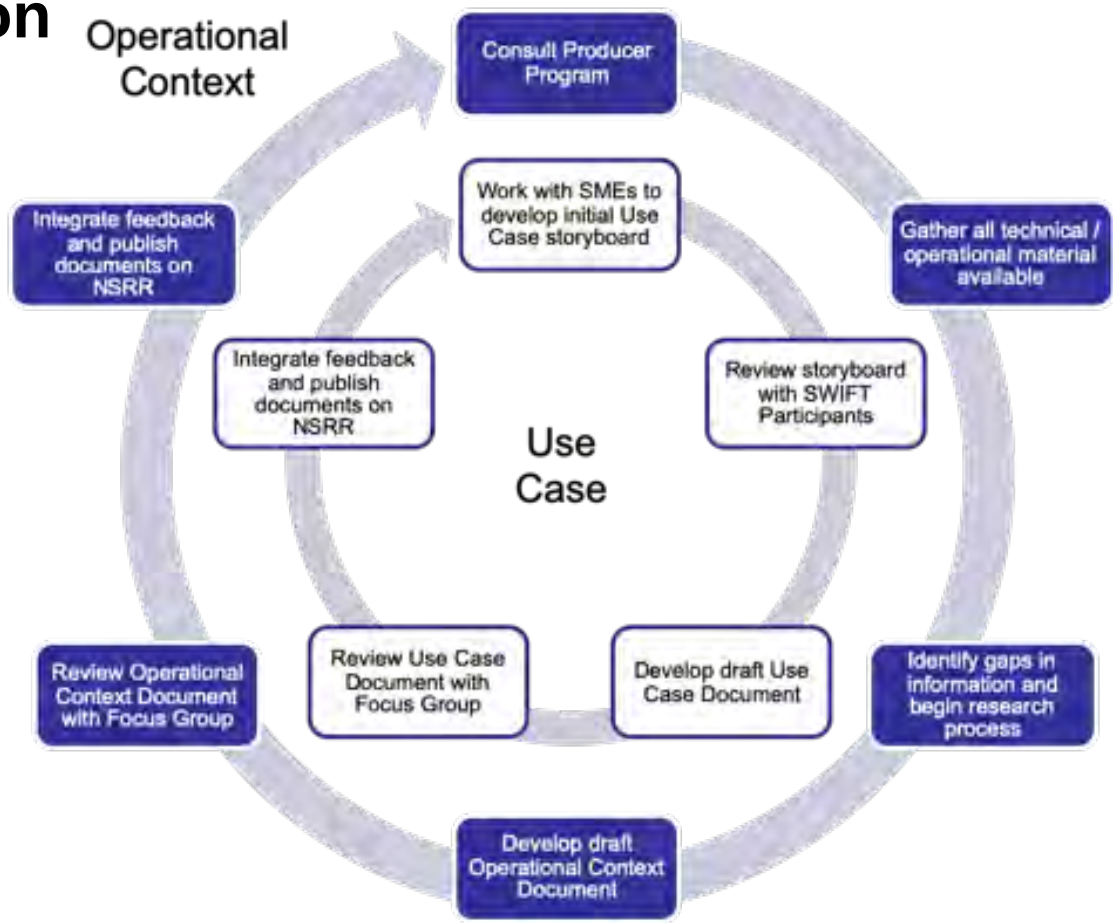
Federal Aviation Administration



Focus Groups

Operational Context for SWIM Data

- **SWIFT Participation on Operational Context and Use Case Documents**
  - Participants provide comments
  - Structure of feedback & nature of questions answered meeting
- **Engage SWIFT Participants in development of Ops Context & Use Case Documents**



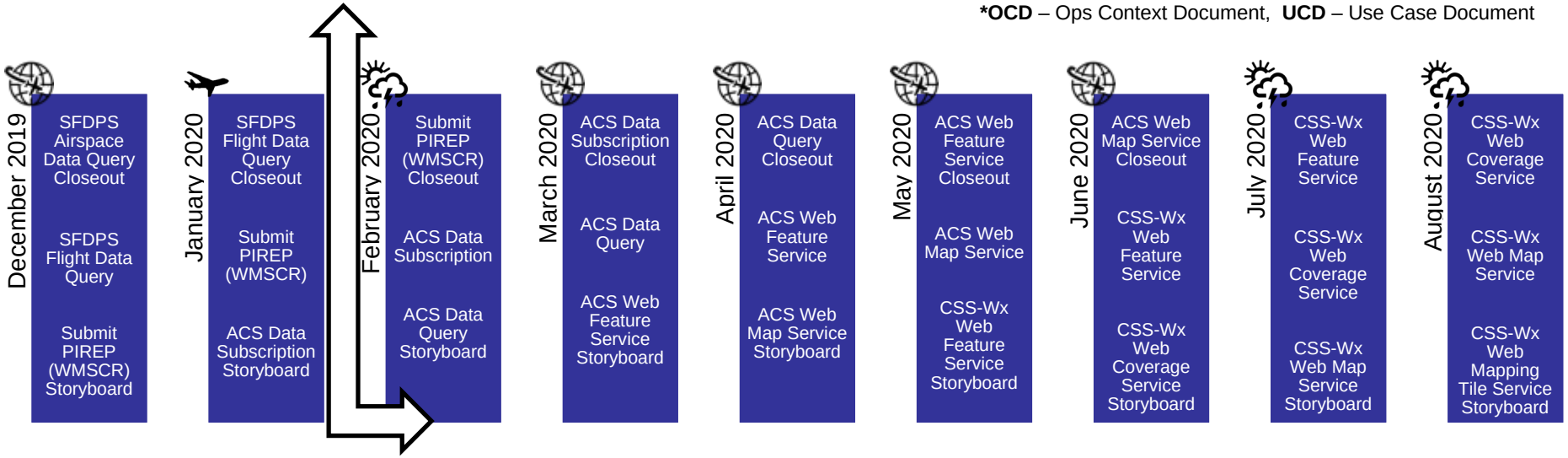
Operational Context Documents Produced

Surveillance	Aeronautical	Flight/Flow	Weather	Status
STDDS TAIS DELIVERED	SFDPS Airspace DELIVERED	TFMS Flow DELIVERED	ITWS DELIVERED	TFMS Status DELIVERED
STDDS SMES DELIVERED	FNS NDS DELIVERED	TFMS Flight * DELIVERED	STDDS APDS DELIVERED	STDDS ISMC DELIVERED
SFDPS Flight DELIVERED	DCNS DLD DELIVERED	TBFM MIS DELIVERED	WMSCR Submit PIREP UNDER REVIEW	
	SFDPS Airspace Data Query DELIVERED	STDDS TDES DELIVERED		
	ACS Data Subscription IN DEVELOPMENT	SFDPS General DELIVERED		
		TFMData Request/Reply DELIVERED		
		SFDPS Flight Data Query UNDER REVIEW		

Focus Group will continue to develop documents as new SWIM services come online

Current Document Schedule

***OCD** – Ops Context Document, **UCD** – Use Case Document



- **In June 2019 delivered final Use Case document, Use Case Focus Group will be suspended unless new services require documentation**
- **Began addressing Request/Reply services in late August**
- **Schedule subject to change if service updates are released and existing Operational Context documents need to be updated**

Interested in the SWIFT Focus Groups?

- **For more information please contact**
- **Ray Mitchell, SWIFT POC**
  - Phone: (703) 963-4979
  - Email: ray.mitchell@lstechllc.com
- **In addition to the NSRR, all SWIFT Documentation can also be found at:**
  - https://connect.lstechllc.com/index.cfm/main/swifthome

Introducing New Focus Groups

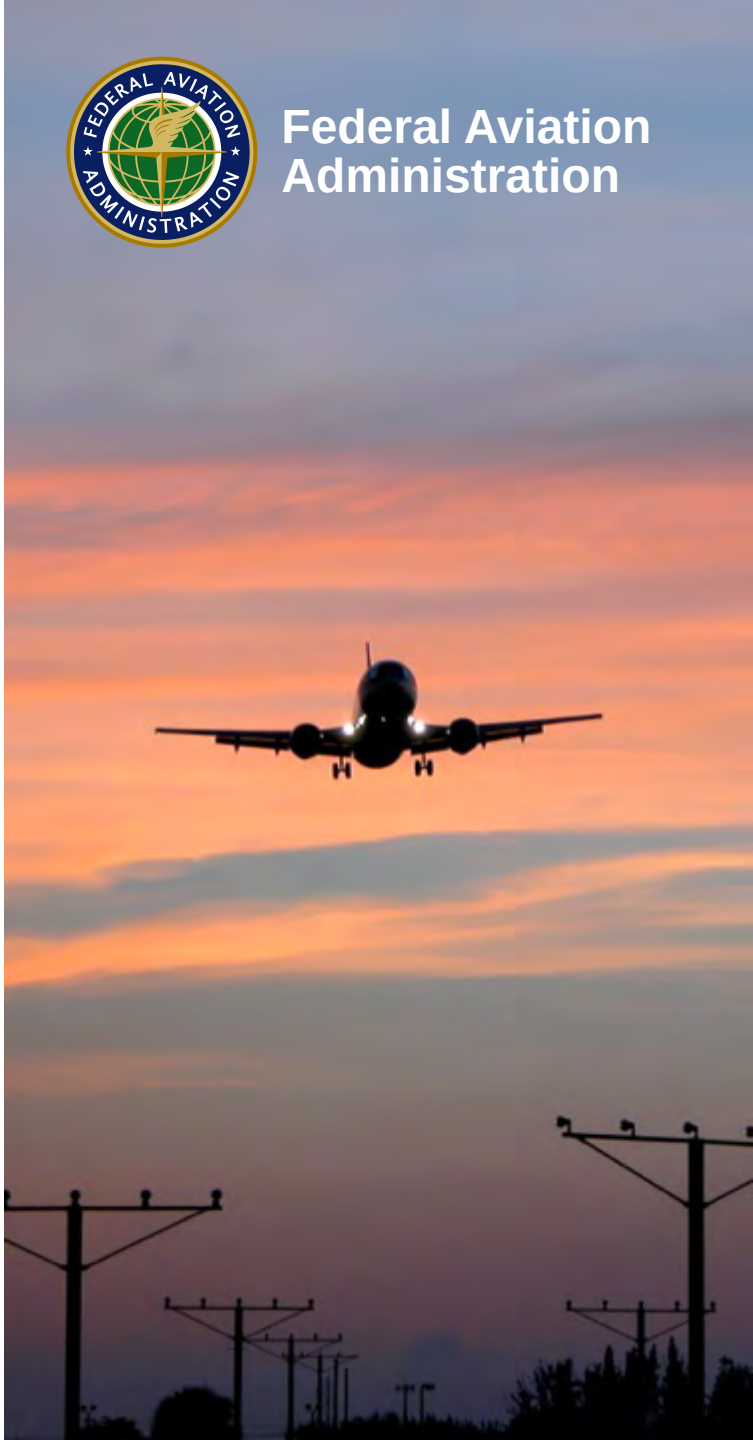
Operational Issues

Development & Analytics

Ray Mitchell, LS Technologies

February 26th , 2020

Federal Aviation Administration



Why Add More Focus Groups?

- **Many issues arise at SWIFT meetings do not get resolved by existing focus groups**
  - SWIFT has presented multiple case studies with proposed solutions that have either been not fully solved or implemented
  - Multiple requests for instructions how to build widgets, requests for help building capabilities with SWIM feeds, etc.

Operational Issues Focus Group

- **Goal: Address NAS-wide issues that are raised at the SWIFT that we never fully resolve**
  - Taxi-out return to gate, TBFM/TFMS interaction issues, Flight planning over IP, etc.
- **Requires input from other NAS programs/SMEs, focus group alone cannot solve these problems, but it can identify the main problems to bring up with other programs**

Development & Analytics Focus Group

Goals

- **Democratize the widget building process**
  - Get input from focus group members about what problems they want to solve or capabilities they want to build/replace with SWIM
  - Previously SWIFT leadership would develop an idea and build a widget, not necessarily starting with an operational problem the group wants to solve first
  - NBAA AFP widget is a step in the right direction, but only developed for 1 stakeholder
- **Avoid requests for sharing code and teach users how to develop these capabilities on their own**
- **Move away from “widgets” and start building “instruction manuals” for SWIM-enabled capabilities that are technology agnostic**

New Focus Groups

Operational Issues

Identify systemic problems

Coordinate with FAA/Airline stakeholder to identify solutions

Feed solutions to Development/Analytics Focus Group for physical creation if applicable

Development & Analytics

Data Analytics

- Identify smaller scale data, operational, and analytical problems that already exist in the community
- Identify services, messages, data elements, logical transformations to solve problem

Development

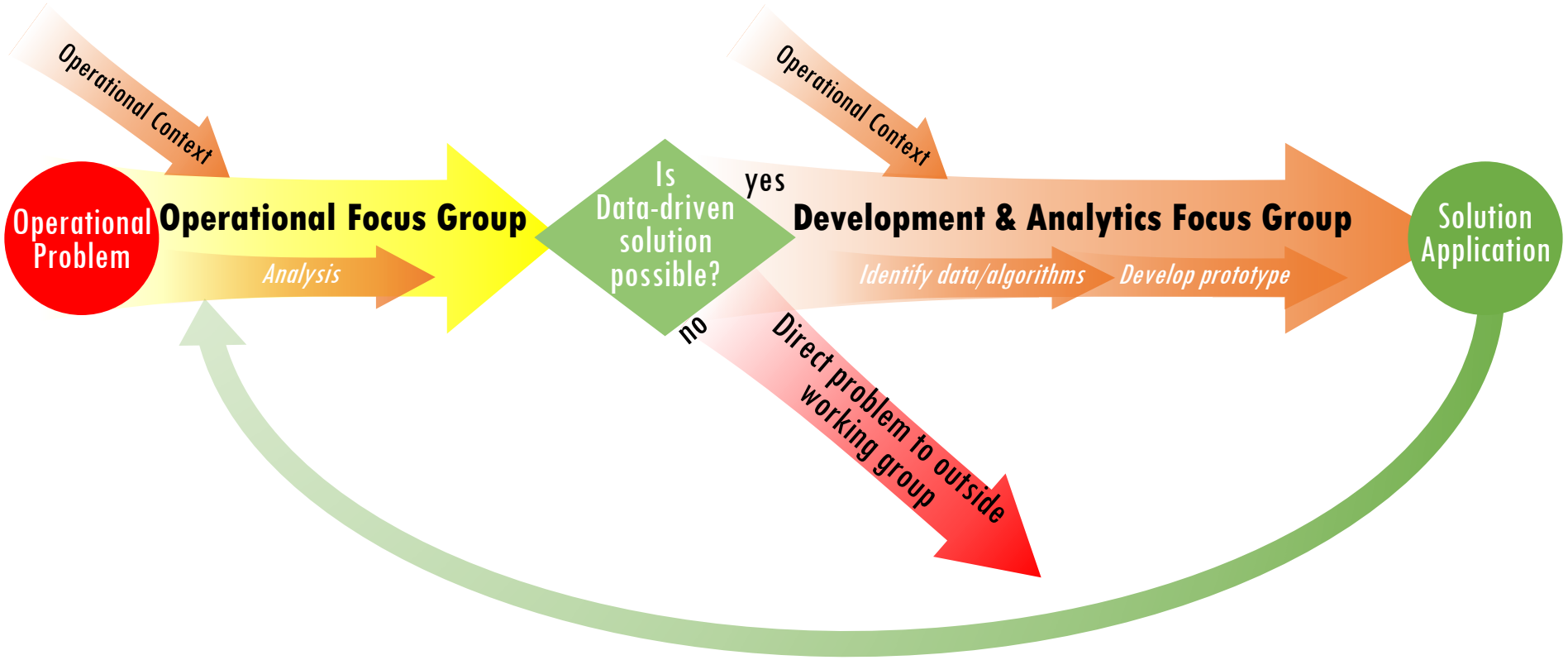
- Create logical software design of widget to solve problem
- Develop physical widget as designed by group

Focus Groups Interface as needed

Development & Analytics Focus Group
What does it look like?

- **Focus group meets and prioritizes a list of capabilities they want to build with SWIM**
- **In the beginning most of these capabilities could more common tools with well documented problem statements/benefits cases**
  - e.g., RAPT with flight planning lookup, Restrictions, TMI flight lists, etc.
- **As focus group gets more mature these capabilities can be driven by other focus groups (e.g., Operational Issues focus group)**
- **Build the logical flow mapping services/data elements to create this capability**
- **Main output will be a new document “SWIM-Enabled Capability Development Document”**

Focus Group Solution Development



jetBlue 20th

SWIM/SWIFT

Christopher Gottlieb
Manager IT Ops Products

Briefing Overview

Department Structure

Technical Inventory

Current Tools

Problems to Solve

Current Team Structure

Manager IT Operations

Project Manager IT

Business Analyst IT

Developer IT

Products are supported by Product Managers in respective Product Silos.

Technical Inventory

Non Production	Production
SQL Database 4 Cores 1 Terabyte	JB Data Warehouse Enterprise Level Support

Scope of Feedback

- Customer Experience
- System Operations Center
- Operational Performance and Analysis
- Airports
- Aircraft Data Strategy

Problems to Solve

- Customer Experience – Reduce Impact to Certain Customer Base.
- System Operations Center – SWAP Route Recovery
- OP&A – Improve D0 and A14.
- Airports – Surface Management/ Extended Taxi outs.
- Aircraft Data Strategy – Transfer of Key Metrics to and from the AC and Cockpit.

Current State

Funding – Manpower , Database, Billable hours – JetBlue will spend between 350,000-700,000 on SWIM development and support. We expect to be over 1 million mark by end of 2021.

Products - We have one fully deployed and supported product (EDCT Dashboard).

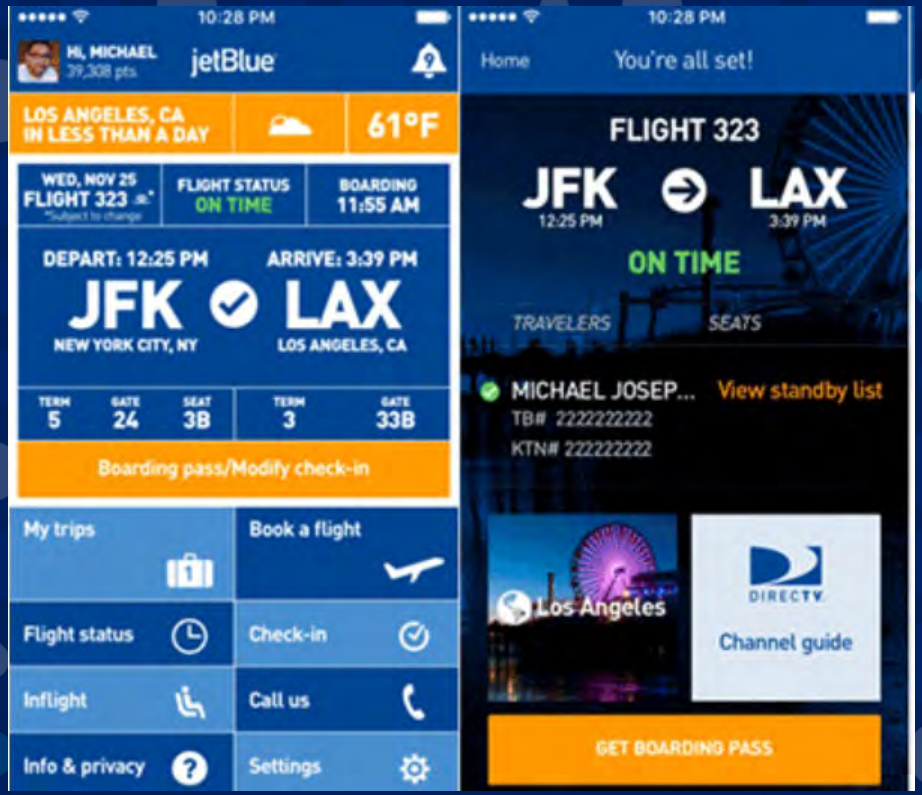
Proof of concepts – Two proof of concepts funded and prioritized.

SWIM IT Department by default are inheriting several other key areas of data integration.

Future state

Mobile App for Frontline Crewmembers.

Enhanced Mobile for key customers.



jetBlue 2020

SWIFT - SWIMming Into Development & Analytics

February 26th, 2020

SWIFT Development & Analytics Focus Group

Overview

- As Industry and Flight Operators have begun to ingest, store, and utilize SWIM data, many **common** challenges have arisen
  - Teams dedicated to solving these challenges outside of SWIFT are needed
- The Analytics & Development Focus Group will work collaboratively to advance the functionality and value of SWIM for Flight Operators and Industry
- Taskings / outcomes will likely connect to Operational Focus Group and CDM

Logistics

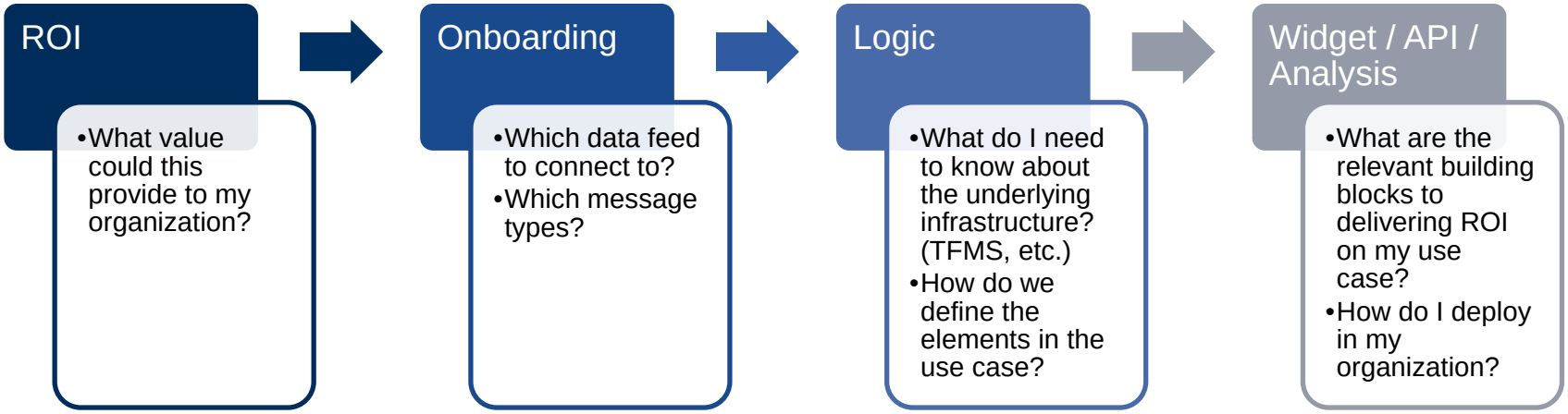
- Team is entirely volunteer based and will meet biweekly
- Target industry participants:
  - Business Analysts, Data Scientists, Data Engineers, App Developers
- Meetings will occur via web conference
  - Team will also assess feasibility of F2F
  - Potential to add meetings immediately preceding / following upcoming SWIFT workshops
- FAA Support team will be available to assist with logistics and documentation support

Mission: Let's collaboratively create a speedy transition from Information to Insights using SWIM

SWIFT Development & Analytics Focus Group

How do we get from Information to Insights?

- It can be a daunting task to start SWIM-ing with just a use case in hand
  - Ops Context Documents took an excellent step towards explaining the data
- Based on previous SWIFT discussions and the 1/14 Kickoff meeting, the following initial tasking is proposed:
  - Take an industry use case from idea to implementation
    - Develop any necessary definitions, logic, or processes
  - Publish for community use



- Use Case Ideas:
  - Demand
  - RAPT
  - Estimated Times

- Flights affected by TMIs
- TBFM impacts
- Gate Returns

SWIFT Operational Context Document

Time Based Flow Management (TBFM) Metering Information Services (MIS)

February 26th, 2020

Xavier Pratt, LS Technologies

February 26th , 2020

Federal Aviation Administration

Agenda

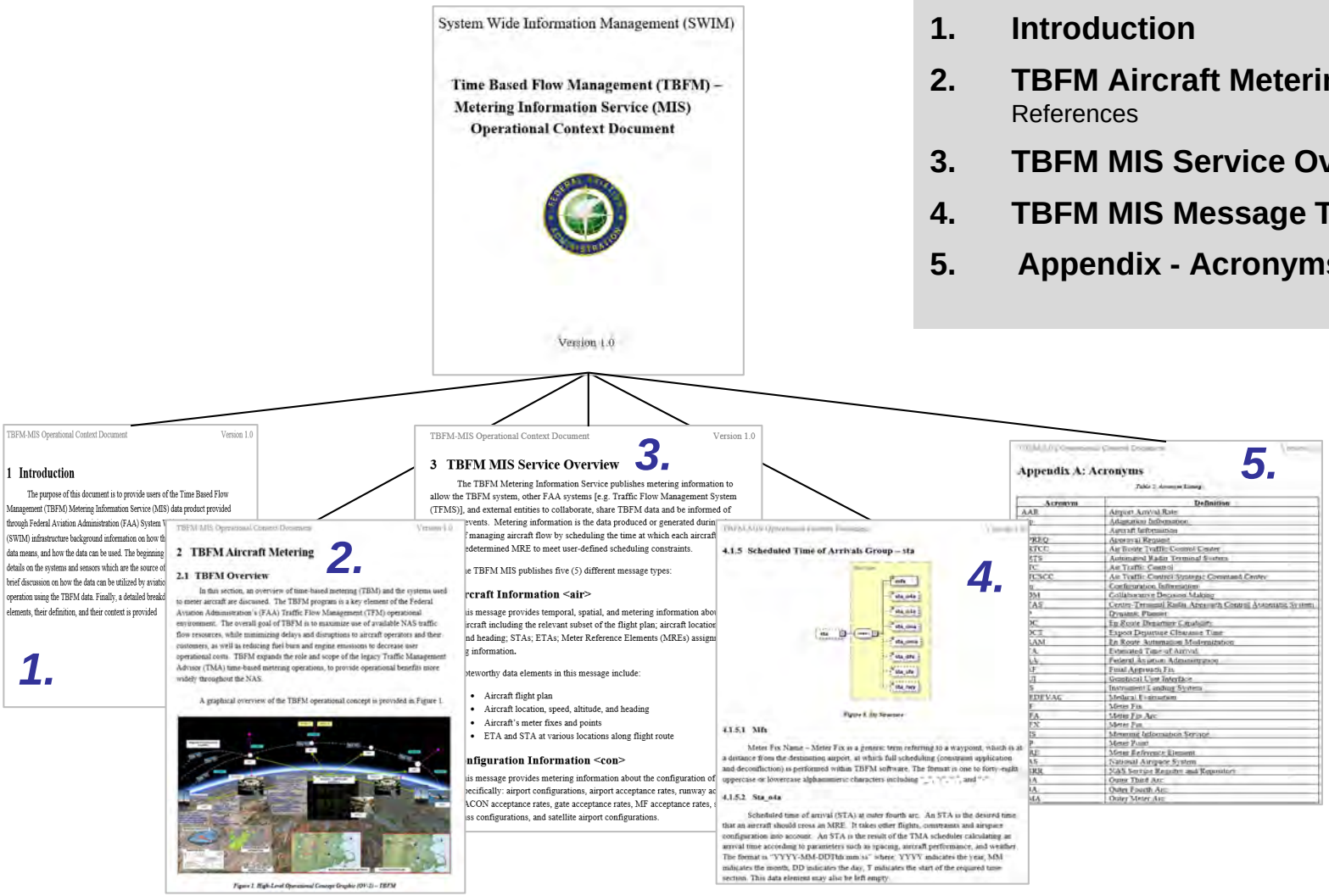
- **TBFM Background**
- **TBFM MIS Ops Context Document Layout**
- **TBFM Aircraft Metering**
- **TBFM MIS Service Overview**
- **TBFM MIS Message Types**

TBFM MIS Background

- **TBFM is a decision support tool used to optimize the flow of aircraft into capacity-constrained areas**
  - Calculates aircraft ETAs and corresponding STAs at various points along the aircraft flight path to an airport.
  - Sequences multiple streams of incoming and scheduled flights to fully utilize runway and other airport resources
  - Displays delay times to respective En Route controllers to aid traffic flow decision making from the ARTCC and/or TRACON controlled airspace to the runway

- **TBFM is operational at all domestic ARTCCs**
  - Access to TBFM schedule timelines and traffic plan views are provided to at least one TRACON and tower associated with each ARTCC
  - The Air Traffic Control System Command Center (ATCSCC) has operational TBFM displays from all of the ARTCCs

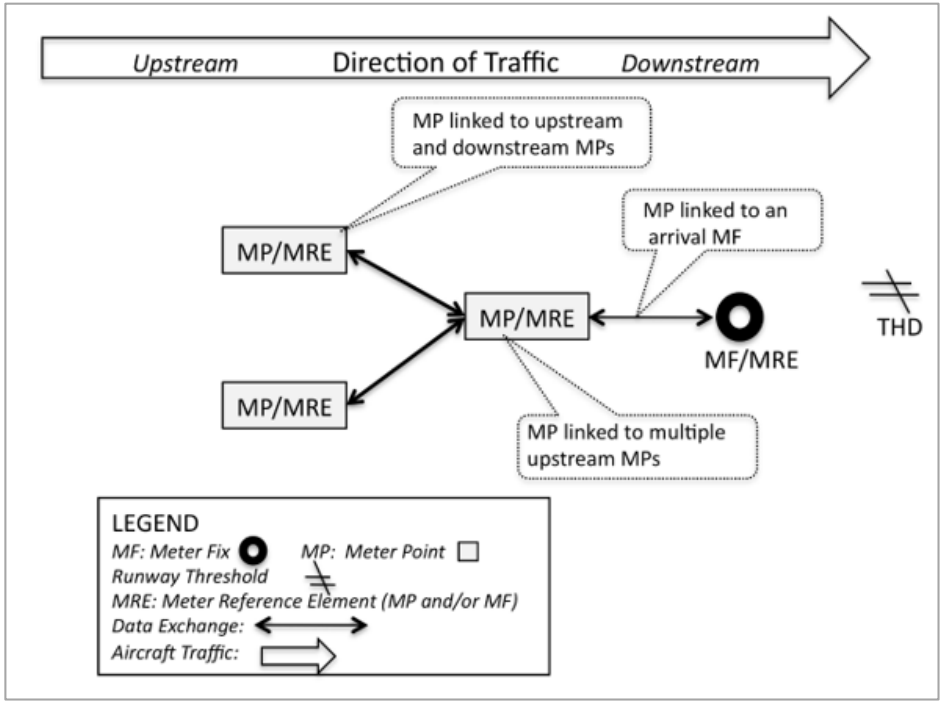
TBFM MIS – Ops Context Document Layout



1. **Introduction**
2. **TBFM Aircraft Metering** – Includes References
3. **TBFM MIS Service Overview**
4. **TBFM MIS Message Types**
5. **Appendix - Acronyms**

TBFM Aircraft Metering

- **TBFM Traffic Management Capabilities**
  - *Goals*
    - Maximize use of available NAS traffic flow resources
    - Minimize delays and disruptions to aircraft operators and customers
    - Reduce fuel burn and exhaust emissions to decrease user Ops costs
  - *Benefits and Capabilities*
    - Departure Scheduling
    - En Route Departure Capability
    - Airborne Metering
    - Arrival Management/Situational Awareness



Representation of TBFM Extended Metering Reference Element (MRE) Capability

TBFM Aircraft Metering

- **The focus of the TBFM is to more efficiently utilize the available airport capacity without decreasing flight safety.**

- **TBFM accomplishes this by providing automation aids for sequencing and scheduling flights to assist in optimizing:**
  - Airborne and arrival traffic flows
  - Departure flows
  - Departure flows into airborne and arrival traffic flows
  - Coordinated scheduling of traffic flows across adjacent facilities
  - Flexible scheduling of unused airspace capacity
  - Accuracy of scheduling information
  - Exchange of TBFM scheduling information
  - Situational display of weather impacts to traffic flow schedules
  - Unused airspace capacity

TBFM MIS Service Overview

- **Service Description**
  - The TBFM MIS publishes metering information to allow the TBFM system, FAA systems (e.g. TFMS), and industry to collaborate, share TBFM data and be informed of TBFM STAs that are in effect during metering events.
- **Service Consumers**
  - TBFM MIS is consumed by two types of subscribers: those subscribers internal to the NAS and those subscribers that are external to the NAS.
- **Service Interface**
  - TBFM MIS publisher interfaces with the NEMS using the NEMS Java Message Service Consumer (JMS-C) service with the Weblogic implementation
- **Service Functionality**
  - Aircraft Information
  - Configuration Information
  - Status Group Information
  - Adaption Information

TBFM MIS Message Types

Message Name	Description
Aircraft Information <air>	Provides metering information about an aircraft; specifically: flight plan (relevant subset), STAs, ETAs, Meter Reference Elements (MREs) Assignments, and scheduling group information
Configuration Information <con>	Provides metering information about the configuration of the system; specifically: airport configurations, airport acceptance rates, TRACON acceptance rates, gate acceptance rates, Meter Point acceptance rates, runway acceptances rates, super stream class configurations, and satellite airport configurations
Other Information <oth>	Provides metering information about the status of metering and the status of system interfaces
Adaptation Information <adp>	Provides information about applicable system adaptation to include TRACON names, gate names, configuration names, Meter Reference Point names, and stream class names
Synchronization Information	Sent only to indicate an impending refresh of all TBFM data, either as a result of system startup or a periodic synchronization event.

TBFM MIS Message Types – Category Groups

Message Category	Message Group	Message
"**air**" (Aircraft Information)	<**flt**>	Flight Plan Information
	<**trk**>	Tracking Information
	<**mrp**>	Meter Reference Element (MRE) Assignments
	<**eta**>	Estimated Time of Arrival (ETA)s
	<**sta**>	Scheduled Time of Arrival (STA)s
	<**sch**>	Scheduling Information
"**con**" (Configuration Information)	<**aac**>	Arrival Airport Configuration Information
	<**mar**>	Meter Point Acceptance Rate
	<**sac**>	Satellite Airport Configuration
	<**rar**>	Runway Acceptance Rate
	<**aar**>	Airport Acceptance Rate
	<**scc**>	Super Stream Class Configuration
	<**tar**>	TRACON Acceptance Rate
	<**gar**>	Gate Acceptance Rate
"**oth**" (Other Information)	<**int**>	TBFM Interface Status Information Group
	<**tmg**>	TBFM Metering Status Information Group
"**adp**" (Adaptation Information)	<**trn**>	TRACON Name Group
	<**gans**>	Gate Names
	<**apns**>	Airport/Runway/Configuration Names
	<**mrns**>	MRE Names
	<**scns**>	Stream Class Names
"sync" Synchronization Information	<**system_start**>	System Sync Start
	<**periodic_start**>	Periodic Sync Start
	<**periodic_end**>	Periodic Sync End

TBFM MIS Message Types – Category Groups

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"sync" Synchronization Information	<**system_start**>	System Sync Start
	<**periodic_start**>	Periodic Sync Start
	<**periodic_end**>	Periodic Sync End

TBFM MIS Message Example – Message <air> Category <flt> Flight Plan Information Properties

flt attribute or <element>	Format / Range	Element Description
airType	NEW | AMD | DEL	Aircraft data type NEW – new aircraft AMD – amend aircraft data DEL – delete aircraft
aid	[A-Z][A-Z0-9]{1,6}	Aircraft Identifier
dap	[A-Z0-9][A-Z0-9_/]{2,11}	Departure Airport/Fix Name
apt	[A-Z0-9][A-Z0-9_/]{2,11}	Destination Airport Name
tmaId	[A-Z][0-9]{5}	TMA unique identifier - Guaranteed to be unique between all TMAs, however, in the event of a TMA failure, after recovery or system restart, the tmaID for any aircraft previously received will change.
<old>	[A-Z][A-Z0-9]{1-6}	Aircraft identification before amendment
<aid>	[A-Z][A-Z0-9]{1,6}|	Aircraft identification
<dap>	[A-Z0-9][A-Z0-9_/]{2,11}	Departure airport/fix name
<apt>	[A-Z0-9]{3,9}	Destination airport name
<fps>	ACTIVE ESTIMATED DEPARTED PROPOSED BLOCKED_SLOT, ***Defined but not used:*** FP_TYPE_INVALID, LANDED, INVALID_FP_STATUS	Flight plan status
<acs>	ACTIVE DROPPED INACTIVE LANDED LOST PROPOSED TRACKED UNKNOWN_STATUS	Aircraft status ACTIVE - Departed/Estimated (no track) DROPPED - Host RH received INACTIVE – Tracking has stopped LANDED - Landed LOST - Temporary track loss PROPOSED – Proposed TRACKED - Actively tracking

TBFM MIS Message Example – Message <air> Category <flt> Flight Plan Information Properties [continued]

<**typ**>	Field 03a/03c/03e ([A-Za-z0-9]{1,3}/)?[A-Z][A-Za-z0-9]{1,3}(/[A-Za-z0-9])	Aircraft type, See NAS-IR-8217
<**eng**>	PISTON TURBO_PROP JET INVALID_ENGINE_TYPE	Engine Type P – Piston T – Turbo Prop J - Jet
<**bcn**>	[0-7]{4}|	Beacon code
<**spd**>	[0-9]{1,3}.[0-9]|[0-9].[0-9][0-9]|	Flight plan filed speed (nm/hr or mach)
<**ara**>	See Schema in above Appendix for AraType.	Assigned requested altitude (feet) or Visual Flight Rules or On Top
<**ina**>	[1-9][0-9]{2,5}|	Interim altitude (feet)
<**trw**>	[0-9]{1,2}[R|L|C]{0,1}|	TRACON assigned runway, not used by TMA
<**drw**>	[A-Z0-9_]{1,9}|	Departure runway name
<**tds**>	[A-Z][A-Z0-9]{2}|	Current track data source
<**cfx**>	[0-9A-Z/_]{2,12}	Coordination fix from most upstream Center
<**ctm**>	yyyy-mm-ddThh:mm:ssZ	Coordination time from most upstream Center
<**etd**>	yyyy-mm-ddThh:mm:ssZ	Estimated time of departure - Estimate of when aircraft actually departed, after the fact
<**std**>	yyyy-mm-ddThh:mm:ssZ	Scheduled time of departure - Set only if aircraft was manually scheduled by TMC
<**etm**>	yyyy-mm-ddThh:mm:ssZ	Estimated Departure Clearance Time This is the time from Host/TFMS
<**est**>	FAA | EDC	Estimated Departure Clearance Status FAA – Using FAA coordination time or STD EDC – Using EDCT time (if ETM non-zero)
<**a10**>	[0-9A-Z./_+]{6,940}	Flight plan Field 10A route
<**b10**>	[0-9A-Z./_+*]{6,940}	Flight plan Field 10B route (future)
<**c10**>	[0-9A-Z./_+*]{6,940}	Flight plan Field 10C route (future)
<**tcr**>	[0-9A-Za-z/0000 ./_+]+	TMA converted route

SWIFT Information & References

- **SWIFT Focus Group Website**
  - http://connect.lstechllc.com/index.cfm/main/opconfocusgroup
- **Documents**
  - In addition to the NSRR, all SWIFT Documentation can also be found at: https://connect.lstechllc.com/index.cfm/main/swifthome
- **Contacts**
  - Xavier Pratt xavier.pratt@lstechllc.com
  - Ray Mitchell ray.mitchell@lstechllc.com
  - Felisa White felisa.white@faa.gov

Examples of Machine Learning with TBFM Data
SWIM Industry/FAA Team (SWIFT) Briefing

February 26th, 2020

Al Capps - Al.Capps@nasa.gov

Objectives

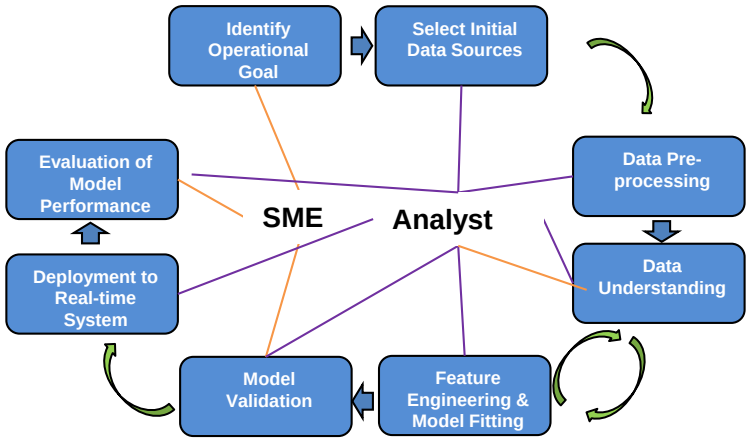
- *Describe Problem Solving Workflow*
  - Apply a cross-industry standard collaborative workflow to aviation data mining
- *Provide Examples*
  - Demonstrate versatility of analytical solutions via the use of a collaborative workflow in rapid development of machine learning models on different NAS challenges
- *Demonstrate Machine Learning as a Service*
  - Demonstrate how solutions can be rapidly deployed for real-time operations, not just post operations analysis
- *Obtain required input on a specific problem*
  - Obtain problem definition clarification information from the aviation community on the ‘High TBFM Delay’ problem mentioned in prior SWIFT meetings
- *Identify who can meet more frequently for faster progress*
  - Convey a sense of urgency to work quickly and collaboratively on common analytical aviation needs

CRISP-DM Process Applied to Aviation

50K Foot View

Cross-Industry Standard Process for Data Mining (**CRISP-DM**)

Variation of CRISP-DM Used by NASA



A key point to providing these two workflows is to highlight the ***necessity*** of an iterative workflow between SMEs and Analysts.

Each step is important, and there are experts in each of these workflow areas that can perform these tasks quickly.

Example 1 - Motivation and Operational Goal

Motivation

- It may surprise some aviation enthusiasts to learn that at large multi-runway airports in the National Airspace System (NAS), the arrival landing runway is often not known ahead of the actual landing

- Knowledge of landing runway can provide benefits:
  - Landing time prediction
  - Taxi-in time prediction
  - Gate Conflict prediction
  - Gate resource utilization information (e.g. tugs, etc.)

Goals

- Allow operators and ATC systems to identify the most likely landing runway
- Provide this service in near real-time, targeting at least 1 hour ahead of landing
- Report the accuracy of the predictions provided
- Strive for maintainability and scalability across all NAS airports

Identify Operational Goal

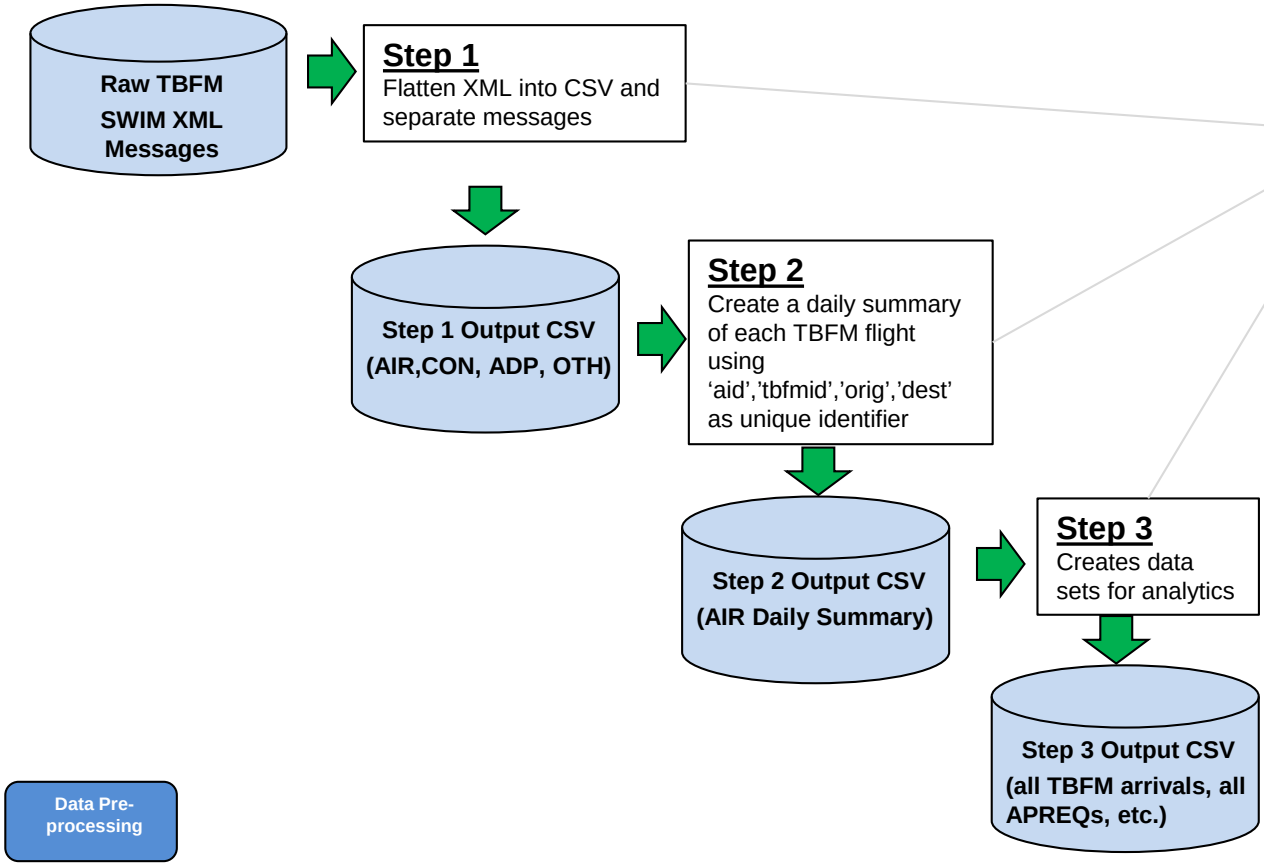
Focus on TBFM SWIM Data

- TBFM SWIM
  - Predicts a landed runway for its own internal processes. This could serve as a useful baseline to assess merit of machine learning comparison.
  - Has other attributes/features that may be beneficial to prediction. Tax payers spent significant funding adapting TBFM across the NAS so additional benefit is desirable.

- Truth data for actual landed runway
  - Controller scratchpad entries provided in TBFM (at some sites)
  - Analysis of alternative sources for larger truth data set likely leads to additional data sources that need to be merged with this initial data set.

Select Initial Data Sources

Python Scripts to Create TBFM SWIM "AIR" Dataset



For this presentation, python scripts were created for each step which pull from public TBFM SWIM data. There are many ways to accomplish this in other languages or designs.

Data Pre-processing

Data Understanding - Description

- For a description of the TBFM SWIM data source and its operational context, see
  - https://nsrr.faa.gov/nsrr-library-document/9298
  - Specifically, section 4.1.1 contains a definition of the data elements used

- Of the columns available in TBFM AIR messages, the ones utilized for this work were:
  - "trw"- TRACON runway assigned by the controller. This was considered "truth" runway. Note: other sources of runway truth are currently being evaluated, especially given controller scratchpad entries are not available for all airports.
  - "rwy" -Runway that TBFM used in its internal model. This was used only to assess TBFM accuracy.
  - "dap" – Departure airport
  - "apt" – Arrival airport
  - "typ" – Aircraft type (although this was later eliminated from modelling)
  - "mfx" – Arrival meter fix name as adapted in TBFM.
  - "gat" – Arrival gate name as adapted in TBFM.
  - "cfg" – The configuration, as listed in TBFM.
  - "scn" – Stream class name. This essentially tells TBFM which flights need to be separated from one another.

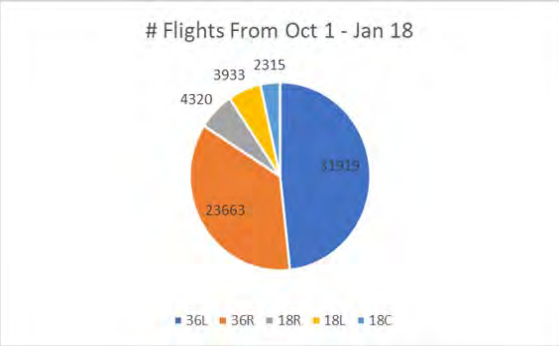
mfx	gat	scn	typ	eng	trw	rwy	match
ADOWN	SHINE	FILPZ_JET	A321/L	JET	18R	5	0
ADOWN	SHINE	FILPZ_JET	A321/L	JET	18R	5	0
BOATN	SHINE	PARQR_JE	C560/L	JET	18C	18R	0
ADOWN	SHINE	FILPZ_JET	A321/L	JET	18R	5	0
SUDSY	MAJIC	CHSLY_JET	B752/L	JET	18R	5	0
ADOWN	SHINE	FILPZ_JET	H/DC10/L	JET	36L	36L	1
FIBBR	CTF	STOCR_EA	C56X/L	JET	36R	36C	0
ADOWN	SHINE	FILPZ_JET	H/B763/L	JET	36L	36L	1
ADOWN	SHINE	FILPZ_JET	H/A306/L	JET	36L	36L	1

Here TBFM's runway (rwy- 36L) matches the target (trw- 36L)

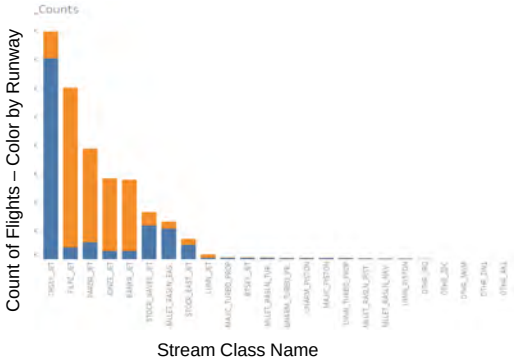
Data Understanding

Data Understanding – Sample & Baseline Description

- CLT data was used given ATD-2 team's ability to verify accuracy (available at many other airports)
- Data was collected from Oct 1st 2019 through Jan 18th, 2020. Only rows with all required data elements properly populated were kept. With this filtering, **66,165** rows/flights remained for training and test.



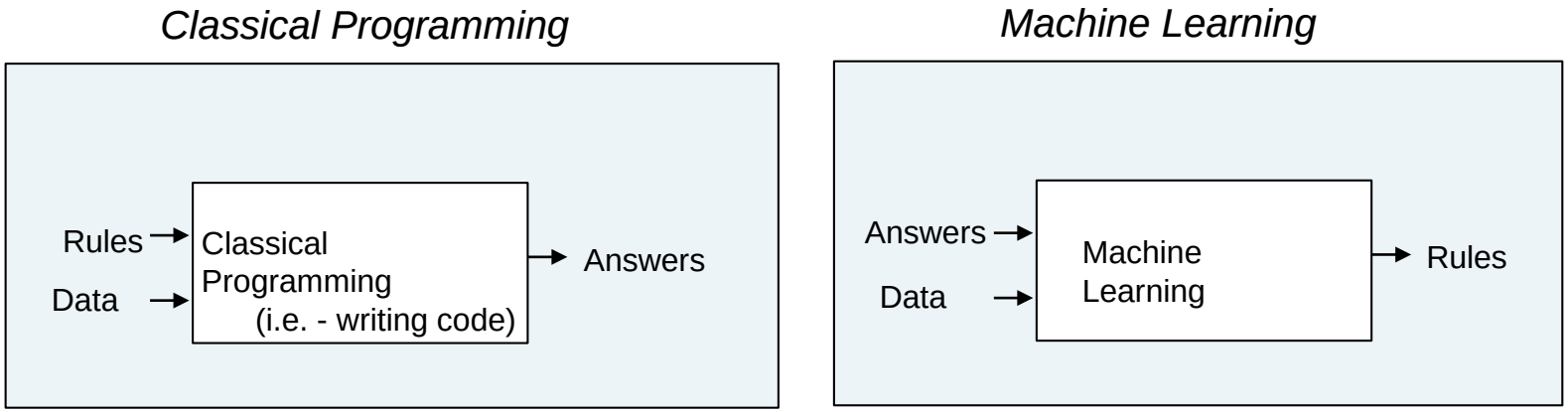
Controller Runway	# Flights	% Flights
36L	31919	48.2
36R	23663	35.8
18R	4320	6.5
18L	3933	5.9
18C	2315	3.5
23	6	0.0



- Given the dominance of North landed runways (36L, 36R), the modelling was specifically developed to focus on this flow direction. This presumes that the configuration, or flow direction, would be passed into any algorithm that would seek to use this modelling.
  - With this decision, this becomes a 'binary classification' problem
- TBFM arrival runway prediction accuracy was approximately 70% accurate to these runways during this time.
  - This served as a baseline for the learner to attempt to beat

Data Understanding

How Machine Learning Differs from Classical Programming (50K Foot View)



The rules that machine learning automatically creates are applied to new data points to provide new answers.

Initial Models to Assess How Well Commonly Used Techniques Will Work with this Dataset

- 8 initial binary classification models were evaluated on the dataset
  - Naïve Bayes
  - Linear regression Model
  - Logistic regression
  - Fast Large Margin
  - **Deep Learning**
  - Decision Tree
  - Random Forest
  - **Gradient Boosted Trees**

- Gradient boosted trees had the highest accuracy and lowest variance
  - This was without any hyperparameter tuning (roughly out-of-the-box models)
  - While other models may appear to be close (e.g. within 1%, their performance on other key metrics beyond accuracy underperformed these two learners)

Feature Engineering & Model Fitting

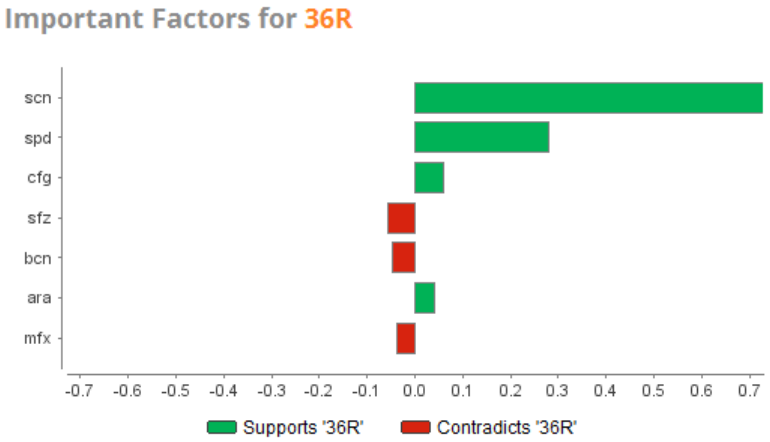
Input Attribute (Feature) Relative Importance

Feature Importance - Overall

Gradient Boosted Trees - Weights

Attribute	Weight
scn	0.352
spd	0.084
sfz	0.081
cfg	0.065
ara	0.045
tds	0.040
mfx	0.022
bcn	0.017
gat	0.017

Feature Importance – By Runway (target)



- Feature importance information from the models were used to continue the winnowing down (reduce dimensions) of the attributes used in the modelling to the most relevant, while also considering new features that would improve performance

Feature Engineering & Model Fitting

Develop Python Model and Validate

- Based on the promising initial results, a Light Gradient Boost (LGBoost) model was developed in python
  - LGB has been recently winning a number of the data science competitions due to its ability to evaluate a leaf of the tree without creating an entire branch (better performance)

- The steps were:
  - Read in the CSV file that came from previous steps into a Pandas data frame
  - Create two data frames. One for features, one for truth.
  - Create and store interim steps in ModelFamily wrapper class. More on this later.
  - Encode variables as required for the Light Gradient boost (LGB) model.
  - Split the dataset into train and test.
  - Specify initial hyperparameters and train the LGB model on the training dataset.
  - Use the trained model to generate new predictions on the test data.
  - Measure the performance of the test dataset.
  - When satisfied with performance of the model, store/save it for later use.

- N-fold validation is a commonly used technique to prevent “over fitting” and create a robust learner that will work well with data it has never seen

```
import lightgbm as lgb
from sklearn.model_selection import train_test_split
from sklearn.metrics import accuracy_score
```

```
##Convert categorical data using 'one hot' encoding
## This tends to be more robust to various models compared to int encoding
one_hot_scn=pd.get_dummies(arr_df.scn)
one_hot_mfx=pd.get_dummies(arr_df.mfx)
one_hot_eng=pd.get_dummies(arr_df.eng)
```

```
##Set paramaters
param = {'num_leaves':150, 'objective':'binary','max_depth':7,
        'learning_rate':.05,'max_bin':200}
param['metric'] = ['auc', 'binary_logloss']

#training the model using light gbm
num_round=50
start=datetime.now()
lgbm=lgb.train(param,train_data,num_round)
```

```
#converting probabilities into 0 or 1
for i in range(len(test_pred)):
    if test_pred[i]>=.5:
        test_pred[i]=1
    else:
        test_pred[i]=0

#calculating accuracy
accuracy_lgbm = accuracy_score(test_pred,y_test)
print(accuracy_lgbm)
```

Model Validation

Saving the Model for Later Use in Web Service

- The final model was saved/serialized for later use
  - In this case, we used ‘pickle’
  - This created a 0.5mb file on disk
- There are a number of different frameworks to use our new model (***as a service***).
- Deployment options need to consider many factors depending on how the service will be used
  - When using the model as a service, you do not need to load the model every request. It can be used efficiently to provide answers just like classical programming services.
  - In our case, we use python ‘flask’

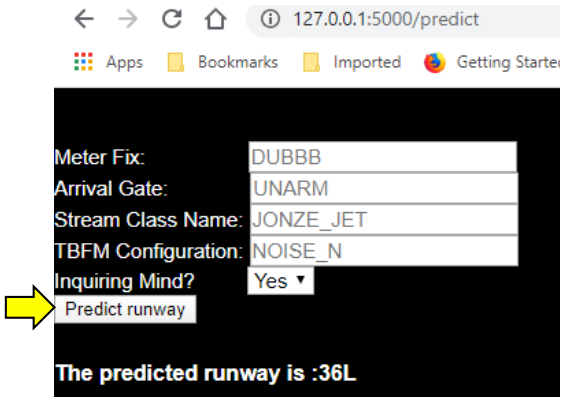

```
##Ok, looks good. Before saving the model, train it on the entire dataset
train_data=lgb.Dataset(x,label=y)
lgbm=lgb.train(param,train_data,num_round)

##Serialize/Save the CLT LGB model to file
filename = 'clt_arr_runway_predictor.sav'
pickle.dump(lgbm, open(filename, 'wb'))
```

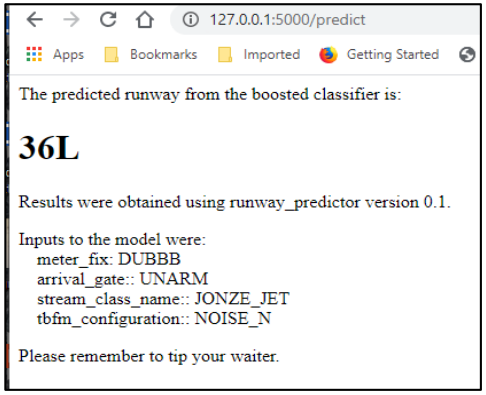
Open source python micro-framework to test services

https://palletsprojects.com/p/flask/

Deployment to Real-time System | Evaluation of Model Performance

Testing Machine Learning as a Service (MLaaS)





Deployment to Real-time System

Evaluation of Model Performance

```python
import pandas as pd
import numpy as np
from flask import Flask, request, jsonify, render_template
import pickle
import warnings
warnings.simplefilter(action='ignore', category=FutureWarning)
import ModelFamily
import lightgbm as lgb

##The following will be loaded and executed as soon as the service is started
app = Flask(__name__)
model_fam = pickle.load(open('arrival_runway_prediction_family.sav', 'rb'))
model=model_fam.models.get("clt_runway")
model_fam_name=model_fam.name
model_fam_version=model_fam.version

@app.route('/')
def home():
    return render_template('index.html')
```

- A simple web page was developed that allowed the user to enter the key inputs required by the model
  - This was just for test, likely different use in operations
- For operational deployment of python consider Heroku or other open source environments
  - For the time being, NASA team is likely to stick with python stack instead of predictive markup modeling language (PMML) given complexities/overhead

Example 2 - Motivation and Operational Goal

Motivation

- At prior SWIFT meetings and other collaborative forums, operators have expressed the desire to find solutions for ***high and unpredictable delay*** from TBFM (APREQs)

- Knowledge of flights that have high delay can lead to:
  - Better understanding of the factors that influence this behaviour
  - Early information on flights that are likely to have high TBFM delay
  - Identification of procedural changes that could help flying public

Goals

- Assess how well the aviation community can estimate the size of TBFM APREQ delay
- Report the accuracy of the predictions provided
- Identify path to provide this information in near real-time (via service)
- Perform root cause analysis and/or recommended next steps to mitigate the problem

Identify Operational Goal

Focus on TBFM SWIM Data *plus 'Ready Time'*

- TBFM SWIM data shown in the prior learner was used as a starting point
  - Given the potential to predict TBFM assigned delay in near real-time, it was important to limit the dataset to those elements that are available prior to APREQ scheduling
  - Step 3 output from the python script was used to obtain all APREQs for a day and the unique TBFM identifiers.
  - This data was re-run through step1 output to only fill in data available up until scheduling

- TBFM delay data
  - NASA pulls down the TBFM system binary data from WJHTC every night
  - This data is in a TBFM proprietary form. It is translated to text.
  - The translated text is then processed for information.
  - The "ready time" from TBFM is a key data element to determining how much TBFM assigned delay a flight has

- TBFM Assigned Delay = *Scheduled Time of Departure from TBFM – Ready Time (in minutes)*

Select Initial Data Sources

Data Understanding - Description

- In addition to the elements earlier, the following TBFM SWIM data elements were used:
  - “ctm” – Coordination time. In our case for departures, that is TBFM’s expected departure time from the airport.
  - “etm” – EDCT time, if it has one. We translated this into a yes/no hasEDCT boolean feature.
  - “scnname” – TBFM “con” message - Stream class name that is used with ssd (below) to determine MIT
  - “ssd” – TBFM “con” message – Super Stream Class distance

- Important note is the “scnname” and “ssd” from TBFM “con” gives the MIT separation for this flight
  - This needs to be synchronized/matched with the “air” messages, and becomes a new feature in our dataset

Data Understanding

Features from “air” messages

dap	apt	mfx	scn	typ	spd	ara	ctm	etm
CVG	EWR	DJB	EWR_DJB	E170/L	431	31000	2019-11-02T00:30:00Z	2019-11-02T01:00:00Z
BOS	EWR	SHF	EWR_SHF	B739/L	354	16000	2019-11-02T00:00:00Z	2019-11-02T01:09:00Z
DTW	EWR	MILTON	EWR_MILTON	BCS1/L	456	37000	2019-11-02T01:22:00Z	2019-11-02T01:14:00Z
BOS	EWR	SHF	EWR_SHF	E190/L	393	16000	2019-11-02T00:20:00Z	2019-11-02T01:20:00Z
BWI	EWR	DYL	EWR_DYL	B737/L	338	23000	2019-11-02T01:59:37Z	2019-11-02T01:51:00Z
CMH	EWR	MILTON	EWR_MILTON	E170/L	425	31000	2019-11-02T00:00:00Z	2019-11-02T02:21:00Z
PIT	EWR	MILTON	EWR_MILTON	E75L/L	433	27000	2019-11-02T01:59:14Z	2019-11-02T02:23:00Z
CMH	EWR	MILTON	EWR_MILTON	E170/L	446	33000	2019-11-02T02:24:00Z	2019-11-02T02:26:00Z
DCA	EWR	DYL	EWR_DYL	E170/L	376	17000	2019-11-02T02:52:24Z	2019-11-02T03:02:00Z
ROC	ORD	PTN/MKG	ORD_PTN/MKG	A320/L	460	34000	2019-11-01T11:50:55Z	
CVG	ORD	MZZ	ORD_MZZ	H/B762/Z	483	28000	2019-11-01T10:58:00Z	
CVG	DFW	PXV	DFW_PXV	H/B763/L	467	32000	2019-11-01T10:55:00Z	
TYS	ORD	MZZ	ORD_MZZ	CRJ2/L	432	30000	2019-11-01T21:54:32Z	
YYZ	ORD	PTN/MKG	ORD_PTN/MKG	E75S/L	455	32000	2019-11-01T10:44:22Z	
CLE	EWR	MILTON	EWR_MILTON	B738/L	443	37000	2019-11-01T11:43:57Z	
PIT	MDW	BAGELMP	MDW_BAGELMP	B737/L	461	32000	2019-11-01T09:44:44Z	

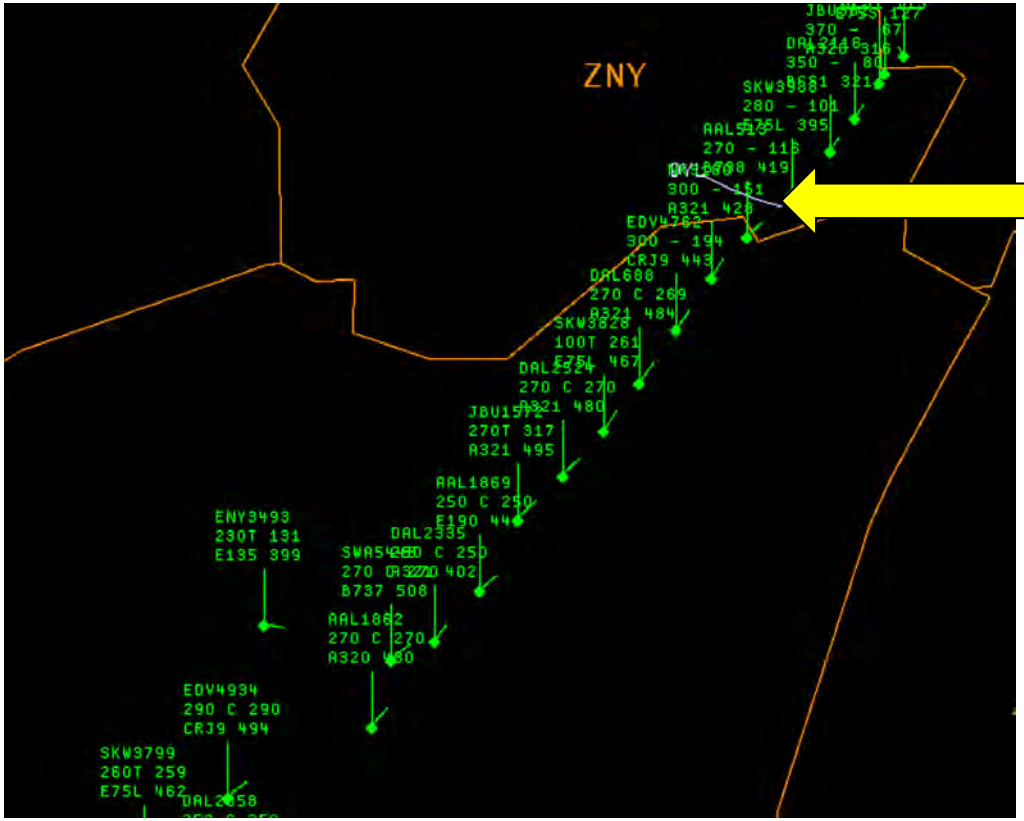
25 MIT over LGA_DYL

Derived feature from “con” messages


```
<ssc
sscType="NEW"><ssn>23</ssn><sscname>LGA_DYL</sscname><ssd>25.0</ssd><s
smin>0</ssmin><sstyp>SSC_MILES_IN_TRAIL</sstyp><scls><scl
sclType="NEW"><scname>LGA_DYL</scname><scmre>DYL</scmre></scl></scls><
ccs><cc
ccType="NEW"><apt>BWI</apt><apreq>SEMI</apreq><sch>ACCEPT</sch></cc><c
c
ccType="NEW"><apt>CLT</apt><apreq>SEMI</apreq><sch>ACCEPT</sch></cc><c
c
ccType="NEW"><apt>DCA</apt><apreq>SEMI</apreq><sch>ACCEPT</sch></cc><c
c
ccType="NEW"><apt>IAD</apt><apreq>SEMI</apreq><sch>ACCEPT</sch></cc><c
c
ccType="NEW"><apt>RDU</apt><apreq>SEMI</apreq><sch>ACCEPT</sch></cc><c
c
ccType="NEW"><apt>RIC</apt><apreq>SEMI</apreq><sch>ACCEPT</sch></cc></
ccs></ssc><ssc
sscType="NEW"><ssn>24</ssn><sscname>JFK_HOG</sscname><ssd>30.0</ssd><s
smin>0</ssmin><sstyp>SSC_MILES_IN_TRAIL</sstyp><scls><scl
sclType="NEW"><scname>JFK_HOG</scname><scmre>HOG</scmre></scl></scls><
ccs><cc ccType="NEW"><apt>BWI</apt><apreq>SEMI</apreq><sch>ACCEPT
```

Importance of Super Stream Classes in TBFM

- LGA_DYL super stream class in TBFM is among the busiest in the county



LGA_DYL Metering Arc

Super stream classes have been adapted across the country in TBFM instances.

They define how flights are grouped coming out of, and leading into airports. Often, a MIT separation is used at these points to regulate the flow of traffic into important airspace/airport locations.

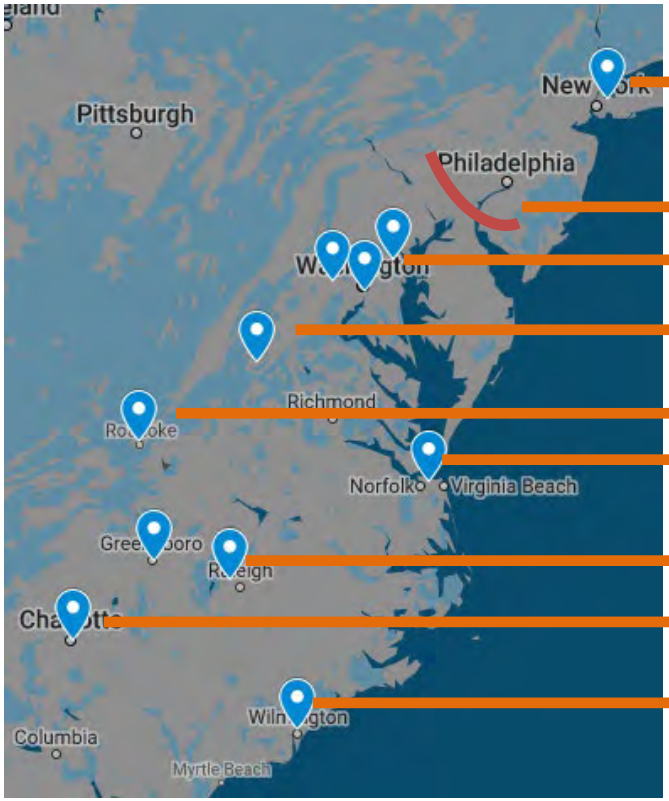
Data Understanding

Goldilocks Zone – Close in Airports are Hot- Have Higher Delay

Estimated 90th Percentile delay by Origin into LGA_DYL for all of 2019

Origin	90th % Delay (min)	Number Apreqs	Distance (nm)
BWI	39	89	132.6
DCA	26	5717	164.9
IAD	33	1110	188.4
RIC	22	2738	213.9
CHO	18	1316	253.9
ORF	17	2386	270.6
RDU	17	4420	329.8
ROA	12	288	347.0
GSO	15	2155	389.6
ILM	15	781	402.7
CLT	8	5036	451.9

Better



LGA Airport

LGA_DYL Metering Arc

32 minute delays (90th %)

18 minute delays (90th %)

12 minute delays (90th %)

17 minute delays (90th %)

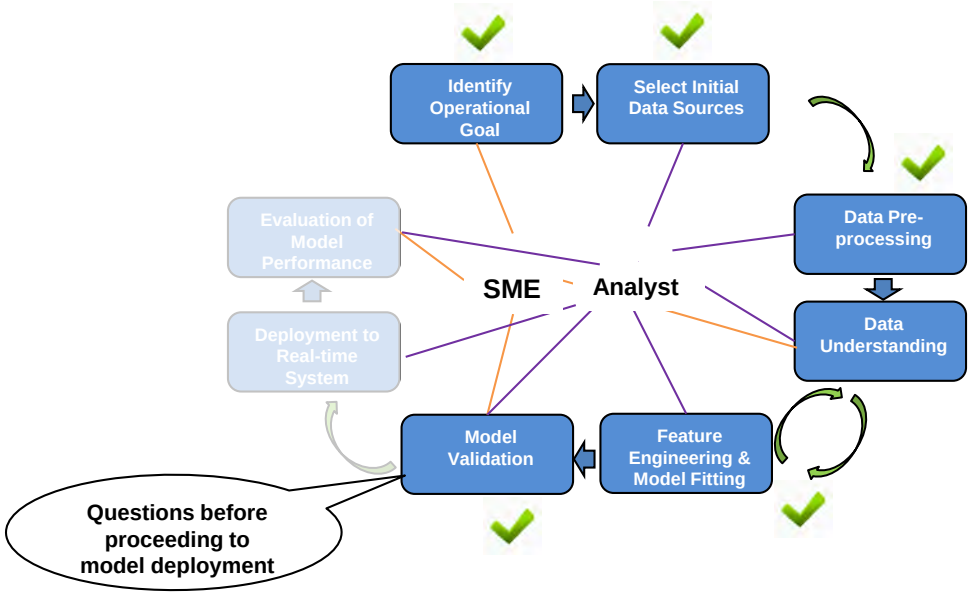
16 minute delays (90th %)

8 minute delays (90th %)

15 minute delays (90th %)

Data Understanding

Questions Before Proceeding



- Questions to community before proceeding:
  - Is a model that lets users know the predicted size and variance of TBFM assigned delay (by city pairs and stream class) valuable to the community even if the standard deviation is extremely large (e.g. 10 minutes)? Or do the predictions need to be more accurate (lower std) to be usable?
  - Can the community use data like that shown in this process to create a science/evidence-based definition of the “high TBFM delay” problem to help us focus our resources on the right problem?

Summary Thoughts

- The aviation industry's biggest barrier to more fully benefitting from ML is ***constructing our problems in the right format*** to take advantage of ML breakthroughs that already exist (and are growing every day). This includes:
  - Creating an operationally meaningful problem as a ML challenge
  - Comporting our data into clean **datasets** with solid "ground truth" data
  - Creating initial **benchmarks** that ML experts can beat

- Can we predict the likely landing runway with high certainty? If so, how good are the predictions?
  - Yes, initial indications are very promising. The current day TBFM arrival runway prediction in this example was on the order of 70% accurate, whereas the gradient boost machine learning models achieve close to 90% accuracy. This is a significant improvement.

- Can models developed with machine learning be deployed and leveraged in near real-time?
  - Yes. In this example we deployed the model that was trained in post ops and leveraged it in a web service. Once the model is deployed as a service, near real-time data can be used to call it and get results from the model predictions.

- More specificity is needed from the community on the "high TBFM delay" operational problem mentioned in prior SWIFT meetings
  - This will help evidence-based solutions and can also be used to measure the benefits once solutions are deployed

- These problems would benefit from more frequent engagement by the aviation analytical community to prevent stovepipe solutions, ensure truth in reporting and leverage lessons learned across teams

BREAK

L3HARRIS™

CASE STUDY:
FLIGHT INFORMATION WIDGETS

Using data from SWIM Cloud Distribution Service (SCDS)

February 26th , 2020 **DOUG HARVEY**

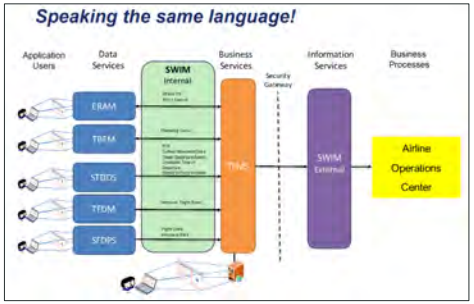
Evolution of SWIFT

YEAR 1: COMMUNICATE

Inform community about SWIM & NAS programs

“Listen to the community”

“Speak the same language”

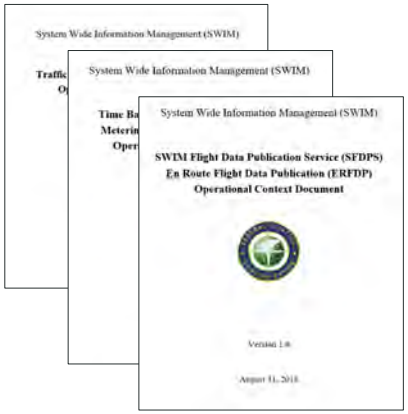


YEAR 2: EDUCATE

Synchronize community on information services

“Show and Tell”

“Share problems we all have”

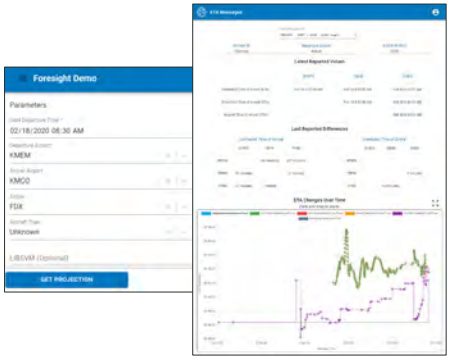


YEAR 3: COLLABORATE

Discuss issues most relevant to community

“Solve case studies”

“Quick wins with widgets”



Easier access to data + more operational context = opportunity for results!!

SWIM Widget Challenge

WIDGET #1

Goal:

Build an interesting widget that uses SWIM data

Background:

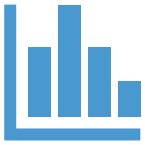
Software Developer type with limited knowledge of consuming or using SWIM data

Project:

Widget that collects multiple ETAs from SWIM feeds and compares them with each other

Limit:

One developer for a week



WIDGET #2

Goal:

Build an interesting widget that uses SWIM data

Background:

Data Scientist / Analyst type with no prior knowledge of consuming or using SWIM data

Project:

Widget that utilizes SWIM data and Machine Learning to predict taxi-out times

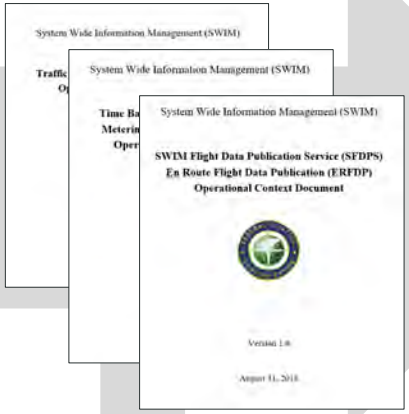
Limit:

One developer for a week

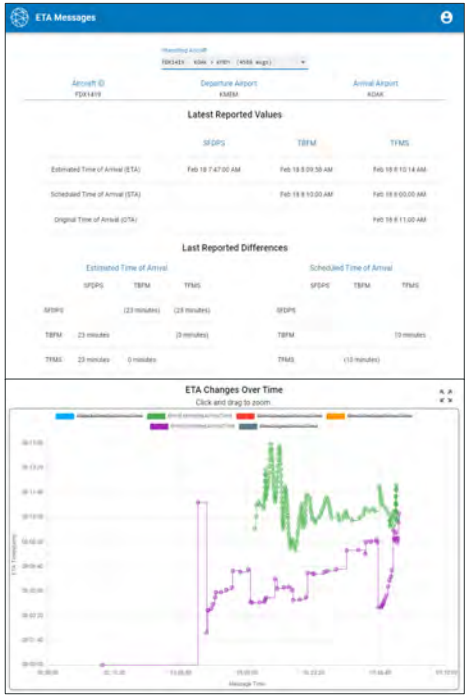
Widget #1: The Concept

https://nsrr.faa.gov

Operational Context & Technical Docs

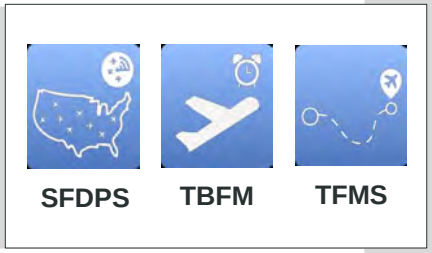


ETA Widget Demo

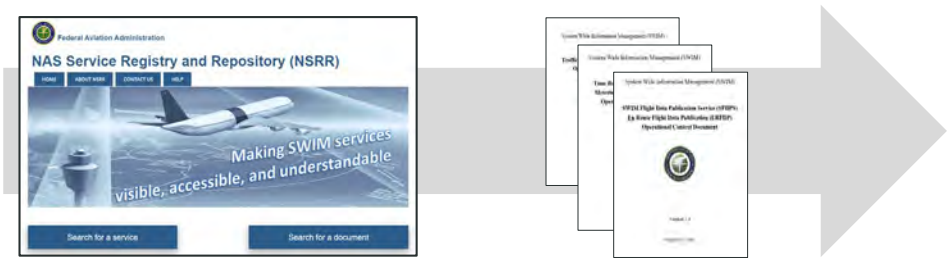


https://scds.swim.faa.gov

SWIM Data Feeds



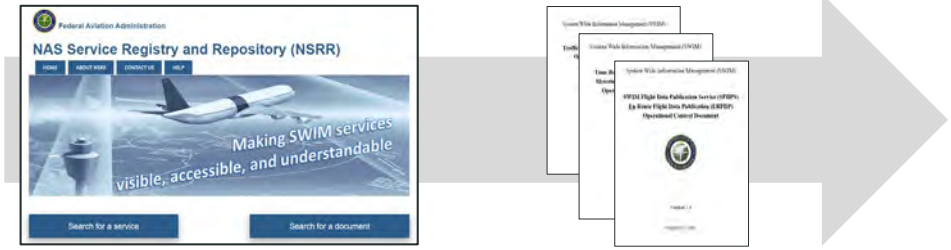
Widget #1: The Research



Operational Context & Technical Docs (JMSDD)

SFDPS	TBFM	
Estimated	Estimated	Scheduled
runwayTime/estimated/@time	eta_rwy	sta_rwy
Estimated Time of Arrival (ETA) at destination in hours and minutes. ETA supplied only if the ETE was filed with the flight plan. Four digits representing time in format hhmm. Departure Information - DH • Page 40 section 4.5.15 Flight Plan Reconstitution Message - DBRTFPI • Page 97 section 4.26.42	The earliest time an aircraft would cross a fix or runway threshold if allowed to follow its assigned flight path without being impeded by separation constraints to other aircraft and with no weather or air traffic control restrictions are placed on the aircraft flight. env/tma/air/eta • Page 27 section 4.1.4.9	An STA is the result of the TMA scheduler calculating an arrival time according to parameters such as spacing, aircraft performance, and weather. env/tma/air/sta • Page 29 section 4.1.4.8

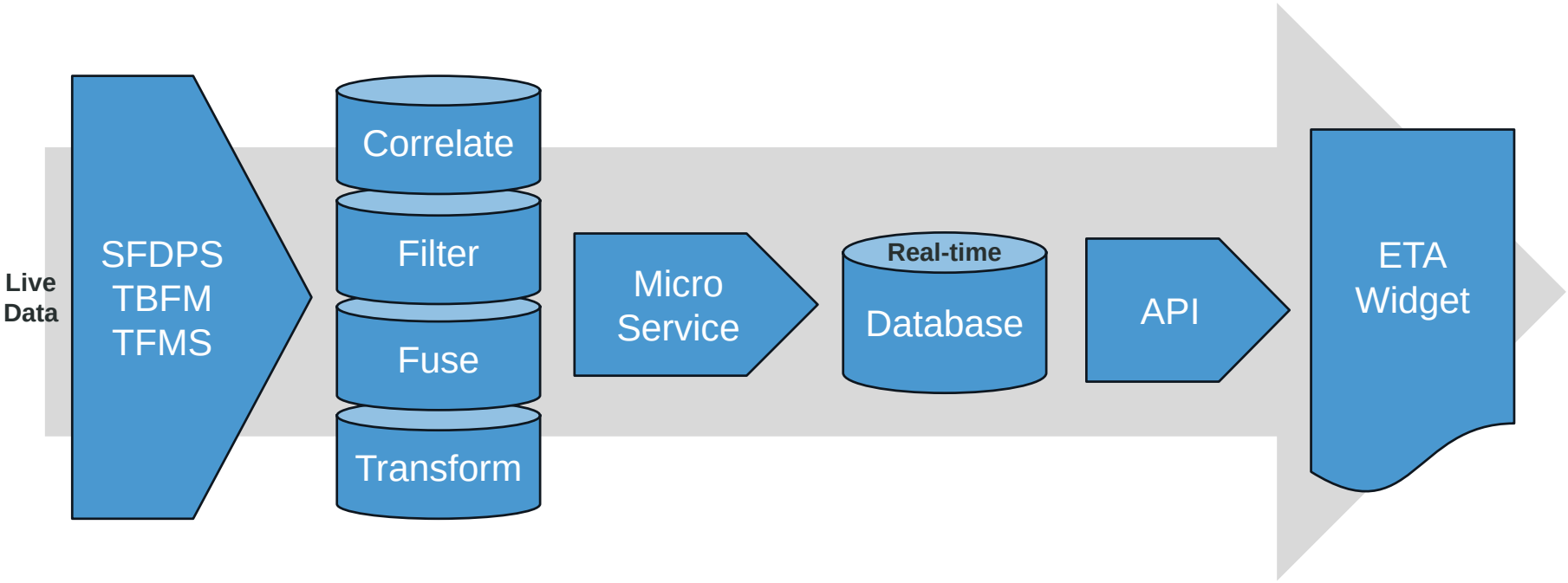
Widget #1: The Research (continued)



Operational Context & Technical Docs (JMSDD)

TFMS		
Estimated	Scheduled	Original
eta/timeValue or estimatedTimeOfArrival (*)	eta/timeValue	originalArrival
The runway arrival time estimated by TFMS. The estimated time of runway arrival as provided by the Airspace User etaType = ESTIMATED flightPlanInformation • Page 28 section 4.1 flightPlanAmendmentInformation (*) • Page 30 section 4.1.1 departureInformation • Page 32 section 4.1.2 trackInformation • Page 38 section 4.1.6 oceanicReport • Page 41 section 4.1.7 ncsmFlightCreate • Page 43 section 4.1.9 ncsmFlightModify • Page 45 section 4.1.10 ncsmFlightScheduleActivate • Page 47 section 4.1.12 ncsmFlightTimes • Page 52 section 4.1.15	The runway arrival time estimated by TFMS. The estimated time of runway arrival as provided by the Airspace User etaType = SCHEDULED flightPlanInformation • Page 28 section 4.1 departureInformation • Page 32 section 4.1.2 trackInformation • Page 38 section 4.1.6 oceanicReport • Page 41 section 4.1.7 ncsmFlightCreate • Page 43 section 4.1.9 ncsmFlightModify • Page 45 section 4.1.10 ncsmFlightScheduleActivate • Page 47 section 4.1.12 ncsmFlightTimes • Page 52 section 4.1.15	The last Runway Arrival Time - Traffic Flow Management System Estimated modeled by TFMS before either a Traffic Management Initiative (TMI) is issued, or the flight departs, or the flight is time-out delayed by TFMS airlineData/FlightTimeData/originalArrival ncsmFlightCreate • Page 43 section 4.1.9 ncsmFlightModify • Page 45 section 4.1.10

Widget #1: The Design



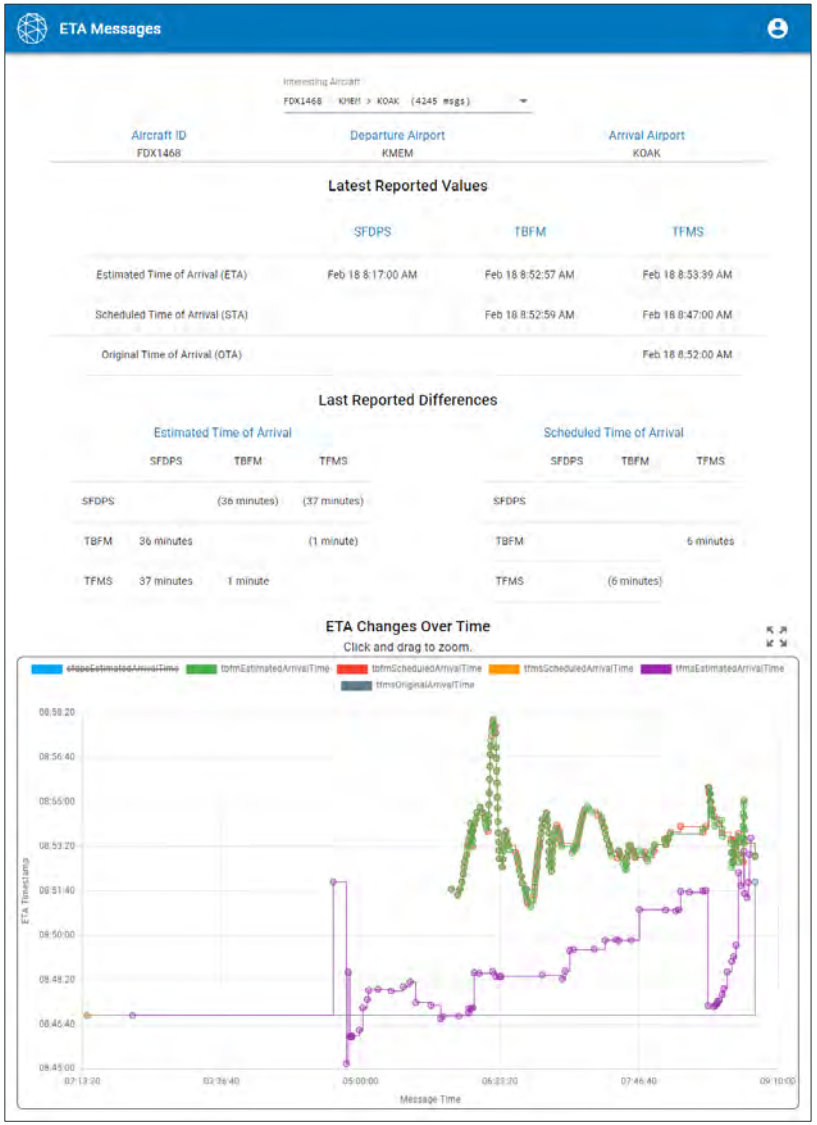
Handling the Data

- Transform SWIM data from XML to JSON
- Filter each data feed for attributes we care about
- Correlate data from each feed and fuse into a single message per flight
- Make fused data available via a micro service
- Consume micro service and place data into database

Visualizing the Data

- Widget calls API to query database for data
- API returns data to the widget in JSON
- Widget displays and visualizes the results

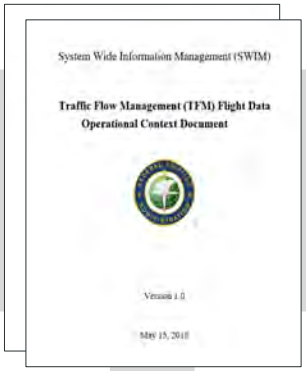
Widget #1: The Demo



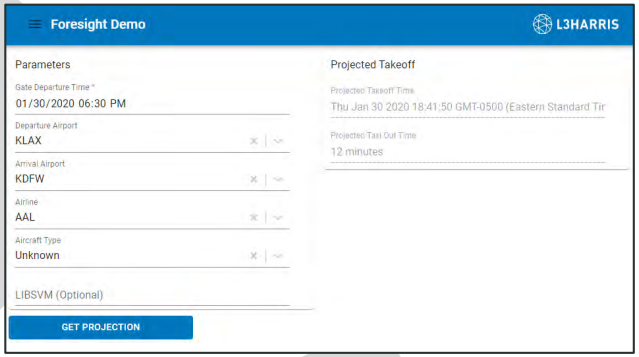
Widget #2: The Concept

https://nsrr.faa.gov

Operational Context & Technical Docs



Foresight Widget Demo



https://scds.swim.faa.gov

SWIM Data Feed

TFMS Flight

Machine Learning

AWS SageMaker

Widget #2: The Research

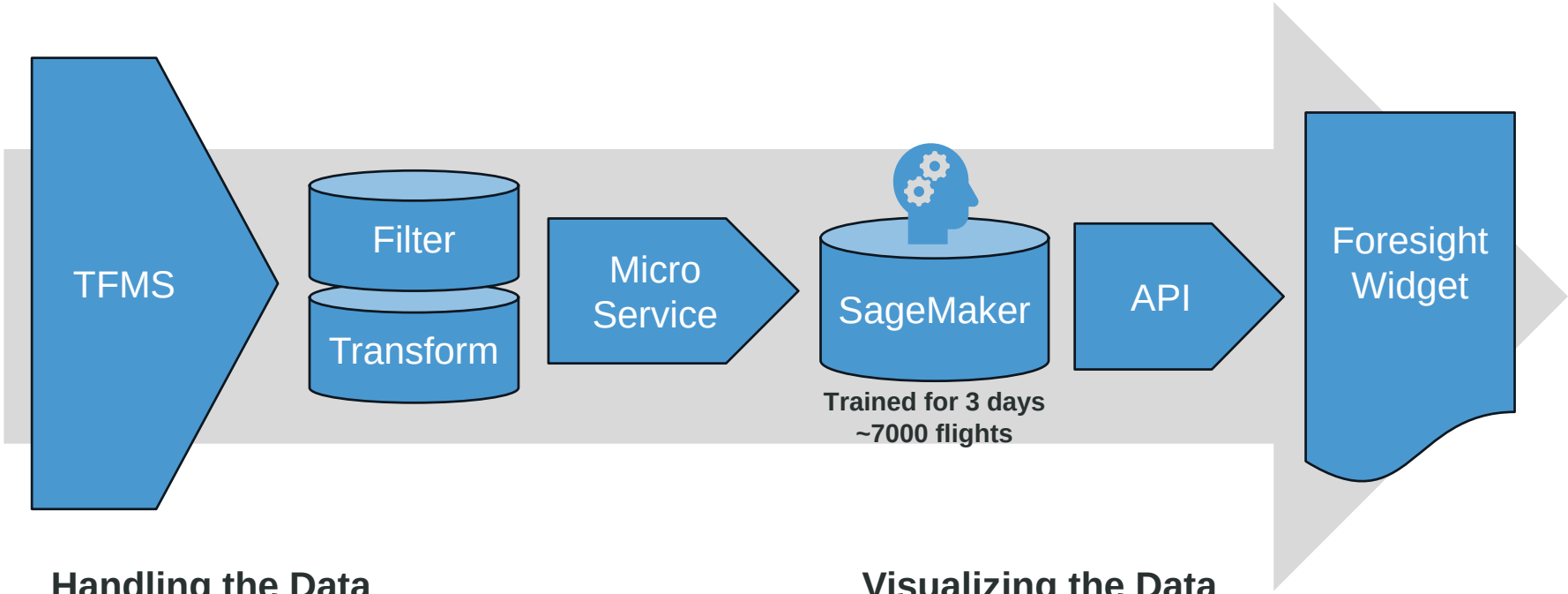
TFMS

Operational Context & Technical Docs (JMSDD)

Initial Gate Time of Departure – Actual Time of Departure = Taxi-out Time

Data Element	TFMS Context Doc	Schema Location
Initial Gate Time of Departure	Page 26 section 4.1	fltdMessage/flightPlanInformation/qualifiedAircraftId/igtd
Departure Airport	Page 26 section 4.1	fltdMessage/flightPlanInformation/qualifiedAircraftId/departurePoint/airport
Arrival Airport	Page 26 section 4.1	fltdMessage/flightPlanInformation/qualifiedAircraftId/airport
Airline	Not Found	fltdMessage/@airline
Aircraft Type	Page 26 section 4.1	fltdMessage/flightPlanInformation/flightAircraftSpecs
Actual Time of Departure	Page 33 section 4.1.3	fltdMessage/arrivalInformation/ncsmFlightTimeData/etd/@timeValue

Widget #2: The Design



Handling the Data

- Filter data feed for attributes we care about
- Transform SWIM data from XML to LIBSVM format
- Make transformed data available via a micro service
- Consume micro service and send data to SageMaker
- SageMaker builds model (XGBoost) for inferencing

Visualizing the Data

- Widget calls API to inference SageMaker
- API returns data to the widget in JSON
- Widget displays the results

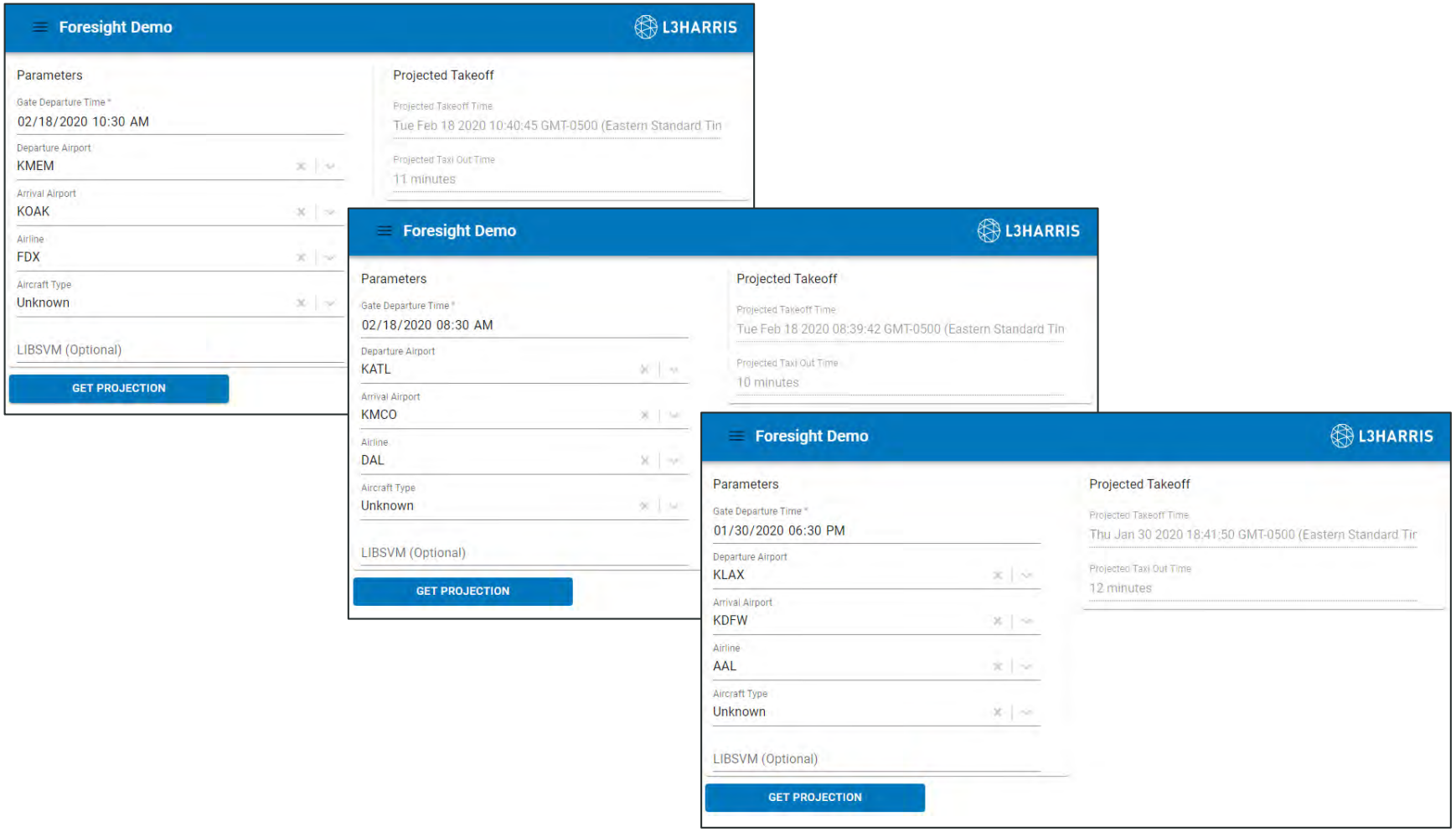
XGBoost – Regression

- Wisdom of crowds approach
- Multiple weak learners
- Decision trees, not neural network, which works well with tabular data

LIBSVM Format

- Compresses CSV formats down to format resembling JSON
- Excellent for sparse input data
- Example: `[0, 0, 0, 0, 0, 1]` becomes `5:1`

Widget #2: The Demo



Widget #2: The Results

Thresholds = 30 minutes, 90 minutes

True Positive Rate: 28%
True Negative Rate: 96%

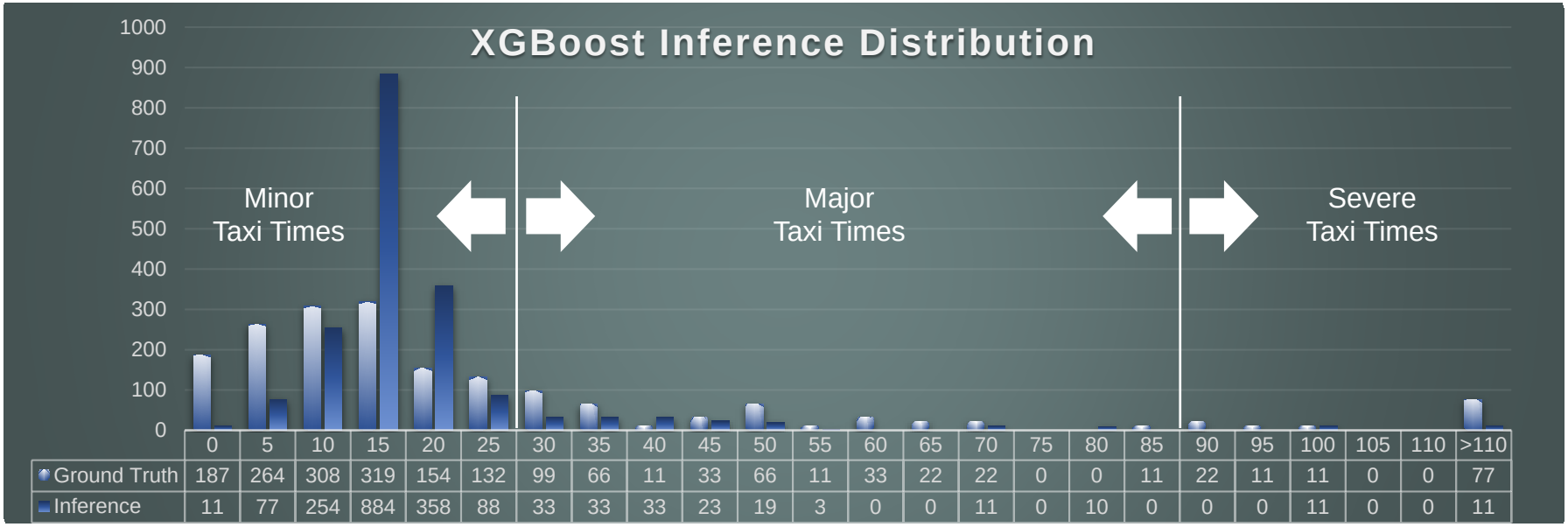
Taxi-out Times Detection Accuracy:

- **Less than 30 min = 96%**
- **Greater than 30 min = 28%**

Average Taxi-out Time: 1744s (29 min)
Standard Deviation: 1733s (28.8 min)

Median Error: 534s (8.9 min)
Average Error: 1004s (16.7 min)

- Severe Taxi Error: 5400s (90 min)
- Major Taxi Error: 1560s (26 min)
- Minor Taxi Error: 458s (7.6 min)



	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	105	110	>110
Ground Truth	187	264	308	319	154	132	99	66	11	33	66	11	33	22	22	0	0	11	22	11	11	0	0	77
Inference	11	77	254	884	358	88	33	33	33	23	19	3	0	0	11	0	10	0	0	0	11	0	0	11

Summary: Lessons Learned

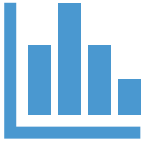
WIDGET #1

Background:

Software Developer type with limited knowledge of consuming or using SWIM data

Feedback:

- Context documents paired with the technical documents (JMSDD) were extremely helpful
- Using SCDS sample message during research phase helped a lot to find the ETA elements
- Context documents and technical documents were found in different locations on NSRR
- Expressed desire to continue project to further improve results



WIDGET #2

Background:

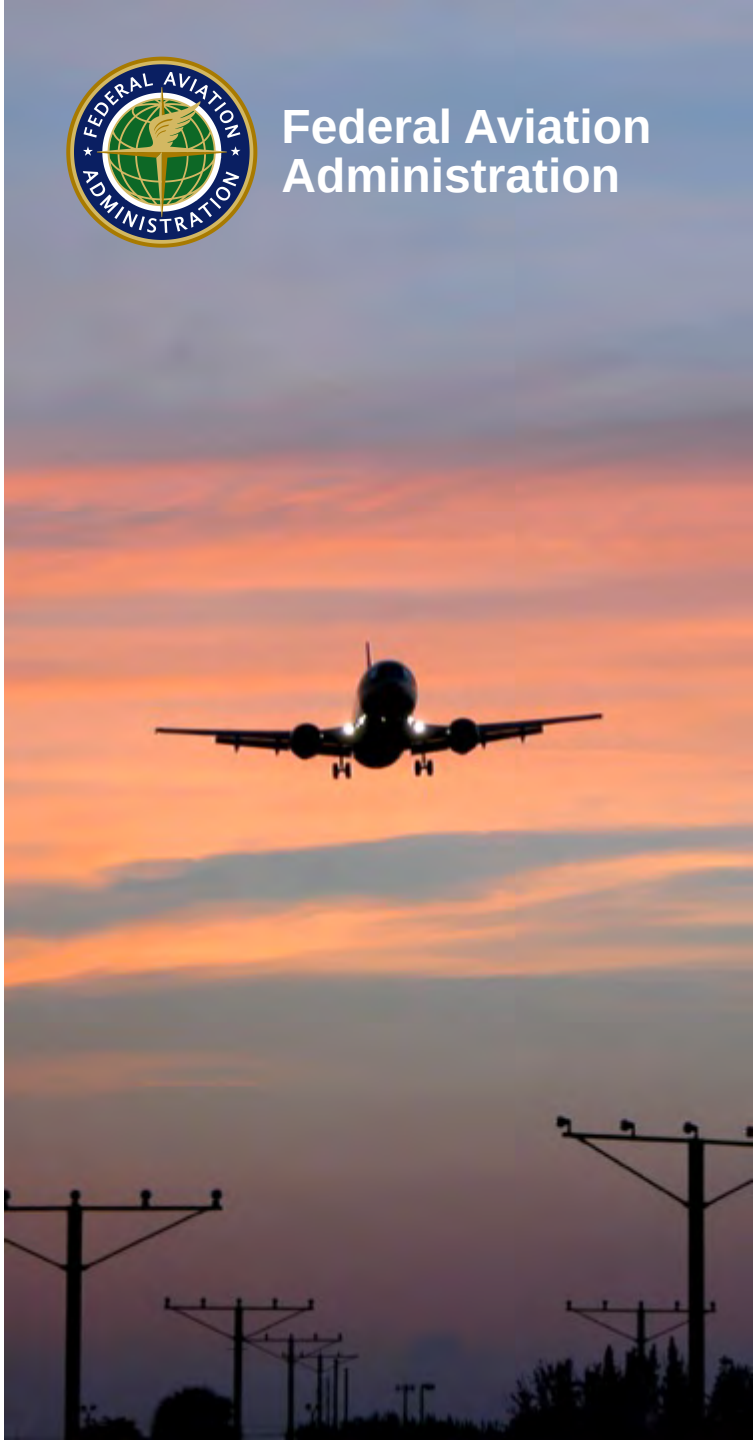
Data Scientist / Analyst type with no prior knowledge of consuming or using SWIM data

Feedback:

- Context documents paired with the technical documents (JMSDD) were extremely helpful
- Learned later should have included flight plan amendment messages into model
- Expressed desire to retrain model with more data points (include amendments, weather, etc)

SWIM Flight Data Publication Service (SFDPS)

SWIFT Conference



Presented to SWIFT

By: Ross Skiles, SWIM Engineering Support

Date February 26th, 2020

Agenda

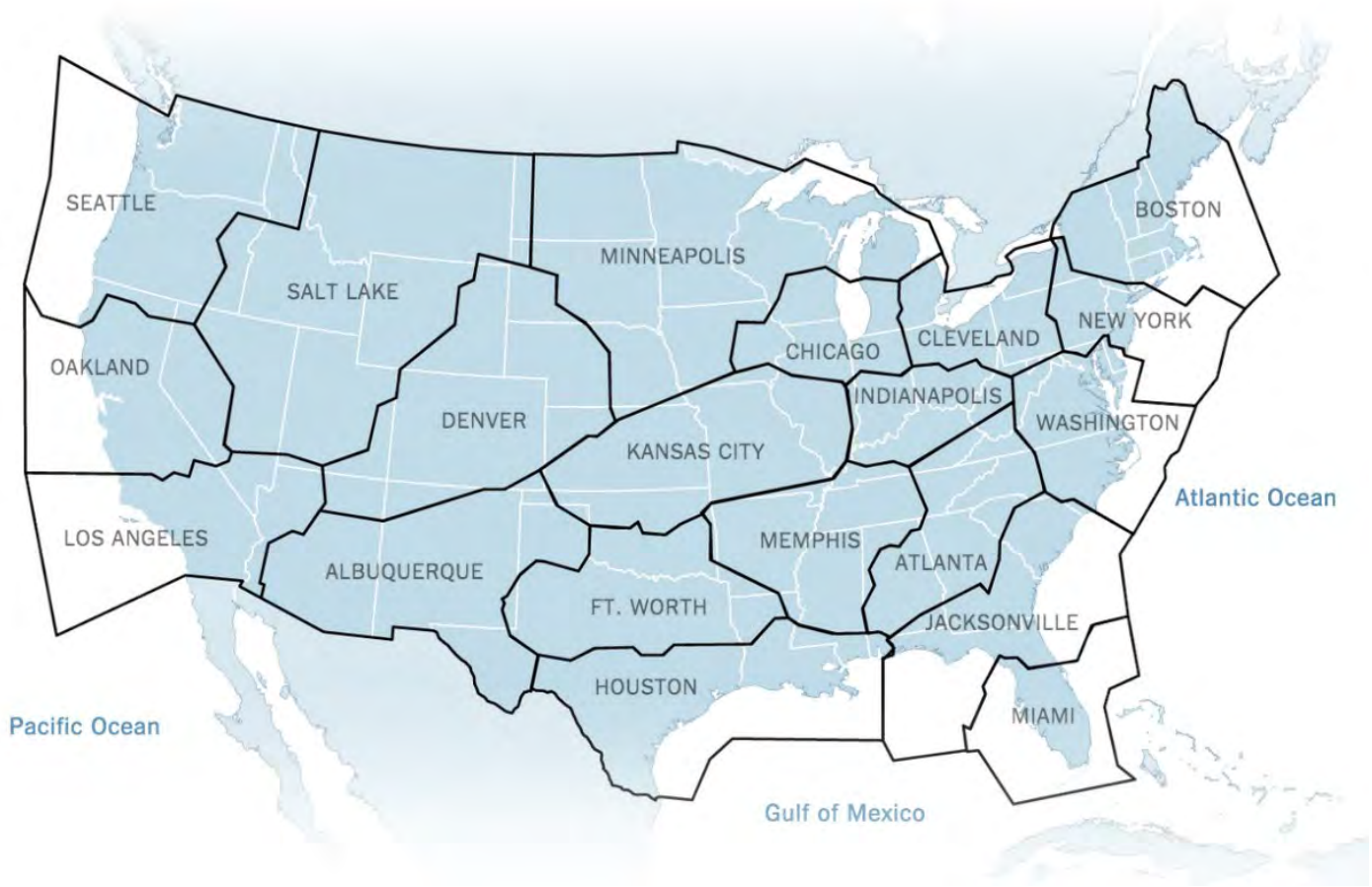
- **Background**
  - Coverage
  - Architecture
  - Services
- **Roadmap**
  - Timeline
  - R1.4
  - Segment 2C
- **Deep Dive**
  - All Services include publication and query versions
    - En Route Airspace Data
    - En Route Flight Data
    - En Route General Message
- **Resources**

SFDPS Background

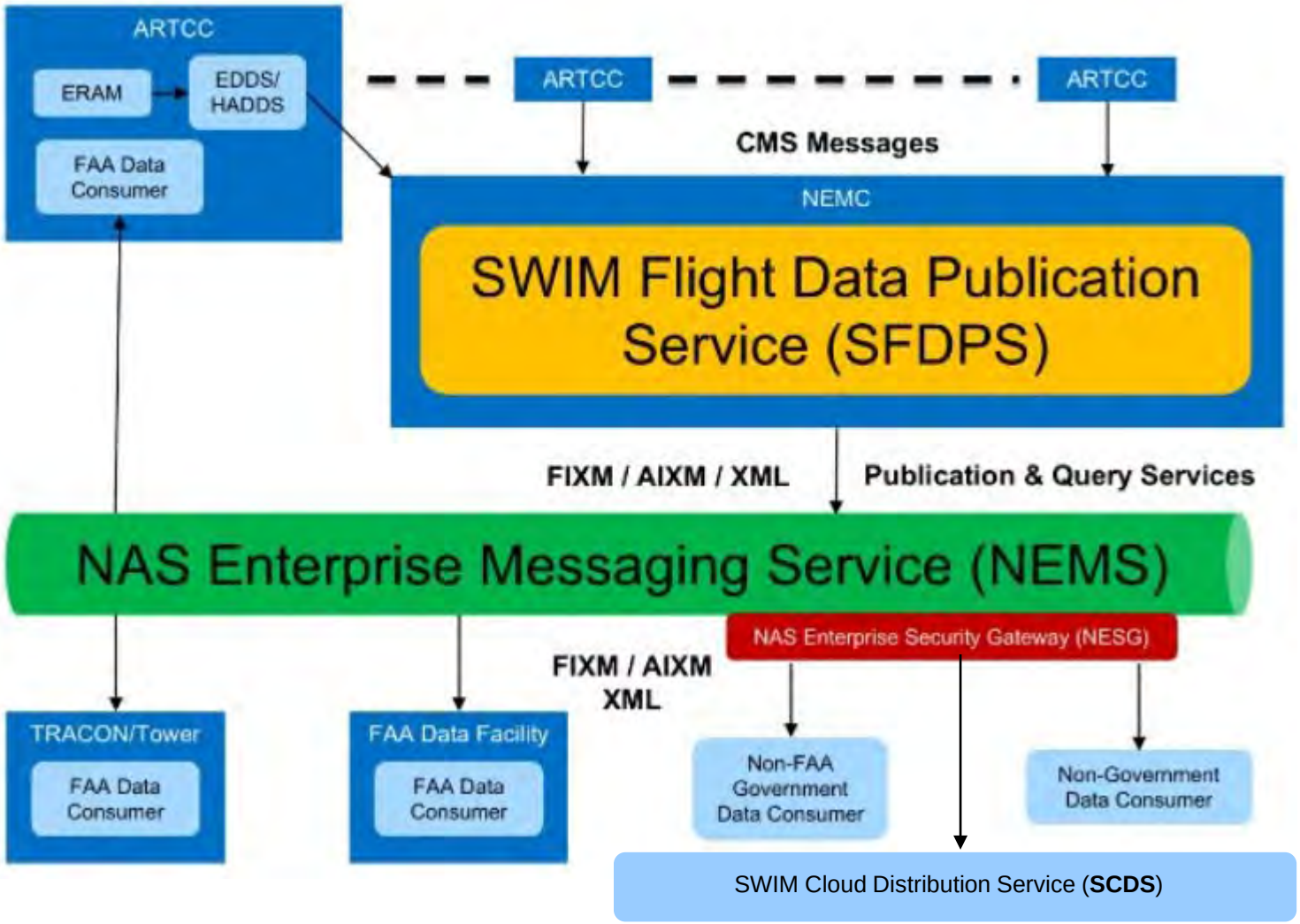
- **Designed and developed by Volpe Center and WJHTC engineers**
- **SWIM Flight Data Publication Service currently provides ARTCC information from ARTCC primary systems called En Route Automation Modernization (ERAM)**
  - ERAM data has served as the information backbone for the development and operation of NAS systems like TFMS, TBFM, STARS and soon TFDM providing flight plan, track and airspace data. Similarly, there are many support, R&D and training systems developed around the use of ERAM data
- **SFDPS data focus is in support of IFR aircraft en route between airports**
- **Developed with Flight Information Exchange Model (FIXM) and Aeronautical Information Exchange Model (AIXM) where applicable**
  - Otherwise, SFDPS services are in simple XML
- **SFDPS has been fully operational since April 23, 2015**

Current SFDPS Data Coverage

- **Current source locations are 20 Air Route Traffic Control Centers (ARTCC) located in lower 48 states**



SFDPS System Architecture



SFDPS Architecture Design

- **Runs on an FAA system called Integrated Enterprise Service Platform (IESP)**
- **Redundant systems geographically diverse**
- **24/7 collocated M&C with operators and maintenance support staff**
- **Systems can be reconfigured for software and hardware changes with no impact to consumers**
- **Operating systems and applications running with VMWare**
- **Software is multithreaded developed in java with persisted output that prevents lost data when data communications disconnects occur**
- **Uses Hadoop database**

SFDPS Services

SFDPS Service	Description
ERADP/Q - En Route Airspace Data Publication and Query services	Near real time dynamic configuration of ARTCC sector, TRACON, DoD and Special Activity (SAA) airspace
ERFDP/Q- En Route Flight Data Publication and Query services	Near real time flight plan and track messages
ERGMP/Q- En Route General Message Publication and Query services	An assortment of general purpose messages

SFDPS Service Formats

SFDPS Service	Description
Simple Schema XML1.3.8	SFDPS defined XML format proprietary to the SFDPS system. This format is recommended for data not covered by currently used versions of FIXM and AIXM. This data is available through both Publish-Subscribe and Request-Response services.
FIXM Core 3.0 (with FIXM US Extension 3.0)	Flight Information Exchange Model, SWIM XML standard format for flight data exchange. This data is available through both Publish-Subscribe and Request-Response services.
AIXM 5.1 (with Annotations SFDPS 1.0)	Aeronautical Information Exchange Model, SWIM XML standard format for airspace data exchange. This data is available through both Publish-Subscribe and Request-Response services.

Deep Dive

- **Service Messages**
- **Example of SFDPS data use**
- **SFDPS value added data**
- **Query services**

FIXM messages

ERFDP/Q Message Name	Message Code
Flight Plan Information	FH/FH_FIXM
Flight Amendment Information	AH/AH_FIXM
Converted Route Information	HX/HX_FIXM
Cancellation Information	CL/CL_FIXM
Departure Information	DH/DH_FIXM
Aircraft Identification Amendment Information	IH/IH_FIXM
Hold Information	HH/HH_FIXM
Progress Report Information	PH/PH_FIXM
Flight Arrival Information	HV/HV_FIXM
Flight Plan Update Information	HU/HU_FIXM
Expected Departure Time Information1	ET/ET_FIXM
Position Update Information	HP/HP_FIXM
Tentative Flight Plan Information	NP/NP_FIXM
Tentative Aircraft Identification Amendment Information	NI/NI_FIXM

FIXM messages continued

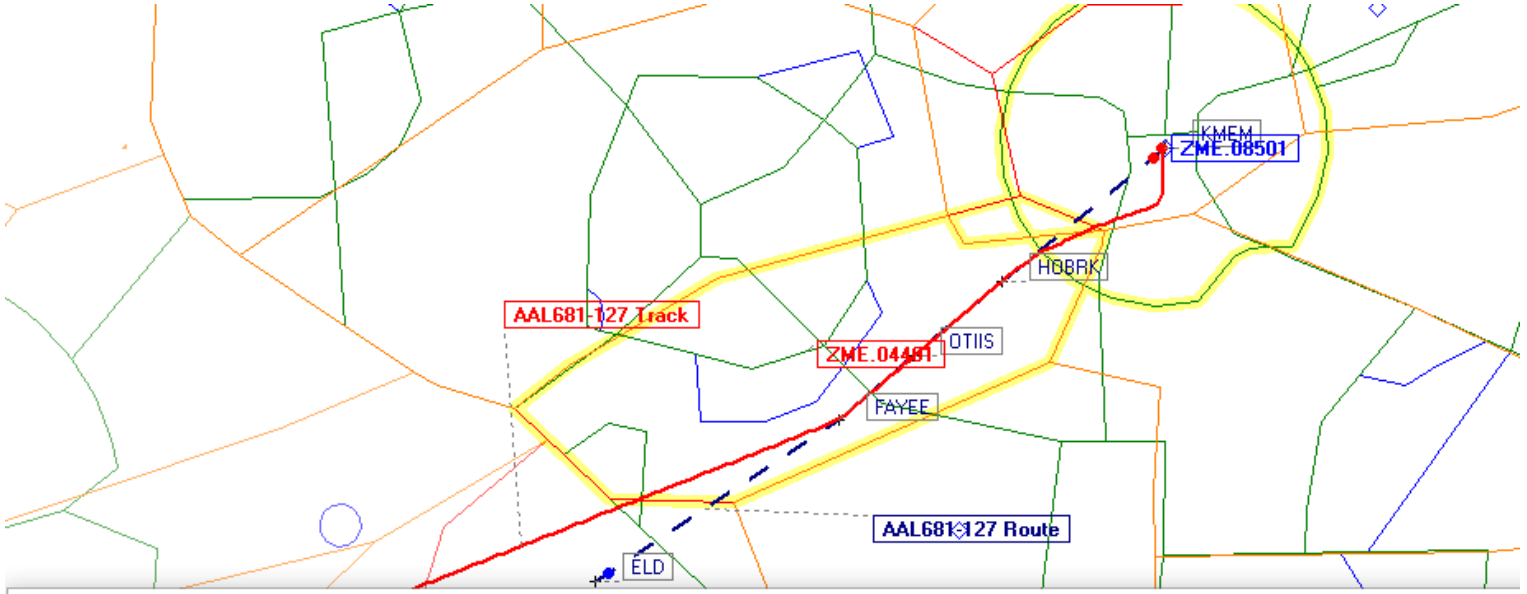
ERFDP/Q- Message Name	Message Code
Tentative Flight Plan Removal	NL/NL_FIXM
Tentative Flight Plan Amendment Information	NU/NU_FIXM
Batch Track Information	BATCH_TH/ BATCH_TH_FIXM
Drop Track Information	RH/RH_FIXM
Interim Altitude Information	LH/LH_FIXM
Automated Radar Terminal System (ARTS) Flow Control Track/Full Data Block Information	HZ/HZ_FIXM
Beacon Code Reassignment	BA/BA_FIXM
Beacon Code Restricted	RE/RE_FIXM
FDB Fourth Line Information	HF/HF_FIXM
Point Out Information	HT/HT_FIXM
Inbound Point Out Information	PT/PT_FIXM
Handoff Status	OH/OH_FIXM
Flight Plan Reconstitution Message	DBRTFPI/ DBRTFPI_FIXM

AIXM messages

ERADP/Q - Message Name	Message Code
Sector Assignment Message	SH/SH_AIXM
Route Status	HR/HR_AIXM
Special Activities Airspace (SAA)	SU/SU_AIXM
Altimeter Setting	HA
Adapted Route Status Reconstitution	DBRTRI_AIXM
Altimeter Status Reconstitution	DBRTAI
Sector Assignment Reconstitution	DBRTSI/DBRTSI_AIXM

Simple XML

ERGMP/Q- Message Name	Message Code
General Information	GH
Interim Altitude Status Information	HE
Hold Status Information	HO
ERAM Status Information	HS
Unsuccessful Transmission Information	UI



AAL681 127 ZME 2020-02-12

Preferences Refresh

Time	Msg	ACType	Code	Field6	XTime	ALT	010A	010B	ADAR	ADR	AAR
17:17:20	FH	A319/L	6202	ELD0...	E1747	350	KDFW.FORCK2.FORCK..ELD.HOBR...				
17:17:52	AH	A319/L	6202	ELD0...	E1747	350	KDFW.FORCK2.FORCK..ELD.HOBR...				
17:25:11	AH	A319/L	6202	ELD0...	E1748	310	KDFW.FORCK2.FORCK..ELD.HOBR...				
17:25:16	AH	A319/L	6202	ELD0...	E1748	310	KDFW./.UIM262041..ELD.HOBRK3....				
17:25:30	AH	A319/L	6202	ELD0...	E1748	310	KDFW./.UIM262039..ELD.HOBRK3....				
17:38:47	AH	A319/L	6202	ELD0...	E1746	310	KDFW./.ELD256059..FAYEE.HOBRK...				

17:17:20 ELD048035 E1747 KDFW.FORCK2.FORCK..ELD.HOBRK3.KMEM/1816

Track Points: (click on time to update Converted Route) Converted Route: 17:17:20 Handoff Sequence: 2020-02-12 Sectors: 2020-02-12

Time	GS	ALT	Lat/Lon
17:22:55	396	172	325413N/0962901W
17:23:07	396	176	325402N/0962727W
17:23:19	396	181	325352N/0962553W
17:23:31	396	185	325348N/0962420W
17:23:43	396	189	325342N/0962242W

Converted Fixes	ETA
ELD	1743
FAYEE	1751
OTIIS	1753
HOBRK	1757
KMEM	1807

Time		WS	DS	AS
17:42:56	I	ZFW 28	ZME 44	
17:43:05	A	ZFW 28	ZME 44	ZME 44
17:47:48	I	ZME 44	ZME 15	
17:47:54	A	ZME 44	ZME 15	ZME 15
17:58:27	I	ZME 15	MMM 00	

Sector	15:45:09
31	3101
31	3001
32	3201
32	3202
33	3301

Created with ERADP, ERFDP and underlying ERAM adaptation

SFDPS Valued Added Data

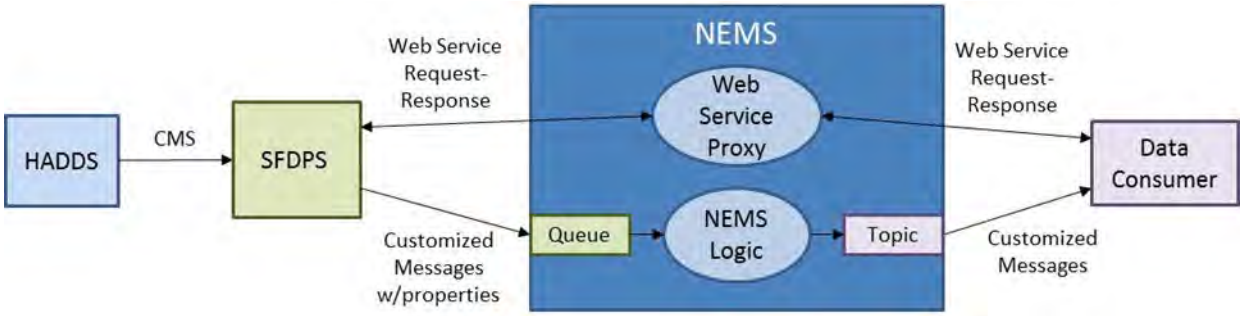
- **SFDPS value added improvements to the HADDS/EDDS source data examples:**
  - Provides alternative service output that offers subscription filters that eliminate duplicate data
    - This simplifies processing for some consumers and helps avoid unnecessary message handling, reduces bandwidth and speeds processing
  - Additional data fields have been added
    - Enhances the original data
    - Supports FIXM and AIXM data standards
  - FIXM compliant SFDPS Global Unique Flight Identifier (GUFI)
  - Message Sequence ID
  - Batched Tracks
  - Track update rate option for 12 seconds or one minute

Tracking Missed Messages with a Message Sequence Number

- **A message sequence number is assigned upon receipt from HADDS and appears as properties on the FIXM or AIXM version of a message**
  - The message sequence number is also found in the body of the message as the value in a MSG_SEQ_NO attribute.
- **Using the message sequence number to detect missing messages only works if the client is subscribed to receive all service messages.**
  - For example, if a client is set up to receive only certain flight messages, then there would be no way to know using sequence numbers whether a message was lost or whether it was just filtered out.
- **To retrieve a missing message, a user would need to request historical data and provide a range of dates to bracket the message retrieval.**

Query Service Design

- **The steps in this request-response processing are as follows:**
  - The consumer sends a Web Service request to the NEMS web service proxy; the request includes the identifier of the topic through which the consumer wants to get the data response. NEMS authenticates the user and passes this request to the SFDPS web service. NEMS passes the user identification along with the request.
  - SFDPS validates the request and checks that the data consumer is authorized to get the requested data. SFDPS responds to the data consumer. If the request is valid, SFDPS sends back a subscription ID. If the request is not valid, SFDPS responds with a rejection message.
  - NEMS forwards the web service response message to the data consumer.
  - If the request was valid, SFDPS generates the requested data and sends it through a NEMS input queue to the consumer's output topic. The response is sent using the same data formats that appear in the pub-sub data. SFDPS attaches the topic identifier and the subscription ID assigned to this response to each message.
  - NEMS passes the transactions to the data consumer, using the topic identifier property to determine the consumer's topic to which the transactions are published.
  - The data consumer uses the subscription ID to identify the messages in the data stream that SFDPS sent in response to the web service request.



History Query Services

- **History 15 days**
- **SFDPS will support the following requests made using web service requests:**
  - **Returns a set of messages that meet some selection criteria. Applies to all three services.**
    - Source facility: The ARTCC(s) from which the data update originated from. For enhanced data, this will be the data-controlling facility.
    - Message type: Indicates the type of CMS message that triggered the update. Can include more than one type.
    - Flight identifier: This is the call sign; that is, the flight identifier under which the flight is operating. Applies only to the flight data service.
    - Flight operator: The FAA-approved three-letter organizational code under which the flight is operating. Applies only to the flight data service; applied only if the flight identifier contains a three-letter code.
    - Origin airport: Applies only to the flight data service.
    - Destination airport: Applies only to the flight data service.
    - Sent time start: The start of the time interval during which the messages were sent from SFDPS to NEMS.
    - Sent time end: The end of the time interval during which the messages were sent from SFDPS to NEMS. If the specified end time is a time in the future, SFDPS will respond with the messages sent from SFDPS to NEMS from the specified start time up to and including the current time.
  - **“SFDPS shall limit the amount of data that a user can obtain. This will help to prevent overloading the system and network. The current limits are set to a maximum of 40,000 messages for a current flight request and to 3,000 messages for all other requests.”**

SFDPS Reconstitution Queries

- **SFDPS will support the following reconstitution requests made using web service requests:**
  - Return the current state for some type of data. This class of request will be used by data consumers to reconstitute their own databases. This request type applies only to the flight data service and airspace data service. The specific requests will be:
    - Request the current flight plans for a set of flights. This returns the current flight plan data for flights that meet some selection criteria. Applies only to the flight data service.
    - Return the current sector status data for ARTCCs that meet some selection criteria. Applies only to the airspace data service.
    - Return the current route status data for ARTCCs that meet some selection criteria. Applies only to the airspace data service.
- **Request the message history for a particular flight. (This could be useful for analysis or troubleshooting.)**
  - Request the latest flight plan data for a particular flight. (This could be useful to keep a consumer database synchronized with the ERAM data.)
  - Request all of the current active and planned flight plans (flight data reconstitution).
  - Request the current sector configurations (sector status reconfiguration).
- **SFDPS reconstitution (Startup or after extended consumer disconnect**
  - SFDPS reconstitution (Can be done for all ARTCCs)
    - Request all of the current active and planned flight plans (flight data reconstitution).

Query Service Request Queueing

- **All SFDPS service requests are processed one at a time with no exceptions**

SFDPS Reconstitution from HADDS

- **The conditions that will trigger a data reconstitution by SFDPS are:**
  - SFDPS Startup
  - SFDPS – HADDS disconnect
  - SFDPS failure
- **Automatically requests reconstitution data when the connection to a HADDS is established.**
- **SFDPS reconstitution messages identify messages updated from HADDS data with the reconstitution property and can be ignored by consumers when received**
- **In the event of a disconnect with HADDS, periodically attempts to reestablish the HADDS connection.**
- **Generates status messages when the following events occur:**
  - Connection to a HADDS is established
  - HADDS disconnects
  - HADDS reconstitution starts
  - HADDS reconstitution has completed

SFDPS Roadmap going forward

Release Planning

- **Release 1.4**
  - This System Support Modification (SSM) will address security bulletins as identified by the NAS Cyber Operations (NCO) applicable to SFDPS to maintain vendor support of commercial off-the shelf (COTS) vendor software products.
  - This SSM will update COTS vendor software product JAVA JVM to a newer version to mitigate the security risks identified by the NCO.
  - This project will implement changes to the database that will reduce the likelihood of SFDPS system latency that has been experienced in Operations.
  - Resolve several software defects identified by users of SFDPS in Operations.
  - Upgrade the TestGen Tool to resolve defects identified by the WJHTC Test Team.
  - Implement any fixes necessary to resolve any compatibility issues that are encountered as a result of updating the JAVA.

Release Planning Continued

- **Release 1.5**
  - Release planning is underway
- **SWIM Segment 2C (Tech Refresh)**
  - Awaiting final investment decision

Enhancements under consideration

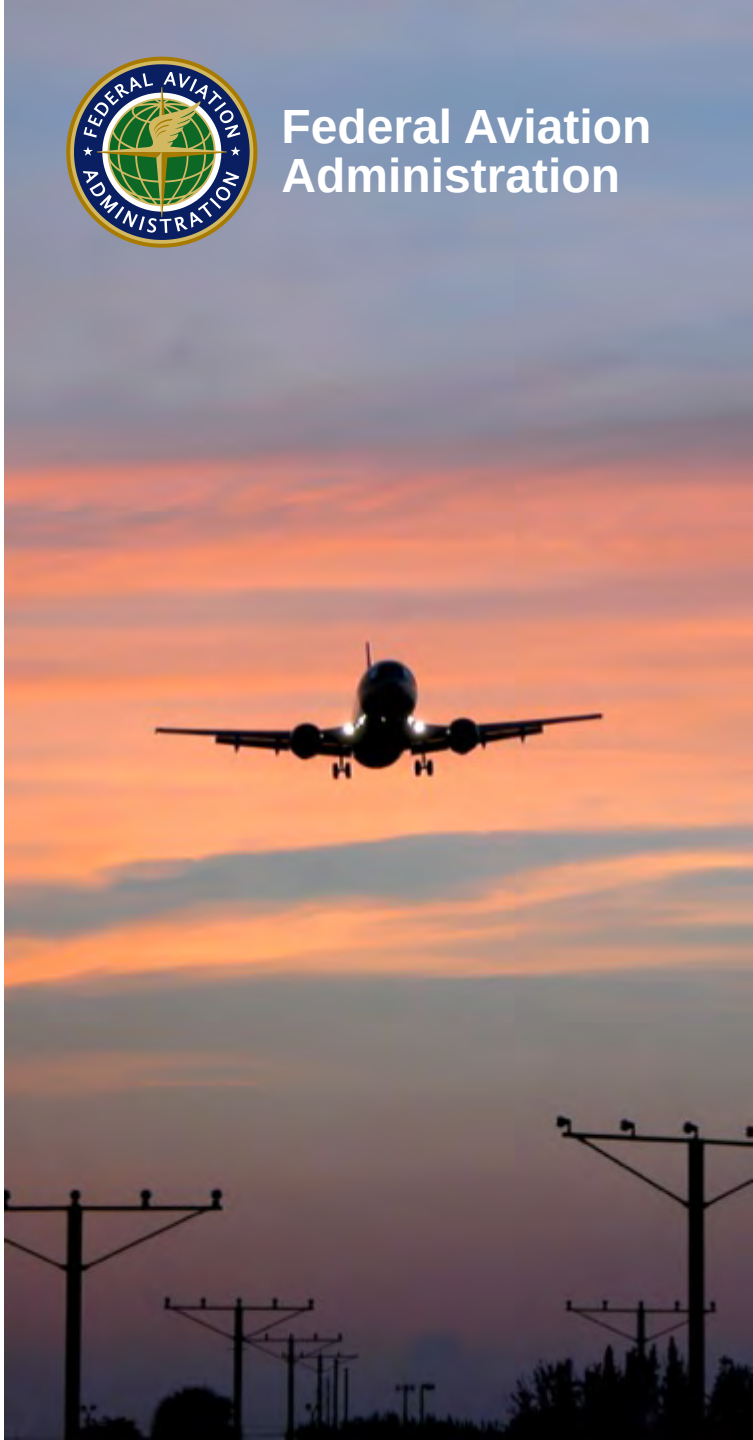
- **Separate sequence numbers for each message type, sensitive and non sensitive, authoritative and non authoritative**
  - Provides ability to identify to identify missing data for consumers with subscriptions not including all SFDPS data
- **FIXM 4.0**
  - Supports commitment to maintain consistency with international data standards
- **Adding adjustable number of threads to support simultaneous, parallel query processing**
  - Needed to support increased use of web service requests and reconstitution
- **Adding additional data fields available in HADDS/EDDS**
  - Utilizes ERAM enhanced data as it becomes available
  - Adding fused ADS-B track fields available in HADDS/EDDS
  - Adding flight strip number to support mobile app clearance delivery at remote airports
  - Adding additional trajectory data

Enhancements under consideration continued

- **Adding flight plan submission as a new SFDPS capability integrated with ERAM**
  - Consolidates consumer interface with ERAM using SWIM
  - Provides standardization of flight plan format input
  - Utilizes SWIM infrastructure and security processes to protect access to NAS systems
- **Adding ATOP oceanic track and flight plan data**
  - Expands and integrates Oceanic track and flight plan data providing consistent format
- **Adding orchestrated service data fields from TAIS, SMES and TDLS services**
  - Notification that ground clearance was delivered
  - Aircraft wheels up and aircraft landed events.
- **Upgrading SFDPS services from essential to efficiency critical**

AIMM ACS & E1 Engagement

Federal Aviation Administration



Presented to:
SWIFT

Davy Andrew
FAA AIMM S2
Program Manager

Suzanne Koppanen
FAA AIMM E1
Program Manager

February 26th , 2020

Agenda

- **Aeronautical Common Service (ACS)**
  - AIMM Overview
  - ACS Web Services
  - ACS Operational Scenarios
  - ACS Consumer Testbed (ACT)
- **AIMM Enhancement 1 (AIMM E1)**

AIMM Overview

- **Three phases planned for Aeronautical Information Management Modernization (AIMM)**
- **Aeronautical information delivered as data instead of products**

AIMM S1

- Established Federal NOTAM System (FNS)
- Improved airspace reservation system

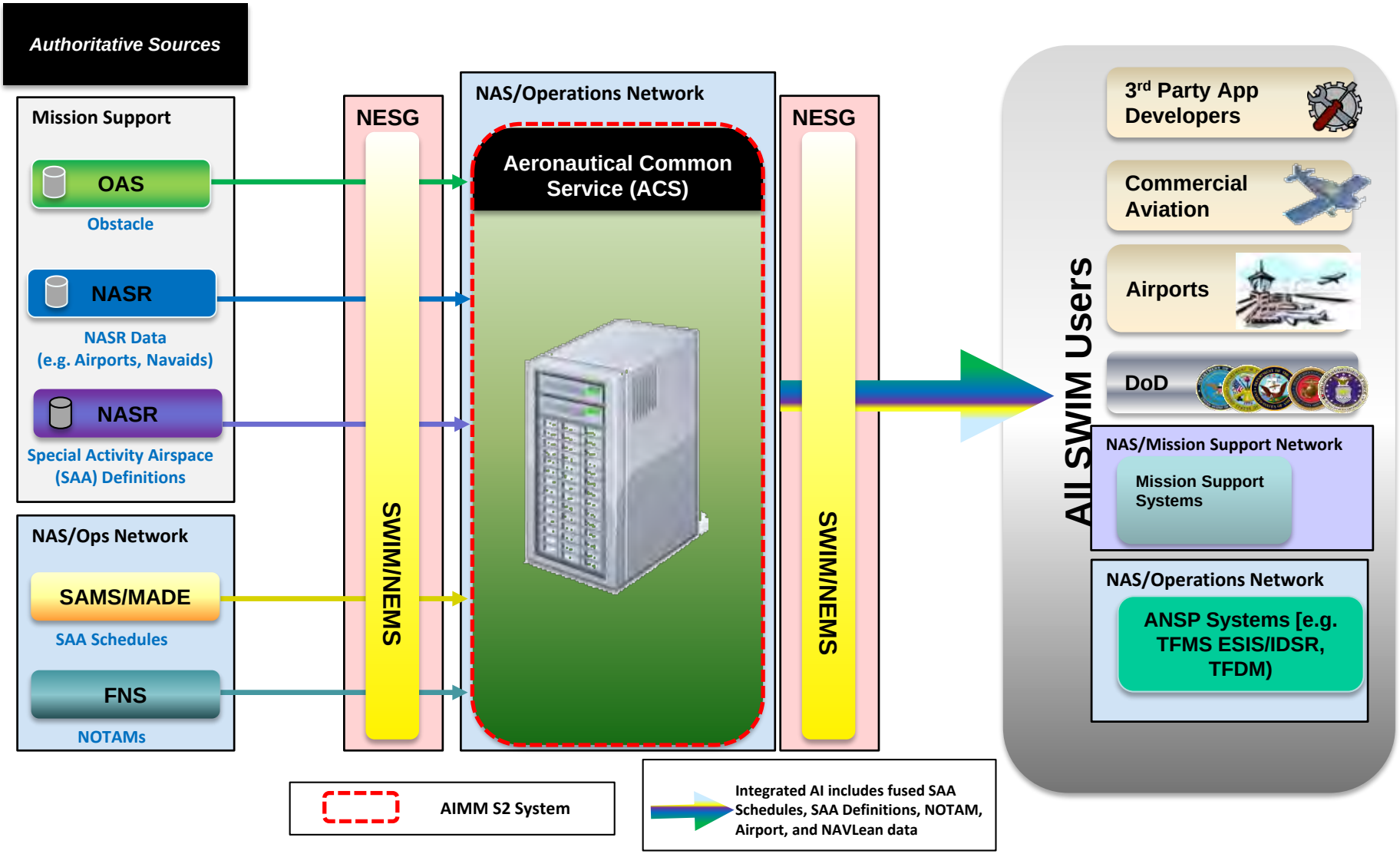
AIMM S2

- Implements Aeronautical Common Service
- Distributes Aeronautical Data over SWIM

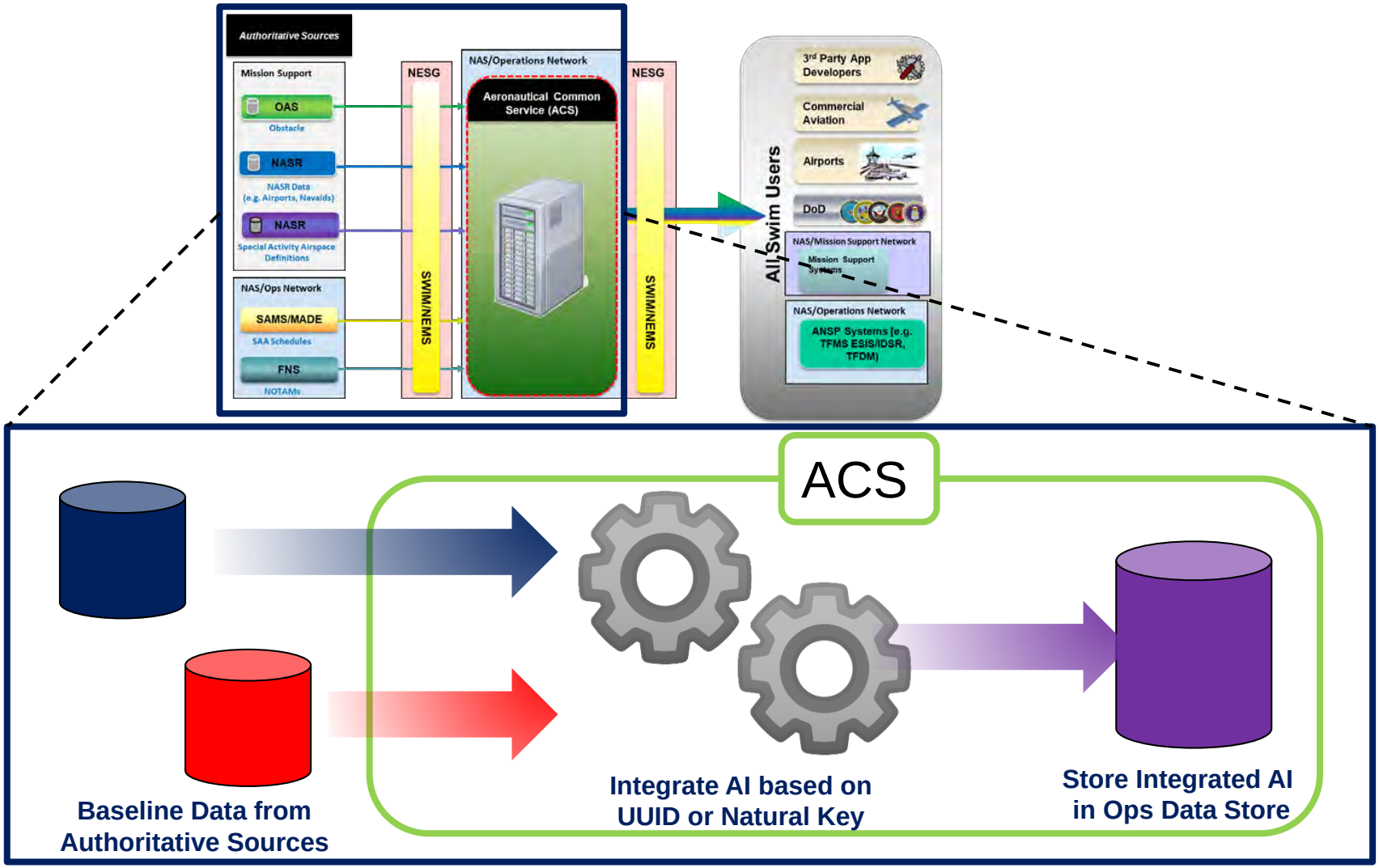
AIMM E1

- FNS improvements
- Airspace tool
- Improved ACS Queries

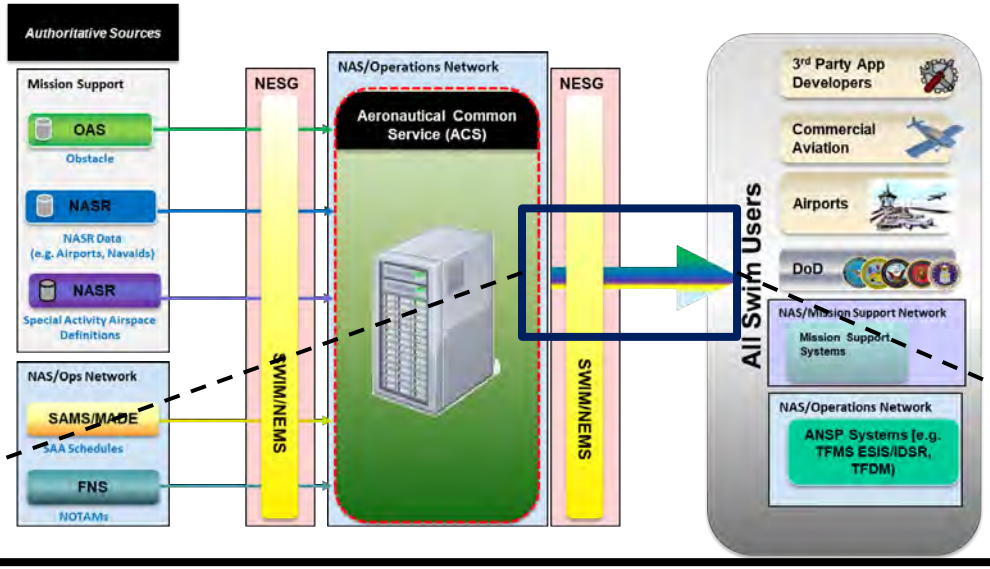
ACS Context Diagram



ACS Data Integration



ACS Web Services



ACS currently provides eight different web services (nsrr.faa.gov):

- Web Feature Service
- Data Query Service
- Data Subscription Service
- Web Map Service
- Web Map Tile Service
- Airspace Conflict Detection
- Geodetic Computation
- Post Operational Metrics

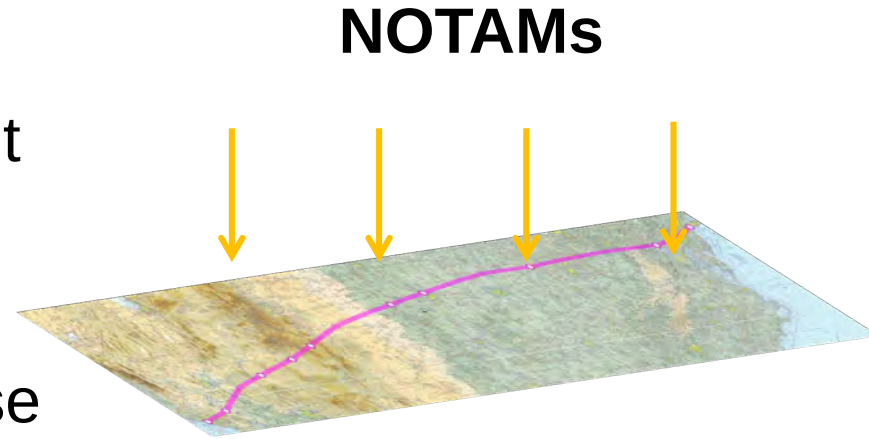
Scenario 1: NOTAMs Along Flight Path

A Flight from LAX to JFK

Pre-Planning: Search for all active NOTAMs along a flight path

1. Data Query Service: Use *GetAIAlongFlightPath* to Identify relevant locations along the flight path. (I.e. NAVAIDs, Airports)

2. Web Feature Service (WFS): Use *GetFeature* to query for all active NOTAMs associated with locations identified along flight path.



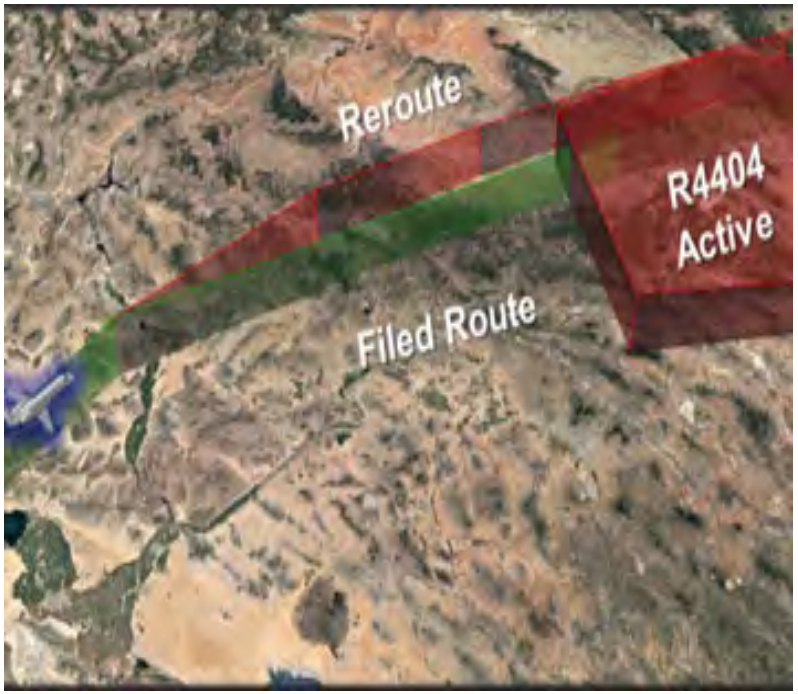
Scenario 2: Airspace Activation

A Flight from LAX to JFK

Pre-Planning: User System is Subscribed to Airspace updates from ACS *Data Subscription Service*

1. User receives an update that a Special Activity Airspace (SAA) along flight path will be activated

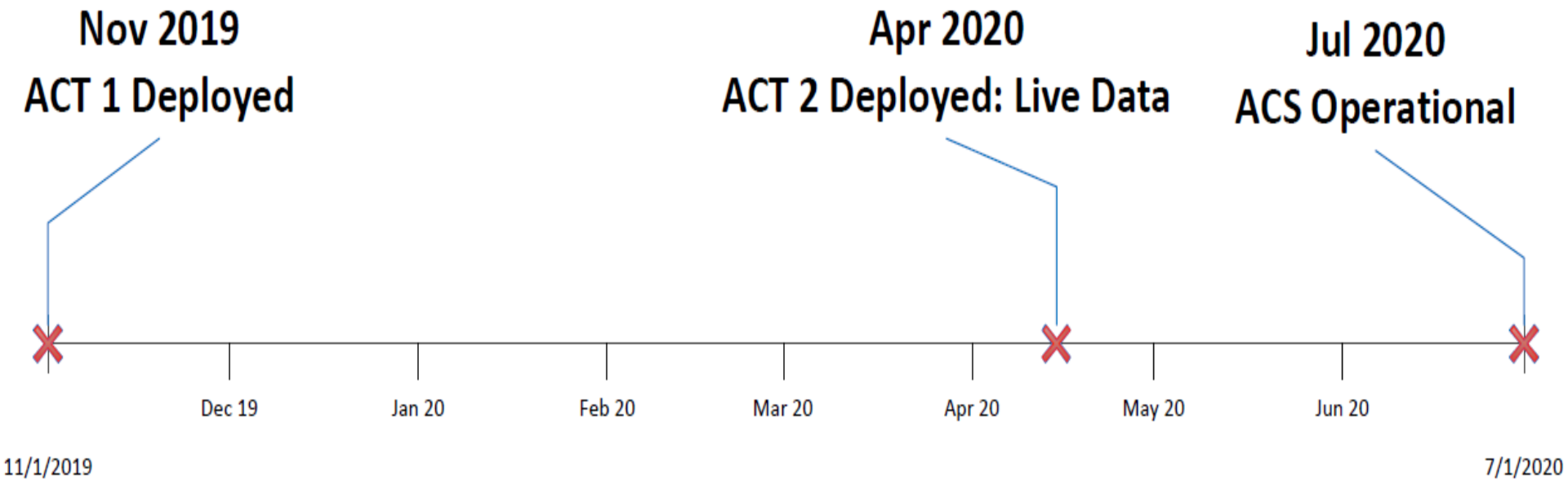
2. User then adjusts flight plan to avoid SAA



ACS Consumer Testbed (ACT)

- **Created in the SWIM R&D domain**
  - Stakeholders get an early access to available ACS data, functionality and SWIM onboarding processes
  - Familiarization with the integrated aeronautical data environment
- **The ACT will provide users the ability to:**
  - Develop and test functionality, and capability of ACS
  - Interact with and understand the aeronautical information available through the ACS

ACT / ACS Timeline



ACS Consumer Test-Bed (ACT 1)

- **Ready for users now**
  - SWIM Terminal Data Distribution System (STDDS) currently connected to ACT
  - Ready for other FAA Stakeholders
- **Complete Static Data Set**
- **8 Web Services available to query data set**
  - Data Subscription Web Service available by request only
  - ACT Team will coordinate with stakeholders to generate changes to trigger service
- **Steps needed to use ACT 1:**
  - Become a SWIM Consumer
  - On-ramping credentials from NEMS
  - Coordination with ACT Team

ACS Consumer Test-Bed (ACT 2)

- **Ready in Spring 2020**
- **Operational Data**
  - Enables Users to test subscriptions with production data
- **All 8 Web Services will be available to query data**
- **Steps needed to use ACT 2:**
  - Already an ACT 1 Consumer
  - Coordination with ACT Team

AIMM Enhancement 1 Scope

- **NOTAM Modernization**
  - Migrate from US NOTAM System (USNS) to Federal NOTAM System (FNS)
  - Complete ICAO formatted NOTAMS
  - Provide NOTAM System and dissemination status capability
- **Airspace**
  - Consolidate and improve existing airspace design tools
- **Aeronautical Common Service (ACS)**
  - Enhancements to web services and data

Questions

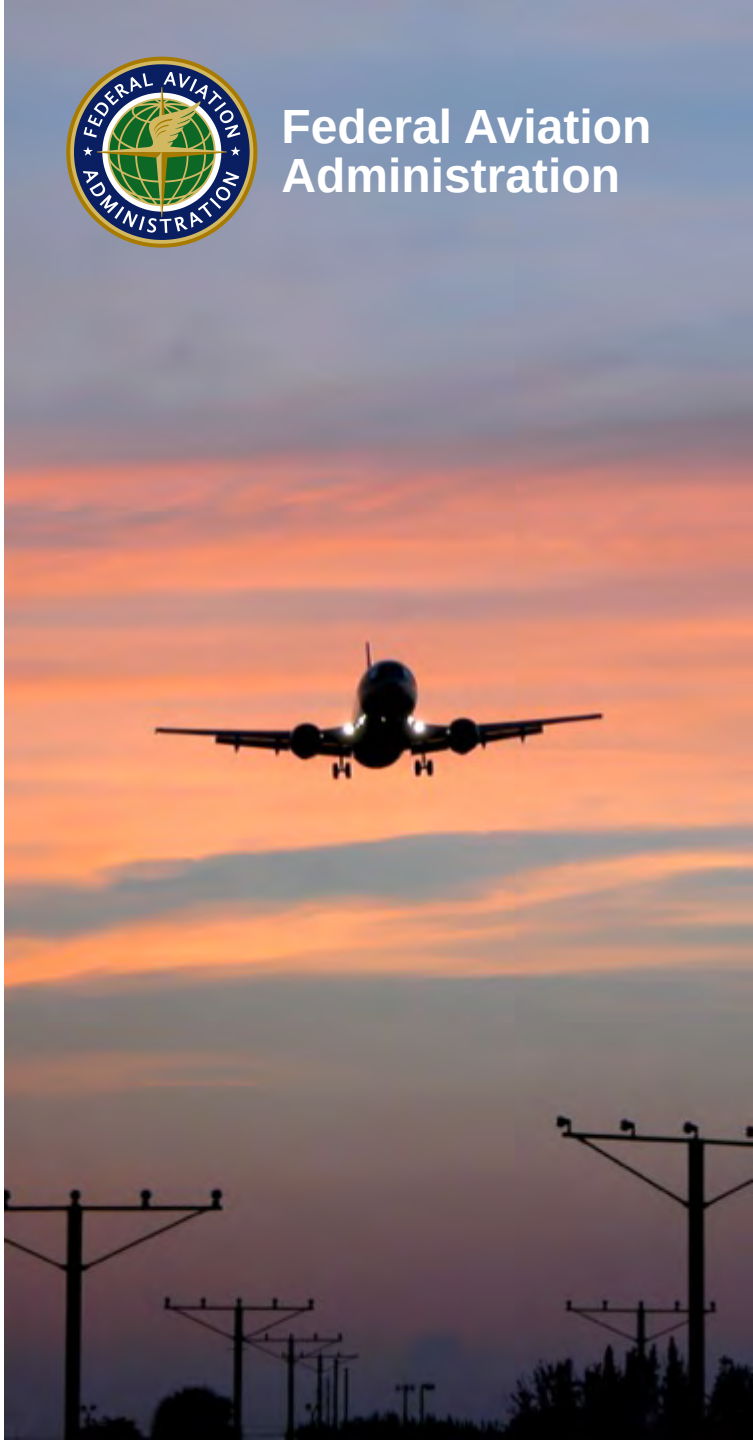
- **For Technical and Programmatic Questions**

  Email: ACSConsumer@FAA.gov

SWIFT:

SWIM Industry Collaboration Workshop #9

CLOSE OUT



Final Announcements

SWIFT Workshop #10

- **Date**
  - **May 21st , 2020**
- **Location**
  - **Mitre HQ in McLean, VA**

SWIFT Contact Information

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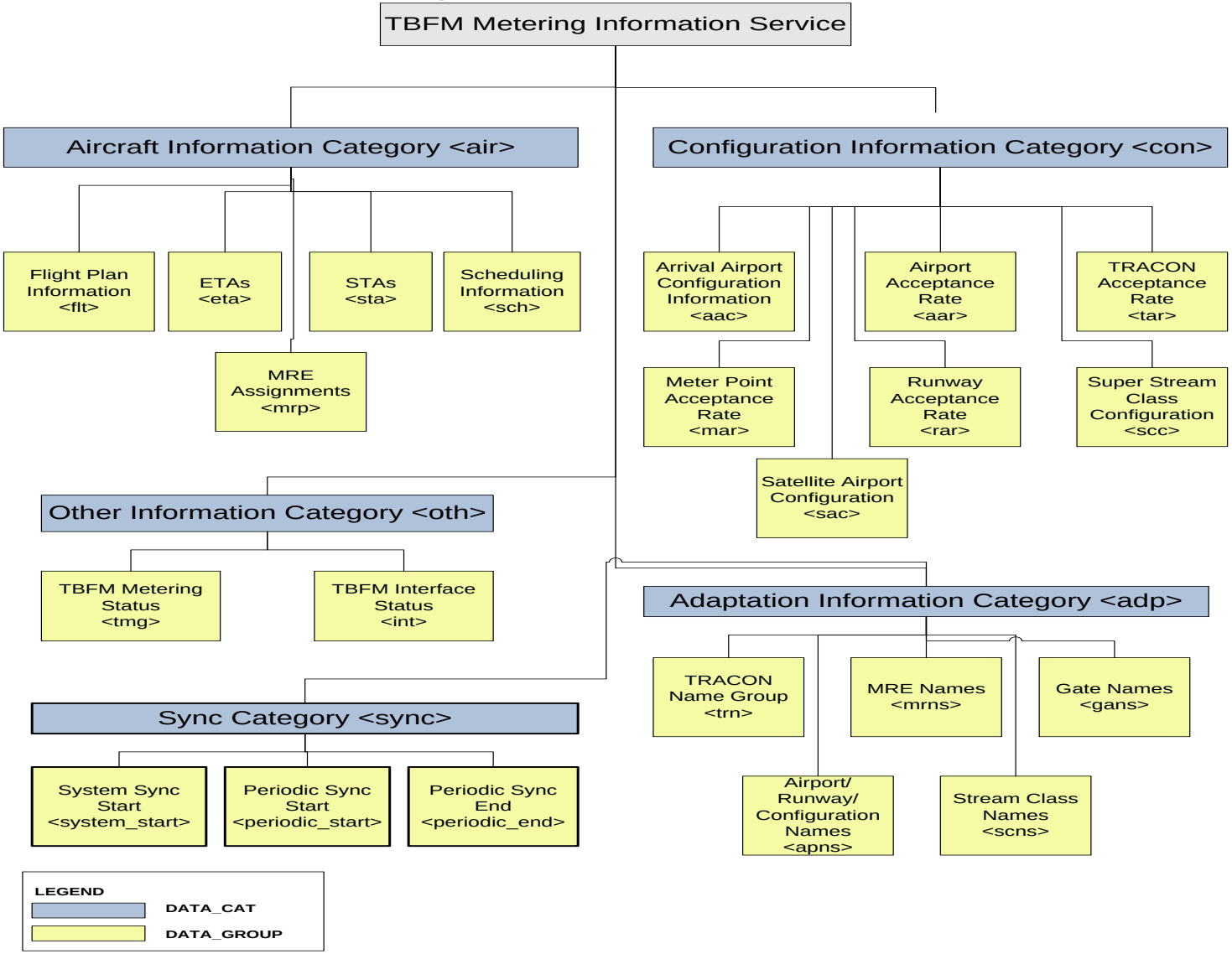
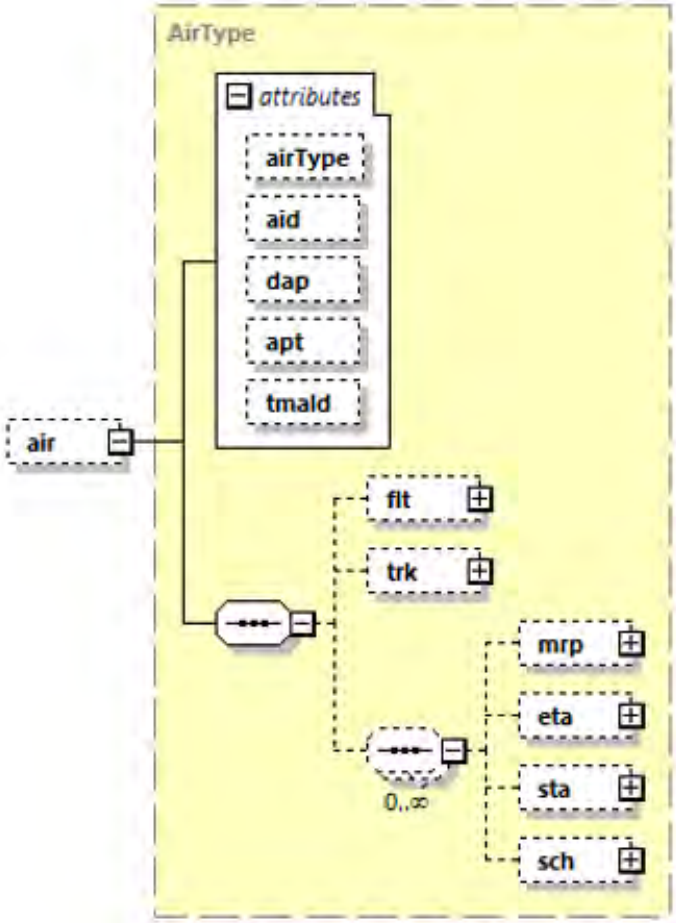
Back-up Information

TBFM MIS Message Types



TBFM MIS Message Types – Category Groups <air>



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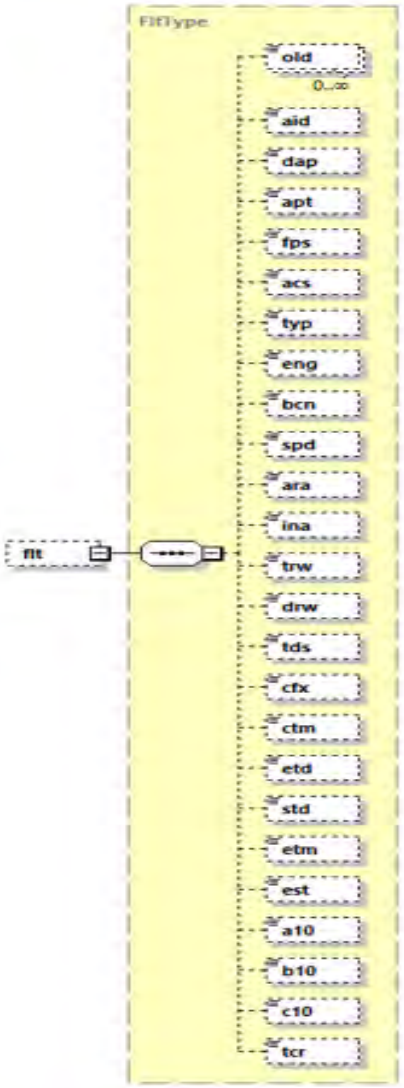

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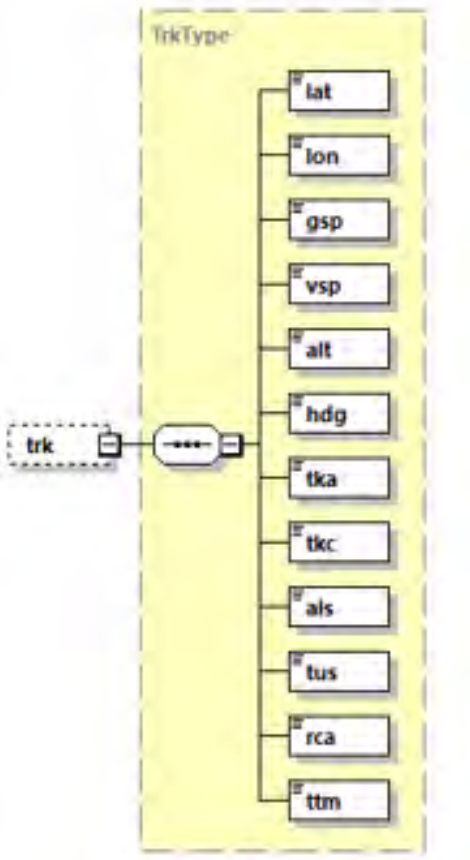

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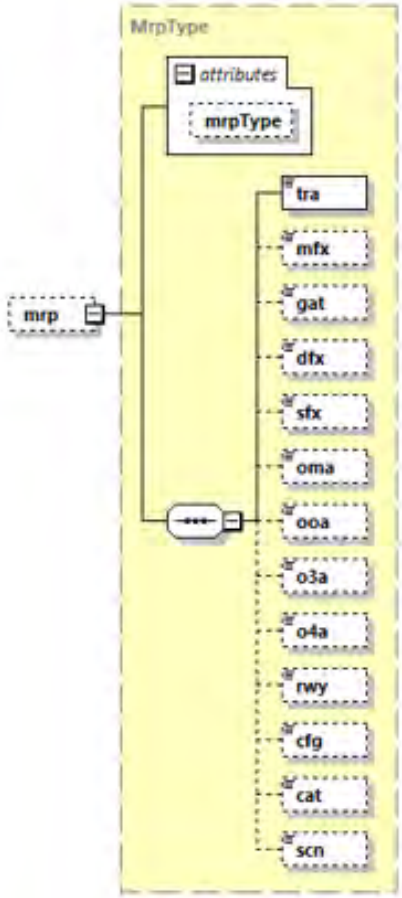

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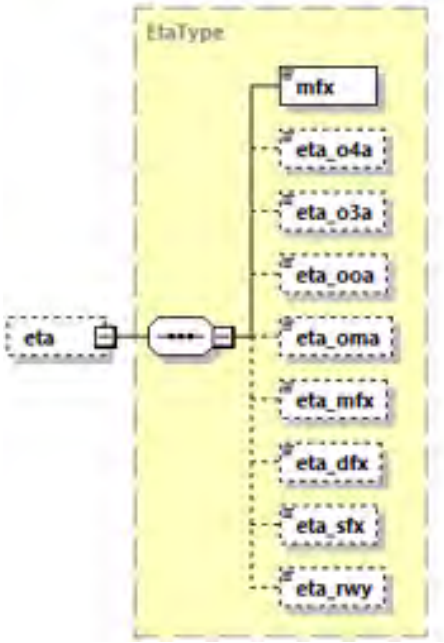

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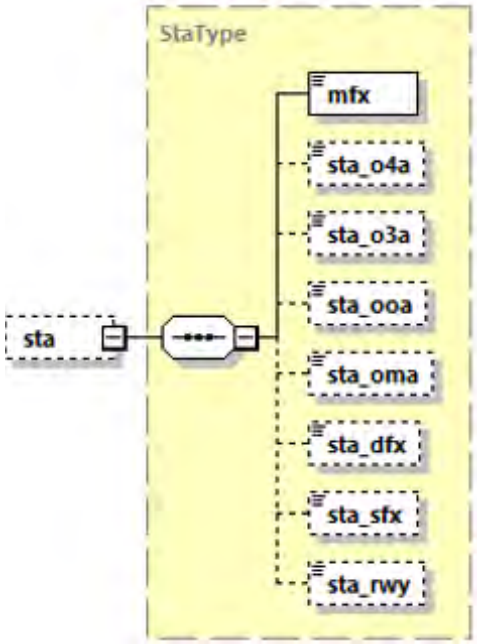


Backup

- Backup

Winnowing Down the Columns/Features Used

Correlation Matrix of Potential Columns/Features to Evaluate Multicollinearity

	dap	mfx	gat	bcn	scn	typ	eng	spd	trw	sfz	rfz	ara	tds	cfx	est	a10	tcr	dfx	sfx	oma	ooa	o3a	ina	sus	man	cfg
dap	1	-0.00145	-0.03543	-0.07917	-0.04536	-0.05964	-0.00527	0.041068	0.010874	0.005316	-0.0065	0.00686	0.021061	0.00216	-0.00075	0.939629	0.630822	-0.0662	-0.0662	-0.03677	0.04478	0.087574	0.018306	-0.00944	0.015639	0.000765
mfx	-0.00145	1	-0.61734	-0.14466	-0.2768	-0.09103	0.039289	-0.05126	0.63309	0.003053	0.022903	0.005807	-0.01988	-0.21168	-0.2053	-0.01052	0.01601	-0.28961	-0.28961	0.355071	-0.46876	-0.14423	-0.0751	0.008983	0.012157	-0.01847
gat	-0.03543	-0.61734	1	0.149252	-0.21986	0.043135	-0.0246	0.099978	-0.67019	0.014579	-0.01275	0.190465	0.026502	0.157427	0.108977	-0.03924	0.013904	-0.19017	-0.19017	-0.01831	0.737105	0.60595	0.110905	-0.00259	-0.01166	0.03186
bcn	-0.07917	-0.14466	0.149252	1	0.082177	0.076444	0.01671	-0.04785	-0.10258	0.018138	0.005441	-0.00598	-0.0138	0.064384	-0.06876	-0.0574	-0.03162	0.087684	0.087684	0.038655	0.008395	0.053181	-0.04337	0.000566	-0.00194	-0.00364
scn	-0.04536	-0.2768	-0.21986	0.082177	1	0.025861	0.087732	-0.08029	-0.01274	-0.00237	0.003443	-0.15745	0.004668	-0.12774	0.150102	-0.01901	-0.10654	0.889123	0.889123	0.126752	-0.18135	-0.13053	-0.0536	0.005412	0.017104	-0.01268
typ	-0.05964	-0.09103	0.043135	0.076444	0.025861	1	0.062898	-0.24457	0.022719	-0.01226	0.002843	-0.0419	-0.01172	0.090266	-0.23045	-0.07153	-0.00372	0.061609	0.061609	-0.16052	-0.10963	-0.00898	-0.09471	0.01646	-0.01646	-0.00406
eng	-0.00527	0.039289	-0.0246	0.01671	0.087732	0.062898	1	-0.39034	0.118461	-0.03428	0.004122	0.151912	-0.06336	-0.00168	-0.00783	-0.00685	-0.00714	0.042251	0.042251	-0.18364	-0.12819	-0.06554	-0.11313	0.092118	0.012898	0.01105
spd	0.041068	-0.05126	0.099978	-0.04785	-0.08029	-0.24457	-0.39034	1	-0.13779	0.033595	-0.00969	0.009892	0.045927	0.01136	0.100406	0.021478	0.043368	-0.08328	-0.08328	0.271311	0.275261	0.165347	0.293994	-0.06926	9.34E-05	-0.00856
trw	0.010874	0.63309	-0.67019	-0.10258	-0.01274	0.022719	0.118461	-0.13779	1	-0.07459	0.010673	-0.04368	-0.06314	-0.15881	-0.13496	0.005074	-0.00161	-0.07591	-0.07591	0.153873	-0.54487	-0.38768	-0.08476	0.024496	0.002421	-0.02122
sfz	0.005316	0.003053	0.014579	0.018138	-0.00237	-0.01226	-0.03428	0.033595	-0.07459	1	0.031748	-0.00399	0.0253	-0.01374	-0.10927	0.001418	-0.01115	-0.00436	-0.00436	0.040926	0.037243	0.039809	0.119295	-0.00518	0.068094	0.11846
rfz	-0.0065	0.022903	-0.01275	0.005441	0.003443	0.002843	0.004122	-0.00969	0.010673	0.031748	1	-0.02644	0.002398	-0.01044	-0.02685	-0.00793	-0.00123	0.005047	0.005047	0.001459	-0.01961	-0.01352	-0.02097	0.031245	0.097663	0.003018
ara	0.00686	0.005807	0.190465	-0.00598	-0.15745	-0.0419	0.151912	0.009892	-0.04368	-0.00399	-0.02644	1	-0.03953	0.009266	0.08378	-0.00479	0.017537	-0.17273	-0.17273	0.144486	0.21842	0.194116	0.115919	0.019563	0.006438	-0.07133
tds	0.021061	-0.01988	0.026502	-0.0138	0.004668	-0.01172	-0.06336	0.045927	-0.06314	0.0253	0.002398	-0.03953	1	0.002363	-0.00601	0.024227	0.015447	0.00917	0.00917	-0.01066	0.025506	0.045873	0.001294	0.001263	0.003459	0.0307
cfx	0.00216	-0.21168	0.157427	0.064384	-0.12774	0.090266	-0.00168	0.01136	-0.15881	-0.01374	-0.01044	0.009266	0.002363	1	0.007487	0.007572	0.020511	-0.07965	-0.07965	-0.2451	0.105652	0.148035	-0.01915	0.001311	-0.00444	0.010108
est	-0.00075	-0.2053	0.108977	-0.06876	0.150102	-0.23045	-0.00783	0.100406	-0.13496	-0.10927	-0.02685	0.08378	-0.00601	0.007487	1	-0.00368	-0.05034	0.125765	0.125765	0.011832	0.228542	0.133347	0.141419	-0.01256	-0.00308	-0.03212
a10	0.939629	-0.01052	-0.03924	-0.0574	-0.01901	-0.07153	-0.00685	0.021478	0.005074	0.001418	-0.00793	-0.00479	0.024227	0.007572	-0.00368	1	0.643958	-0.03906	-0.03906	-0.06386	0.102944	0.09045	0.014117	-0.0089	0.013906	0.0036
tcr	0.630822	0.01601	0.013904	-0.03162	-0.10654	-0.00372	-0.00714	0.043368	-0.00161	-0.01115	-0.00123	0.017537	0.015447	0.020511	-0.05034	0.643958	1	-0.11257	-0.11257	-0.0473	0.035007	0.09045	0.025497	-0.00414	0.002124	-0.00122
dfx	-0.0662	-0.28961	-0.19017	0.087684	0.889123	0.061609	0.042251	-0.08328	-0.07591	-0.00436	0.005047	-0.17273	0.00917	-0.07965	0.125765	-0.03906	-0.11257	1	1	-0.01382	-0.0734	-0.05556	-0.10581	0.007529	0.028378	-0.01316
sfx	-0.0662	-0.28961	-0.19017	0.087684	0.889123	0.061609	0.042251	-0.08328	-0.07591	-0.00436	0.005047	-0.17273	0.00917	-0.07965	0.125765	-0.03906	-0.11257	1	1	-0.01382	-0.0734	-0.05556	-0.10581	0.007529	0.028378	-0.01316
oma	-0.03677	0.355071	-0.01831	0.038655	0.126792	-0.16052	-0.18364	0.271311	0.153873	0.040926	0.001459	0.144486	-0.01066	-0.2451	0.011832	-0.06386	-0.0473	-0.01382	-0.01382	1	0.068907	0.194124	0.28976	-0.03269	-0.00408	-0.01602
ooa	0.04478	-0.46876	0.737105	0.008395	-0.18135	-0.10963	-0.12819	0.275261	-0.54487	0.037243	-0.01961	0.21842	0.025506	0.105652	0.228542	0.024247	0.035007	-0.0734	-0.0734	0.068907	1	0.599109	0.277758	-0.02204	0.014754	0.040703
o3a	0.087574	-0.14423	0.60595	0.053181	-0.13053	-0.00898	-0.06554	0.165347	-0.38768	0.039809	-0.01352	0.194116	0.045873	0.148035	0.133347	0.102944	0.09045	-0.05556	-0.05556	0.194124	0.599109	1	0.181792	-0.01457	0.003687	0.030086
ina	0.018306	-0.0751	0.110905	-0.04337	-0.0536	-0.09471	-0.11313	0.293994	-0.08476	0.119295	-0.02097	0.115919	0.001294	-0.01915	0.141419	0.014117	0.025497	-0.10581	-0.10581	0.28976	0.277758	0.181792	1	-0.02792	-0.01066	0.004117
sus	-0.00944	0.008983	-0.00259	0.000566	0.005412	0.01646	0.092118	-0.06926	0.024496	-0.00518	0.031245	0.019563	0.001263	0.001311	-0.01256	-0.0089	-0.00414	0.007529	0.007529	-0.03269	-0.02204	-0.01457	-0.02792	1	0.014879	-0.00134
man	0.015639	0.012157	-0.01166	-0.00194	0.017104	-0.01646	0.012898	9.34E-05	0.002421	0.068094	0.097663	0.006438	0.003459	-0.00444	-0.00308	0.013906	0.002124	0.028378	0.028378	-0.00408	0.014754	0.003687	-0.01066	0.014879	1	-0.00735
cfg	0.000765	-0.01847	0.03186	-0.00364	-0.01268	-0.00406	0.01105	-0.00856	-0.02122	0.11846	0.003018	-0.07133	0.0307	0.010108	-0.03212	0.0036	-0.00122	-0.01316	-0.01316	-0.01602	0.040703	0.030086	0.004117	-0.00134	-0.00735	1

Run early models with/without certain features to determine if they are beneficial/required

Vars ->	dap	mfx	gat	bcn	scn	typ	spd	ara	tds	cfx	est	a10	tcr	oma	ooa	o3a	ina	cfg	ROC
	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	0.8981
	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	0.9011

Here the receiver operating characteristics (ROC) area under curve (AUC) shows that remove the filed flight plan (A10) yields equivalent or better performance.

- Some of the notably high correlations are:
- A10 vs DAP => .939629
- TCR vs DAP => .630822
- GAT vs MFX => -.61734
- OOA vs GAT => .737105
- O3A vs GAT => .60595
- DFX vs SCN => .889123
- **SFX vs SCN => .889123**
- TCR vs A10 => .643958
- SFX vs DFX => 1
- O3A vs OOA => .599109

Interestingly, the stream class name (SCN) contains useful information that allows removal of other columns without any loss in performance

Feature Engineering & Model Fitting

TBFM APREQs by Super Stream Class

- Using the same 110 day sample mentioned earlier, the table below lists the top 10 SSC across the NAS with flights subject to APREQ, **by count**

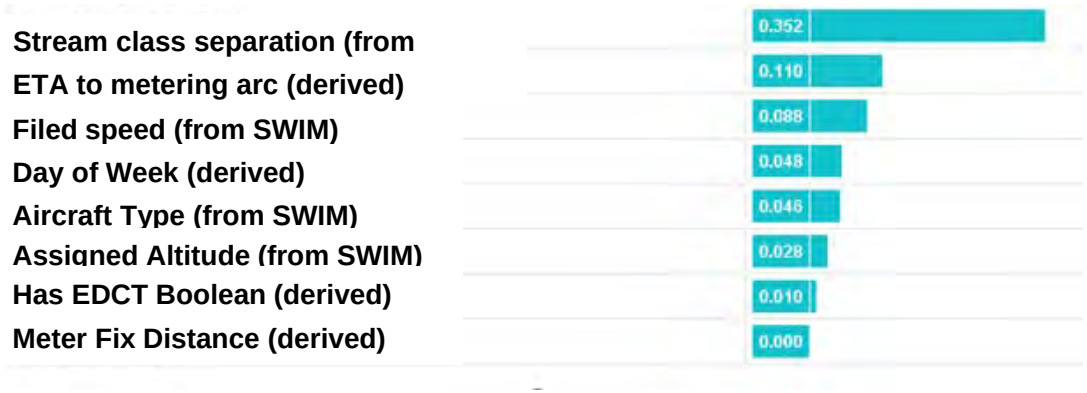
Super Stream Class	Count APREQs	Notes	Arrival %	EDC %	Top Airports Impacted
SE_JET	12197	Into ATL over JJEDI meter fix	100	0	MCO, JAX, CHS,SAV, CAE
LAX_FIM_JETS	12150	Into LAX over LOSHNW, SYMON	30.3	69.6	SFO, SJC, SMF,OAK,RNO
CHSLY_JET	12055	Into CLT over MAJIC	100	0	BWI,IAD,RDU,GSO,DCA
OZZZI_ZDC_JET	8850	Into ATL over OZZZI	100	0	DCA,BWI,RDU,IAD,RIC
FILPZ_JET	8463	Into CLT over SHINE	100	0	TYS,CVG,BNA,IND,AVL
SW_ZME_JET	7966	Into ATL over HOBTT	100	0	BHM,JAN,TPA,MGM,TLH
LAS_CLARR_JETS	7889	Into LAS over CLARR	100	0	LAX,BUR,SNA,SAN,VNY
ATL_J48_J75	7816	Into ATL over J48_J75	0	100	LGA,EWR,PHL,JFK,HPN
LGA_DYL	7536	Into LGA over DYY	0	100	DCA,CLT,RDU,RIC,ORF
CHPPR_JET	7216	Into ATL over CHPPR	100	0	IND,BNA,CHA,SDF,CVG

- Stream classes are what cause delay pass back, not necessarily city-pairs.
- This is just count, what about the delay size and variance?

Data Understanding

Feature Importance and Analytical Lessons

Feature Importance



- Approx. 20 features (not shown here) were developed to achieve greater predictability of TBFM delay
  - The results of this model yielded an overall accuracy of around 6.5 min error and 6.8 min standard deviation
  - Site specific (city pair) predictive accuracy can be as good as 3 min (error and standard deviation) or as high at 10 min
  - The machine learning regressor improved these predictions by 10-20% over any one statistical view

- Important lessons learned were:
  - Analysis of this problem benefits from grouping origin, destination and TBFM stream class name
  - The MIT in use (super stream class separation) is the most important attribute with predictive power/lift
  - Another important attribute is “what time of day do you need the stream class resource” (15 minute bin)

Feature Engineering & Model Fitting

ACS WS Descriptions (1 of 3)

- **Web Feature Service**
  - Provides the ability for user submitted custom queries for AI features
  - Implementing an Open Geospatial Consortium (OGC) standard
- **Data Query Service**
  - Provides a set of predefined queries for users (e.g., querying for airspaces along a flight path)
- **Data Subscription Service**
  - Provides updates to AI features based on what feature groups users are subscribed
  - Users retrieve updates from pullpoints

ACS WS Descriptions (2 of 3)

- **Web Map Service**
  - Allows users to query for map layers with AI feature imagery
  - Users can submit filters to what is displayed on the map
  - Implementing an OGC standard
- **Web Map Tile Service**
  - Allows users to request map layers with AI feature imagery as tiles
  - No user defined filtering for tiles
  - Implementing an OGC standard

ACS WS Descriptions (3 of 3)

- **Post Op Metrics**
  - Provides predefined reports that can be run
  - Provides ability to create user-defined reports that can then be run
- **Airspace Conflict Detection**
  - Identifies conflicts between existing airspaces in the ACS with a user submitted airspace
- **Geodetic Computation**
  - Provides operations to perform a set of geodetic computations
    - For example: Calculating points based on line segment intersections; and calculating points based on bearing and distance