



Airspace Technology Demonstration 2 (ATD-2)

Learning To SWIM with ATD-2

May 22, 2019



- Why ATD-2 chose to SWIM
- ATD-2 Approach to SWIM
- Overview of Data Feeds
- Data Elements of Interest to ATD-2 in Data Feed
- ATD-2 Lessons Learned



- Real time
- Single point of access
- Numerous available products
- More cost effective than legacy alternatives



- To cover the entire flight duration and turn-around process
 - If you want the highest quality data available for the entire flight from gate to gate, this requires the use of multiple sources from SWIM
 - In general, the best data comes from the FAA system whose operational mission most closely matches your data need (e.g. if you want strategic constraints and planning info, then TFMS, tactical then TBFM or TFDM)
- Some information only exist, or is higher quality, in certain feeds
 - APREQ Release Times from TBFM SWIM
 - EDCT information from TFM Flight Data SWIM
 - Surface metering times from TFDM Terminal Publication SWIM
- Data redundancy/backup from secondary sources
 - Loss of any one feed still allows data from other feeds to provide value

Data Exchange and Integration

TMC View



Operational STBO Timeline Runway 23/5 18L/36R

Runway 23/5 (left side) and 18L/36R (right side) are shown with flight paths and times. A yellow box highlights a flight at 18:00 on runway 23/5.

Operational STBO Map 1

Aerial map view showing flight paths and aircraft positions. Key aircraft labeled include UAL305 A319 EWR KILNS APREQ E:1557 and UAL305 A319 EWR KILNS APREQ E:1554.

Operational STBO Arr/Dep

Flight ID	Dest	Dep Fix	Swap	AC Type	Gate	EOBT	AOBT	Flight status	APREQ Req...	APREQ	EC
RPA5103	LGA	BARMY	E170	A4				Scheduled Out	APREQ		
UAL305	EWR	KILNS	A319	A23		15/15:32		Out	APREQ	15/15	
ASH6212	IAH	ESTRR	E170	A25				Scheduled Out			
AAL2030	OCA	KILNS	A320	C15		15/13:55	15/14:54	In Queue		1544	15/15
DAL531	JFK	BARMY	B712	A6		15/15:20	15/15:22	In Queue	15/15:46	1546	
AAL837	EWR	KILNS	A321	C10		15/15:22	15/15:34	Pushback	15/15:54	APREQ...	15/15
AAL1782	LGA	BARMY	A321	C12		15/15:31		Scheduled Out	APREQ		
AAL864	ORD	JOJO	A321	B15		15/15:39		Scheduled Out	APREQ		
AAL518	DCA	KILNS	A319	B2		15/15:39		Scheduled Out	APREQ	15/16	
JAS333	ATL	BOBZY	CRJ9	E26		15/15:41		Scheduled Out	15/16:17	1618	

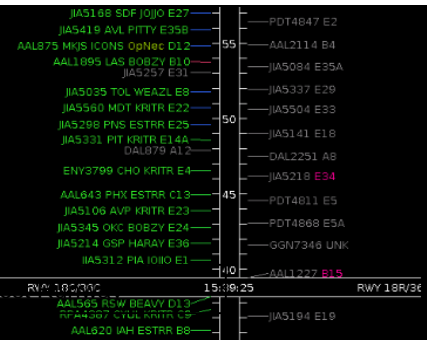
Operational STBO Arr/Dep = Departure; Destination has APREQ = Yes; Has AOFF = No; Ga

Quick summary (Oct 15, 2018):

- On East (left) side, several flights have both APREQs and EDCTs
- This is a dual use runway with arrivals (gray) mixed with departures (green)
- At this moment, the ATCT TMC is searching for an APREQ time to EWR for UAL305 that also meets its existing EDCT (green space shown from ZDC TBFM IDAC)
- On West (right) side, two flights are showing gate conflict (magenta/pink gate)
- AAL875 pilot has requested West runway for operational necessity

SWIM Data

- APREQ times from TBFM
- EDCT times from TFMS and TBFM
- Flight plans from TFMS and TBFM
- Surface surveillance from STDDS
- EOBTs from TFMS Terminal Flight Data
- Gates from TFM Terminal Flight Data
- Arrival times from TBFM and TFMS





- Get Familiar with Documentation
- On Ramping
- Consume
- Monitor
- Raw Archives
- Parse
- Create Database
- Match (to be discussed in more detail later in this presentation)
- Fuse (to be discussed in more detail in later presentations)
- Add value (model / scheduler)



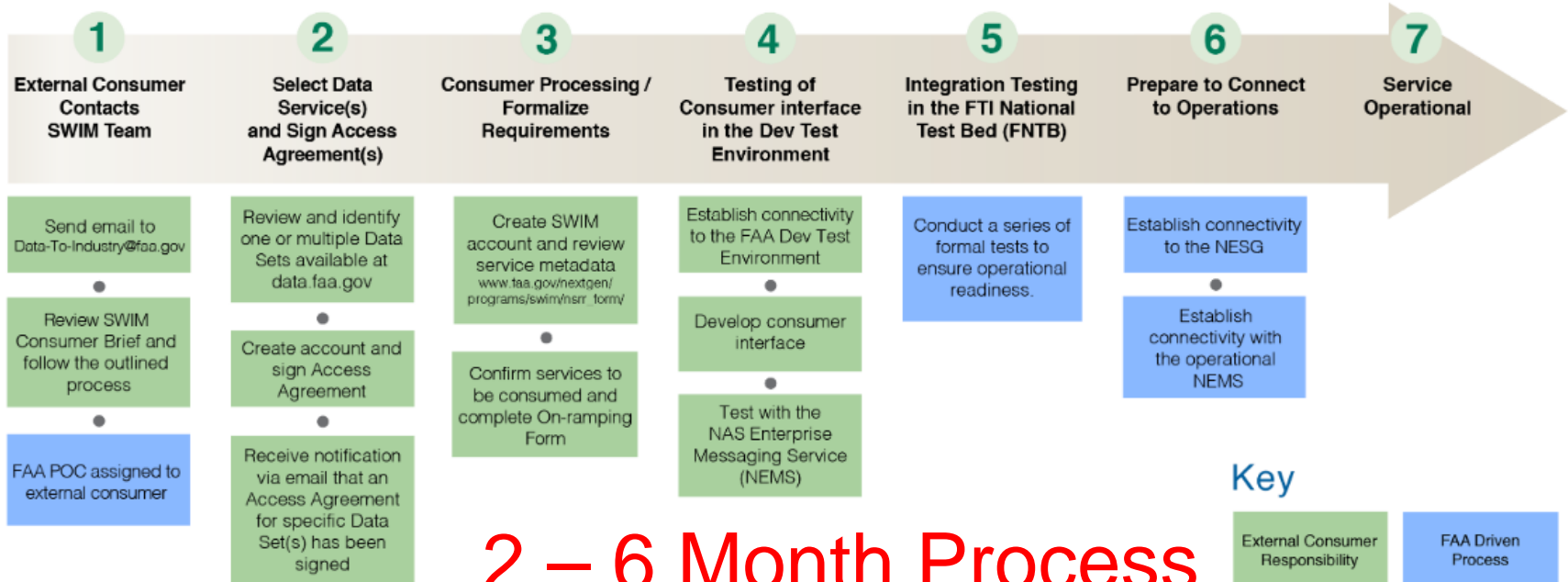
- NAS Service Registry and Repository (NSRR)
 - <https://nsrr.faa.gov/>
- SWIFT Operational Context and Use Cases
 - <https://connect.lstechllc.com/index.cfm/main/opconfocusgroup>
- FAA NAS Storyboards
 - https://www.faa.gov/about/office_org/headquarters_offices/ang/offices/tc/library/Storyboard/nextgen-overview.html#home
- SWIM Main Page
 - https://www.faa.gov/air_traffic/technology/swim/
- SWIM Users Forum
 - https://www.faa.gov/air_traffic/technology/swim/users_forum/



- Generally Two Options
 - Site to site VPN
 - Up until recently this was your only option
 - Long on ramping process
 - Great when working
 - Can be challenging to troubleshoot with something goes wrong
 - SWIM Cloud Distribution Service (SCDS)
 - Relatively new
 - Very fast on ramping process
 - Does not support request/reply

External Consumer On Ramping Process

Getting Access to SWIM



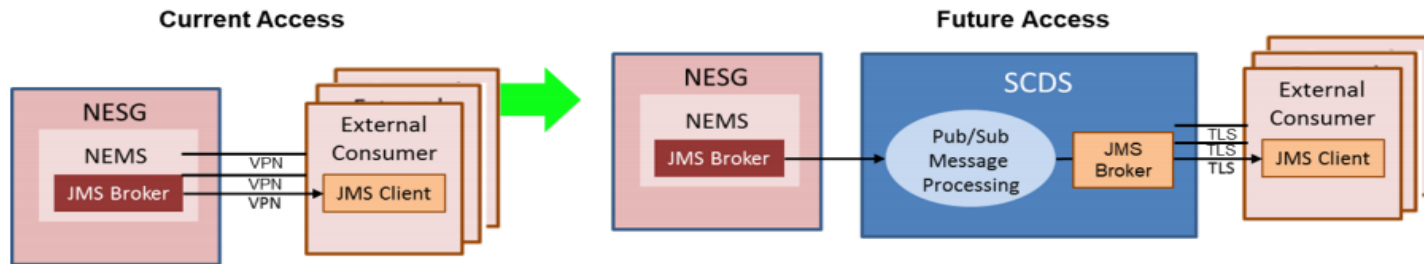
2 – 6 Month Process

https://www.faa.gov/air_traffic/technology/swim/products/get_connected/#ecbrief

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.

- **Provides access to all publicly available pub/sub SWIM services**
 - Data is forwarded from NAS Enterprise Security Gateway (NESG) via a secure connection and will automate failover between ACY and OEX
 - Distributes data to SCDS users over a TLS connection



* Slide copied directly from [SWIM Users Forum 24 Briefing](#)

Consumer Services NESG vs. SCDS

CONSUMER SERVICES	NESG	SCDS	Notes
Data Request	✓	✓	SCDS expedites data request process
Data Access Approval	✓	✓	SCDS expedites data release process
Self Provisioning		✓	
No Service Acceptance Tests Required (L3, SA, etc.)		✓	SCDS does not require SAT
Sensitive Data Availability	✓		Sensitive data will not be shared via SCDS
Help Desk Resolution	✓	✓	Enterprise Data Services (EDS) provides 24/7/365 resolution
Web Services	✓		SCDS does not currently support web services
Sample Data Availability	✓	✓	NESG request is manual, SCDS is automated
Jumpstart Kit Availability	✓	✓	NESG available on request, SCDS is self-service
Data Metrics / Statistics		✓	
SWIM Service Status (self-service)		✓	
Client Data Compression	✓	✓	
Client Data Encryption (required)	VPN	SSL/TLS	

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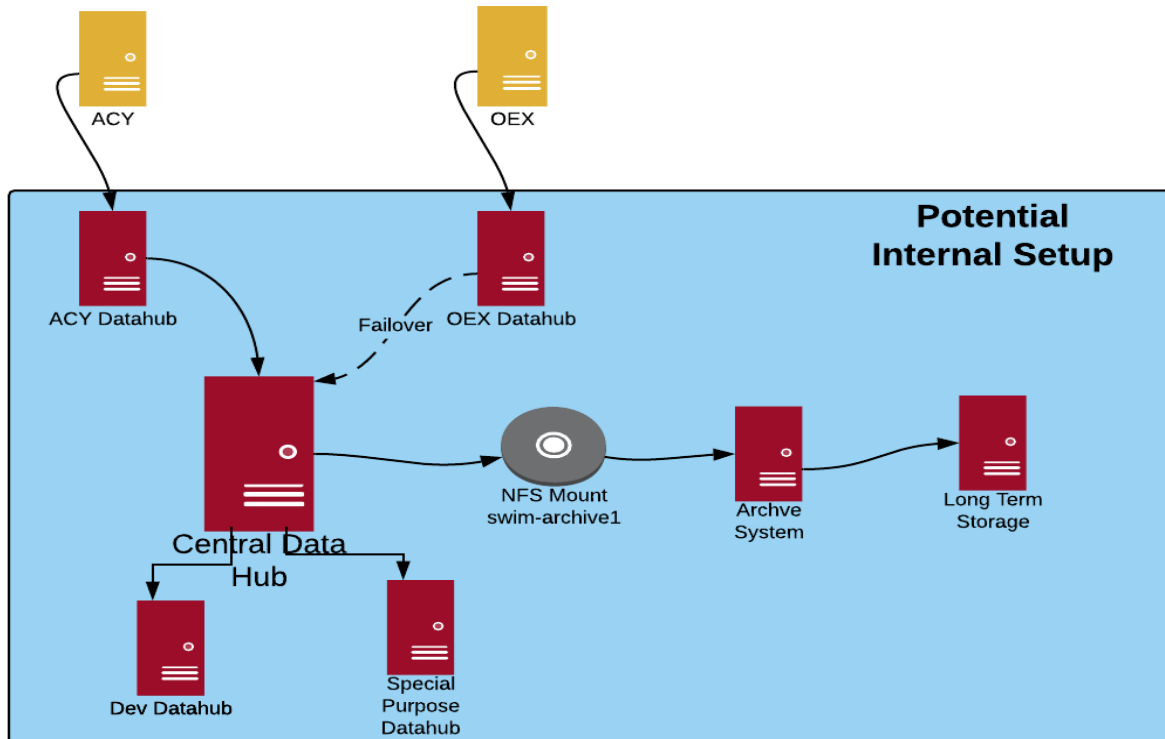


- Develop your own consumer application
 - Getting started resources
 - NEMS jumpstart kit - https://www.faa.gov/air_traffic/technology/swim/documents/media/user-guide/JumpstartKit-5.1.1.zip
 - SCDS jumpstart kit – available after registering with SCDS
- Use a 3rd party vendor
 - Fastest way to start consuming (if you haven't developed something already)
 - Bonus, you can skip the testing steps if you are using software from a vendor that has already gone through the process



- ATD-2 uses a JMS consumer application
 - Capabilities
 - Connecting to various JMS brokers including
 - Solace
 - Weblogic
 - ActiveMQ
 - IBM MQ
 - AWS SQS
 - Filtering
 - Splitting
 - Recording
 - Repeating
 - Performance Monitoring

- SWIM Data is distributed over queues
 - Can only have one consumer per queue
- Typically an organization will connect and then repeat the data to an internal message bus to allow for other internal functions.





- Why
 - Inspect and understand the data
 - Playback
 - Historical archives
 - Recovery option
- Not without effort and cost
 - Need a process for recording the data to files (or other data store)
 - Has to be managed
 - ATD-2 archives TBs of data
- General guidance
 - Capture headers and message content
 - Store by hour
 - Organize by year, month, day
 - Compress the files
 - Prepare a lot of storage space or have an expandable storage solution
 - Never met an analyst willing to get rid of data



- Grafana Reports
- System Monitor
- Prometheus Alerts/Emails

- Monitors feeds over time
- Allows us to compare feeds from multiple sources (ACY and OEX)



- Quick look view of the status of key ATD-2 Systems
- Ability to drill down to the specific metrics
- Custom developed for ATD-2

The screenshot displays the System Monitor interface, which is organized into several sections:

- System Report:** A summary view showing the health status of various systems. It includes a row of status indicators (green checkmarks, yellow warning triangles, and a black circle) for systems like bradley, houston, ctak, cit-stbo-demo, cit-stbo-ops, cit-stbo-train, database, database, devicelink, dfw-stbo-ops, dfw-stbo-train, hawk, and iata-system1.
- STBO Report:** A detailed view of the STBO (Surface Terminal Boarding Operations) systems. It shows a grid of status indicators for systems such as bradley, cit-stbo-demo, cit-stbo-ops, cit-stbo-train, and dfw-stbo-ops, with columns representing different database and service components.
- Metrics Report:** A table providing detailed performance metrics for various services and processes. The table includes columns for process name, command, status, and various performance metrics.
- Exception Panel:** A section at the bottom of the interface for handling system exceptions.

Process	Command	Status	Value 1	Value 2	Value 3	Value 4	Value 5	Value 6	Value 7	Value 8	Value 9	Value 10	Value 11	Value 12	Value 13	Value 14	Value 15	Value 16	Value 17	Value 18	Value 19	Value 20	
fuser	com.mosaicatm.fuser.aggregator.MainCitAggregator	com	0	0	5225	2.54																	
fuserSurveillanceProcessor	totalProcessTime	totalProcessTime	0	0	117	4.66																	
guiService	com.mosaicatm.guiService.GuiServiceMultiThreaded.requestGui	com	0	0	448	1.71365000087926	0	0	1025	1.6161324829178	0	0	5932	1.6690									
guiService	com.mosaicatm.guiService.GuiServiceMultiThreaded.updateGui	com	0	0	2609	0.00605253593174137	0	0	12618	0.00630901396366631	0	0	37708	0.0053									
guiService	com.mosaicatm.guiService.repository.GuiProxyRepository.deleteFlights	com	0	0	262	7807038.15289	0	0	262	7807038.15289	0	0	1	260.68									
idacProcessor	totalProcessTime	totalProcessTime	1	0	0	11.7291824860043	1	0	0	11.7291824860043	0	0	11	17.153									
thmFlightXmlParser	totalProcessTime	totalProcessTime	0	0	143	84.4561513355766	0	0	922	69.62494200995306	0	0	3267	91.143									



1 alert for job=dfwdatahub

[View In AlertManager](#)

[1] Firing

Labels

alertname = rateAlert_dfwdatahub_TFM_TFDM

instance = datahub2:9097

job = dfwdatahub

topic = TFM_TFDM

Annotations

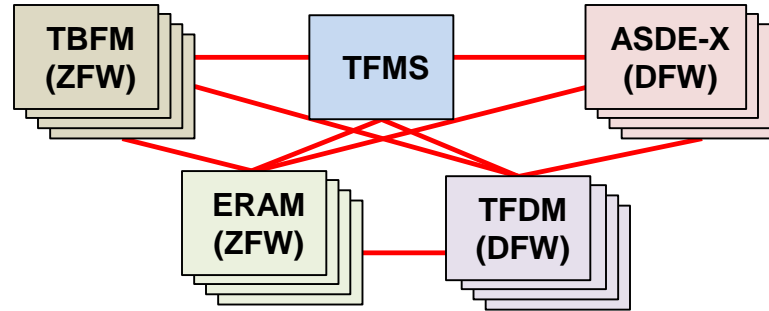
subject = No messages for topic TFM_TFDM on dfwdatahub

summary = Topic TFM_TFDM on dfwdatahub has not received a message for at least 10 minutes

[Source](#)

Feed	Data Source	ATD-2 Use	Data
TfmData Flight	TFMS	<ul style="list-style-type: none"> • Schedule data • CDM data • Flight plans • EDCTs • Track data 	Flight
STDDS SMES	ASDE-X/ASSC	<ul style="list-style-type: none"> • Surface track data 	Track
TBFM MIS	TBFM	<ul style="list-style-type: none"> • Release times • EDCTs 	Flight Plan
TfmData Terminal	TFMS	<ul style="list-style-type: none"> • EOBTs • Gates • Tail Numbers 	Flight
TfmData Flow	TFMS	<ul style="list-style-type: none"> • Ground Stops • MIT restrictions (planned) 	TMIs
SFDPS	ERAM	<ul style="list-style-type: none"> • Support for NASA research TBFM 	Flight Plan

- The NAS systems generating flight data SWIM feeds are interconnected.
 - Basic understanding the NAS architecture helps make sense of the SWIM data.



NAS System	SWIM Feeds	Primary Inputs	Secondary Inputs	Deployments
TFMS	<ul style="list-style-type: none"> TfmData Flight TfmData Flow TfmData Terminal 	<ul style="list-style-type: none"> ERAM flight/track data OAG schedule Airline CDM messages ATOP oceanic track 	<ul style="list-style-type: none"> TBFM release times STDDS surface times OIS / NTML International feeds TFDM predictions 	1
ERAM	<ul style="list-style-type: none"> SFDPS 	<ul style="list-style-type: none"> ATC flight plan data En route radar track 	<ul style="list-style-type: none"> TFMS EDCTs TFMS reroutes 	1 per ARTCC (20 total)
TBFM	<ul style="list-style-type: none"> TBFM MIS 	<ul style="list-style-type: none"> ERAM flight/track data (adjacent ARTCCs) TRACON flight/track data 	<ul style="list-style-type: none"> TFMS international track TFDM release time negotiation 	1 per ARTCC (20 total)
ASDE-X	<ul style="list-style-type: none"> STDDS SMES 	<ul style="list-style-type: none"> Surface radar track ERAM flight data 		1 per airport (38 total)
TFDM	<ul style="list-style-type: none"> TTP 	<ul style="list-style-type: none"> All the above 		1 per airport (future)

Feed	Daily Volume	Sync Messages?	Diff or Full Messages
TfmData Flight	280k (note: much larger batches)	No	Full
STDDS SMES	22.5 million	No	Diff (with full at regular intervals per flight)
TBFM MIS	25 million	Yes	Diff
TfmData Terminal	225k	No	Full
TfmData Flow	1.7 million	Yes	Full
SFDPS	5.3 million	No	Full

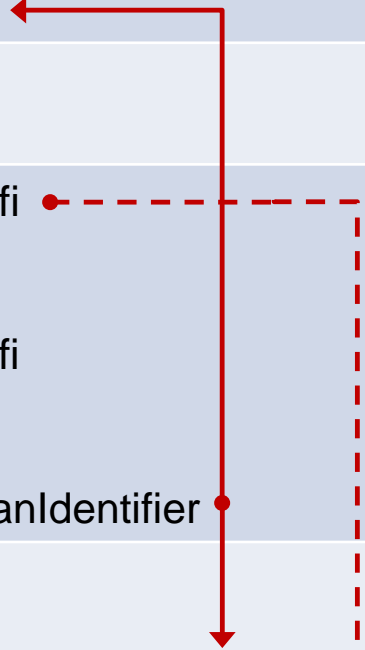
Source	Flights Included	Earliest Flight Data	Latest Flight Data
TFMData Flight	All IFR	~24 hours before scheduled OAG operation	“Actual” arrival gate time published by Operators (up to 2 hours after taxi in)
TFMData Terminal	Only flights that publish CDM messages including Terminal Flight Data elements	~24 hours before scheduled operation	“Actual” arrival gate time published by Operators (up to 2 hours after taxi in)
SFDPS	All IFR and some VFR	Filed flight plan	Flight lands
TBFM MIS	Impacted by a TBFM arrival (TMA) or departure (EDC) system	Flight plan filed within TBFM adapted region	Track ends or leaves TBFM adapted region
STDDS SMES	Operating at or near ASDEX airport	First correlated flight track	Last correlated flight track

Overview of Data Feeds

SWIM Feed IDs

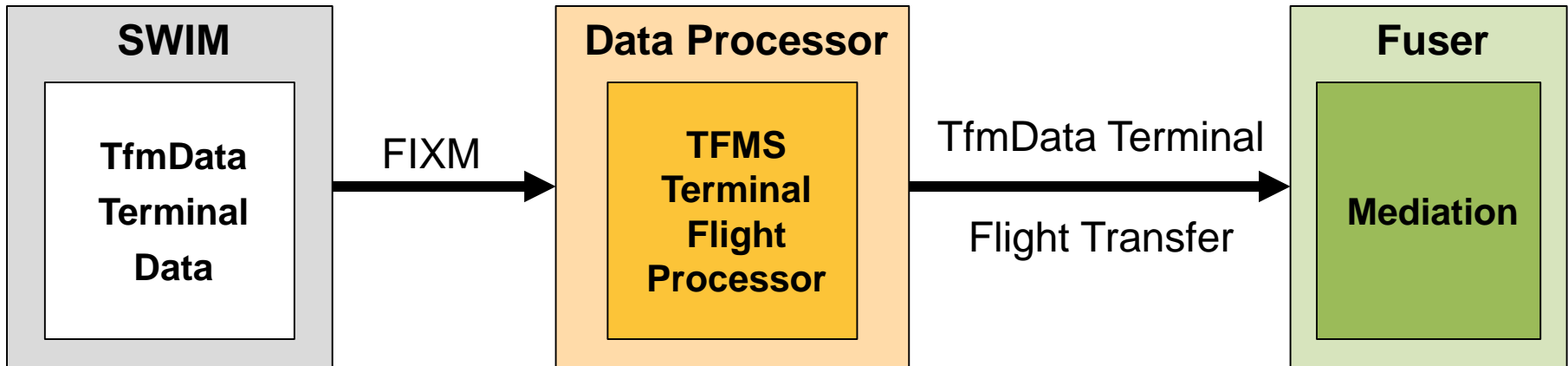


Source	Unique Flight IDs	Examples	ID Recycles	Multiple IDs per Flight
TFMData Flight	<ul style="list-style-type: none"> flightRef gufi 	<ul style="list-style-type: none"> 100725389 KT44707500 	<ul style="list-style-type: none"> Infrequent Infrequent 	<ul style="list-style-type: none"> Rare Yes
TBFM MIS	<ul style="list-style-type: none"> tmald 	<ul style="list-style-type: none"> T06629 	<ul style="list-style-type: none"> Immediately 	<ul style="list-style-type: none"> Yes
SFDPS	<ul style="list-style-type: none"> fdpsGufi uuidGufi flightPlanIdentifier 	<ul style="list-style-type: none"> us.fdps.2019-05-09T13:40:40Z.000/19/501 b443e49c-0cdf-47ed-bce5-5275a54a8cc0 KT44707500 	<ul style="list-style-type: none"> Never Unlikely Infrequent 	<ul style="list-style-type: none"> Rare Yes, on failover Yes
STDDS SMES	<ul style="list-style-type: none"> stid track enhancedData.eramGufi enhancedData.sfdpsGufi 	<ul style="list-style-type: none"> 1716539 862 KT44707500 us.fdps.2019-05-09T13:40:40Z.000/19/501 	<ul style="list-style-type: none"> Infrequent Frequent Infrequent Never 	<ul style="list-style-type: none"> Possible Frequent Yes Rare



- Full mappings available publically here:
 - https://aviationsystems.arc.nasa.gov/atd2-industry-days/fuser/TFMS-Flight-Data-Mapping_85328230.html
- Mapping Example – TfmData Flight Messages

Data Element	TfmData Flight Message Type	TfmData Flight Data Element
acid	<all>	qualifiedAircraftId.aircraftId
aircraftType	BOUNDARY_CROSSING_UPDATE DEPARTURE_INFORMATION FLIGHT_CREATE FLIGHT_MODIFY FLIGHT_PLAN_AMENDMENT_INFO FLIGHT_PLAN_INFORMATION FLIGHT_ROUTE FLIGHT_SCHEDULE_ACTIVATE FLIGHT_TIMES	flightAircraftSpecs flightStatusAndSpec.aircraftspecification airlineData.flightStatusAndSpec.aircraftspecification airlineData.flightStatusAndSpec.aircraftspecification newFlightAircraftSpecs flightAircraftSpecs flightStatusAndSpec.aircraftspecification flightStatusAndSpec.aircraftspecification flightStatusAndSpec.aircraftspecification



```
flight.getDepartureNas().getStandPositionAndTime().getStandTime().  
getActual().getTime()
```



```
flight.getActualOffBlockTime()
```

- One parser per feed
 - Transforms raw XML file into flattened object structure
 - Leveraging JAXB with jaxb2-basics to simply XML->Java Object conversion
 - In some cases, perform aggregation against messages from the same source

- Aggregation examples

- STDDS SMES

- Track data is sent as diffs
- Have to aggregate with previous messages for same flight so that complete position update is processed by Fuser

	Previous	Current	To Fuser
Time	12:00:01	12:00:02	12:00:02
Latitude	35.2156	-----	35.2156
Longitude	-80.9473	-80.9475	-80.9475

- TBFM-MIS

- Need to be able to handle SYNC messages properly

- Parsers archive raw message to databases for analysis



- Parser features
 - Message splitting/filtering
 - Filter to MessageType=FlightDataMessageOutgoing.
 - Un-batch incoming messages.
 - Message aggregation
 - Sort messages within each by time order.
 - Messages are full, but message types contain different types of data.
 - Message matching
 - Global GUFID assigned from ATD2 GufiService.
 - Locally match data on Flight Ref with additional internal validation.
 - Message Transformation
 - Common format with GUFID and all possible data across TFM message types.

- Key headers
 - MessageType : FlowInformationMessageOutgoing / FlightDataMessageOutgoing



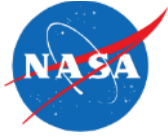
- Lessons learned
 - TFMS Flight Ref is good for matching NAS-wide flight data.
 - Schema is somewhat challenging to parse -- most messages are different format.
 - Message types (and message trigger) are important to interpreting the message intent.
 - E.g. MsgType=FLIGHT_TIMES, Trigger=NEMS_TBFM_FLT_DEPARTURE_MSG
 - Some JMSDD data elements are not available yet (e.g. etdTimeType=METERED).



- Parser features
 - Message splitting/filtering
 - Process each airport independently.
 - Message aggregation
 - Merge input data on track number.
 - Handle “full=true” sync messages.
 - Handle the delete element (r=1) attribute.
 - Message matching
 - Global GUFU assigned from ATD2 GufiService.
 - Locally match data on STDDS Surface Track ID with additional internal validation.
 - Message Transformation
 - Common format with value-added fields (e.g. GUFU).
- Key headers
 - airport
 - msgType : AT (PositionReport), AY (SystemStatus), AD (adsbReport), ML (mlatReport)



- Lessons learned
 - Beacon code used to retrieve core data from ERAM (e.g. ACID, aircraft type, etc).
 - When aircraft emit the “wrong” beacon code, ACID will also be wrong.
 - Track messages are interpolated (may indicate wrong location).
 - Schema updates are deployed to different airports at different times.



- Parser features
 - Message filtering
 - ATD2 filters to messages from TBFM ARTCCs of interest.
 - Message aggregation
 - Merge input data on TMA ID.
 - Merge elements in sta, eta, sch, mrp data groups by common “mfx” name.
 - Handle NEW, AMD, DEL message types.
 - Handle messages out of order.
 - Handle sync messages.
 - Message matching
 - Global GUFID assigned from ATD2 GufiService.
 - Locally match data on TMA ID with additional internal validation.
 - Message Transformation
 - Common format with value-added fields (e.g. GUFID).
- Key headers
 - ARTCC – TBFM originating ARTCC.
 - SYNC – sync message.
 - STDCHG – indicator that release time either set or unset.



- Lessons learned
 - Tmald used for merging data, but can recycle very quickly.
 - TBFM SYNC messages had to be handled as syncs and not updates.
 - Sync messages can take many minutes to complete. Prevented resetting the EDCT back to an old value.
 - Treat AMD/NEW the same.



- Animated storyboards
 - [About ERAM in general](#)
 - [About TBFM in general](#)
 - [About TFMS in general](#)
 - [About TFDM in general](#)
- Operation Context and Use Cases
 - [About TfmData Flow Operational Context and Use Cases](#)
 - [About TfmData Flight Operational Context and Use Cases](#)
 - [About TBFM SWIM Operational Context and Use Cases](#)
 - [About SFDPS Operational Context and Use Cases](#)



- SWIM contains lots of data
- The data has lots of value
- But consuming that data is challenging
- If only there were some way to fuse the data together...

