



Airspace Technology Demonstration 2 (ATD-2)

ATD-2 Fuser Database

May 22, 2019



- Purpose
- Database Overview
- Database Details
- Use Cases

Understanding the Data

What is in the raw data?
When is a specific field set in a SWIM feed?
How did a SWIM feed handle a specific flight?



End Results

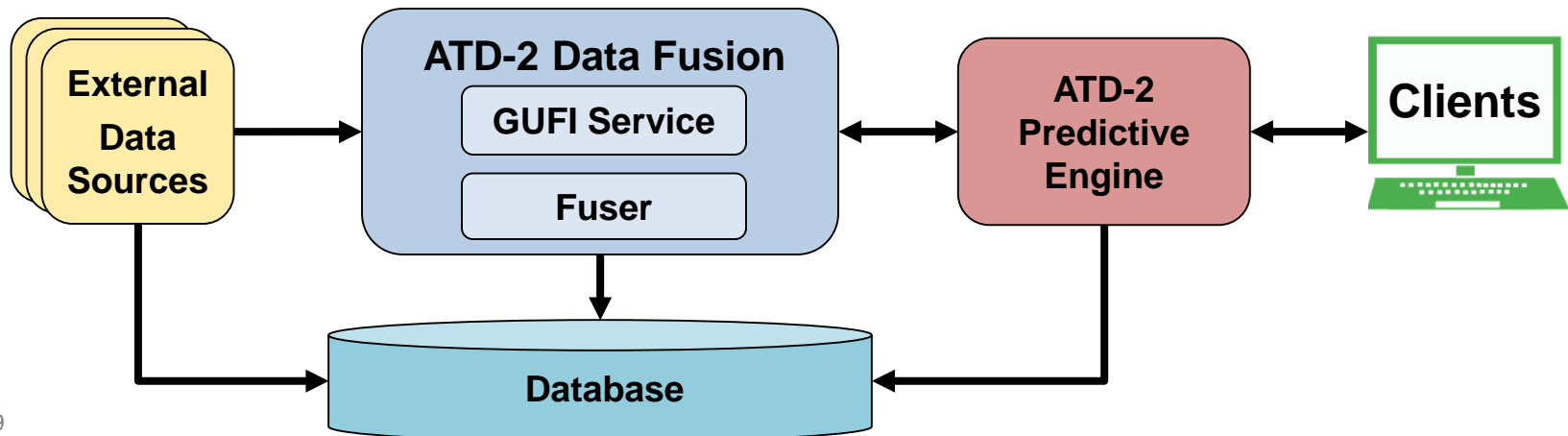
How were operations yesterday / last week / last year?
Are there areas for improvement?
Did we see any benefits?

Traceability / Debugging

How did our data processing handle this case?

What triggered this update in our system?

- Each ATD-2 system has a dedicated system that captures the data necessary to meet objectives
- Each database contains tables with
 - Flattened messages from external sources
 - Flight matching data
 - Fuser mediated data
 - Data from ATD-2 internal components
- Database structure prefers wide tables that contain flattened data
 - Very few joins or tree traversals needed



- ATD-2 Data Fusion Tables
 - Fuser flight tables
 - GUFU (Global Unique Flight Identifier) tables
- Source Data Tables
 - TfmData flight tables
 - TBFM table
 - ASDEX (STDDS SMES) table
 - TfmData Terminal table

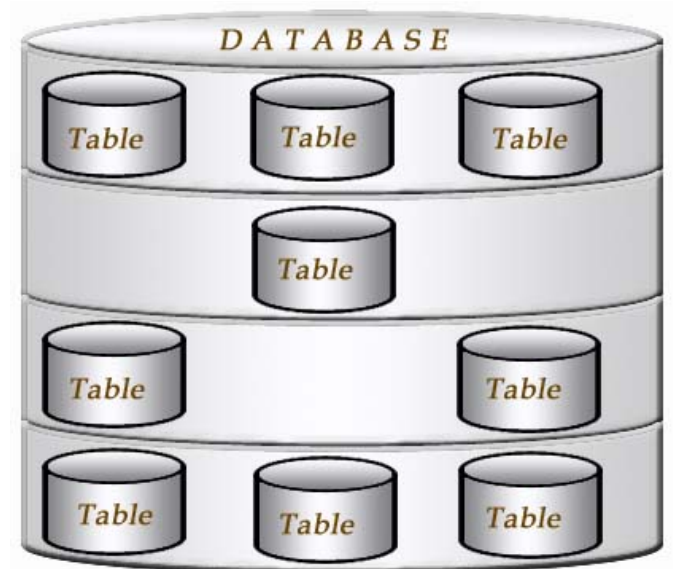




Table	Contains
matm_flight_all	A snapshot of the current flight state after every update
matm_flight	Just the fields that changed as part of each flight update
matm_flight_summary	A single record per flight with the current state of the flight
*_extension	Processed data updates that apply only to a specific source

MATM_FLIGHT

acid	departure stand airline	departure stand airline time	departure stand actual time	Last update source	System id	Timestamp
ABC1234	B1	2017-04-05 11:00		TFM_TFDM	ABC	2017-04-05 10:00
ABC1234		2017-04-05 11:15		TFM_TFDM	ABC	2017-04-05 10:30
ABC1234			2017-04-05 11:17	TFM_TFDM	ABC	2017-04-05 11:17

MATM_FLIGHT_ALL

acid	departure stand airline	departure stand airline time	departure stand actual time	Last update source	System id	Timestamp
ABC1234	B1	2017-04-05 11:00		TFM_TFDM	ABC	2017-04-05 10:00
ABC1234	B1	2017-04-05 11:15		TFM_TFDM	ABC	2017-04-05 10:30
ABC1234	B1	2017-04-05 11:15	2017-04-05 11:17	TFM_TFDM	ABC	2017-04-05 11:17

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MATM_FLIGHT_SUMMARY – at 10:00

acid	departure stand airline	departure stand airline time	departure stand actual time	Last update source	System id	Timestamp
ABC1234	B1	2017-04-05 11:00		TFM_TFDM	ABC	2017-04-05 10:00

MATM_FLIGHT_SUMMARY – at 10:30

acid	departure stand airline	departure stand airline time	departure stand actual time	Last update source	System id	Timestamp
ABC1234	B1	2017-04-05 11:15		TFM_TFDM	ABC	2017-04-05 10:30

MATM_FLIGHT_SUMMARY – at 11:17

acid	departure stand airline	departure stand airline time	departure stand actual time	Last update source	System id	Timestamp
ABC1234	B1	2017-04-05 11:15	2017-04-05 11:17	TFM_TFDM	ABC	2017-04-05 11:17

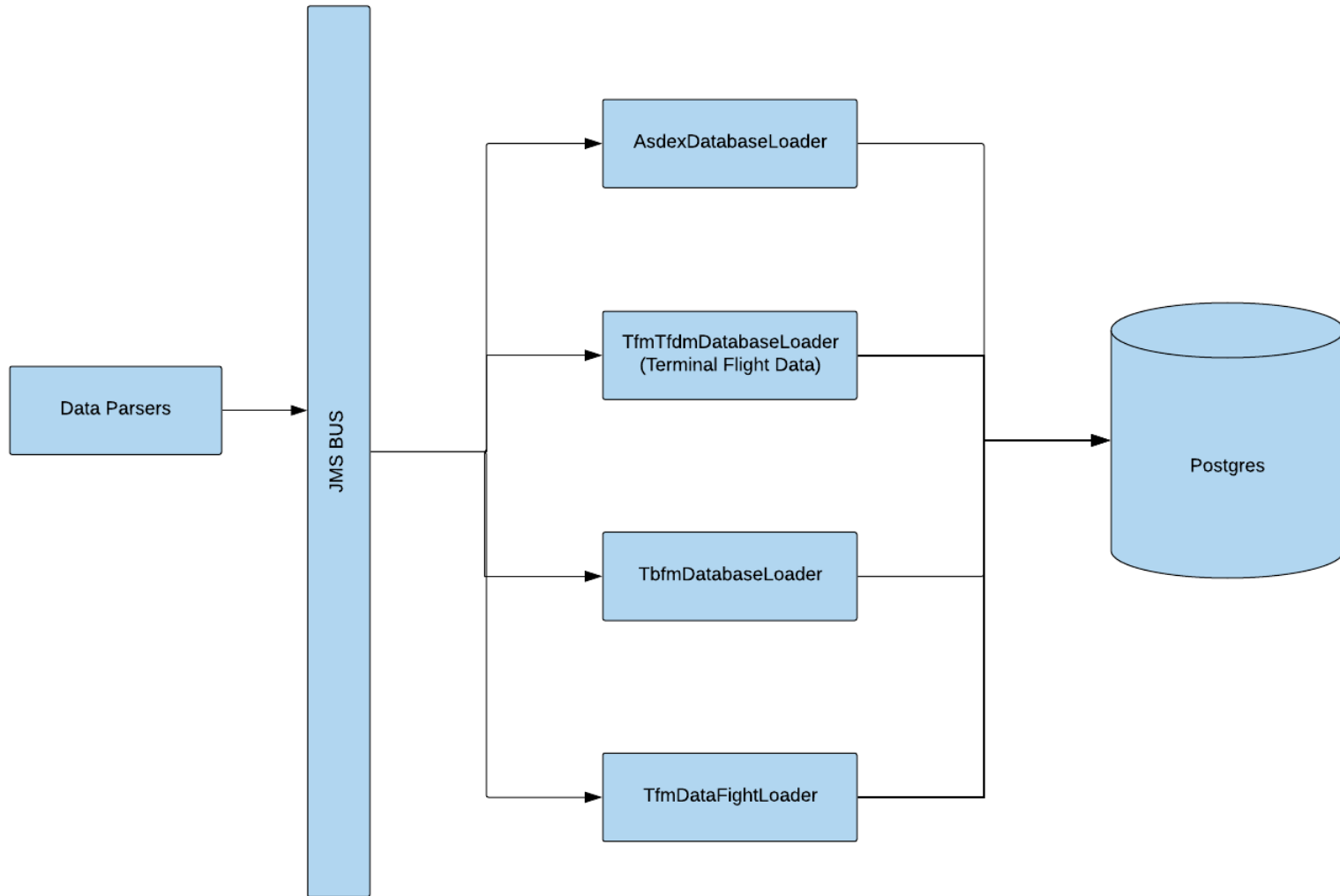


Table	Contains
gufiflightmessage	Data on how each flight message from an external source was matched to a Fuser GUFi
gufiflighthistory	A snapshot of the current flight state in the GUFi flight matching service after every message



Table	Contains
asdex_messages	ASDE-X track data
tfm_*	TFMS flight data – one table per message type
tma_message	<p>NASA research TBFM and SWIM TBFM data</p> <ul style="list-style-type: none"> • See the source column. Contains either <ul style="list-style-type: none"> • SWIM • NASA-ZTL • NASA-ZDC
tfm_tfdm	TfmData Terminal Flight Data

TFM Table	Message Triggered When
tfm_arrival	TFMS detects that a flight has landed
tfm_boundary_crossing	A flight crosses between ARTCCs
tfm_departure	TFMS detects that a flight takes off
tfm_flight_control	TFMS issues an EDCT for a flight
tfm_flight_create	An airline submits a Flight Create message
tfm_flight_modify	An airlines submits a Flight Modify message
tfm_flight_plan	A flight plan is filed
tfm_flight_plan_amend	A flight plan is amended
tfm_flight_plan_cancel	A flight plan is canceled
tfm_flight_route	A flight's route changes
tfm_flight_schedule_activate	TFMS activates a scheduled flight 24 hours in advance
tfm_flight_times	A flight's ETD or ETA changes due to events at the origin
tfm_oceanic_report	An oceanic report is made
tfm_track	TFMS track data at 1 minute update rate

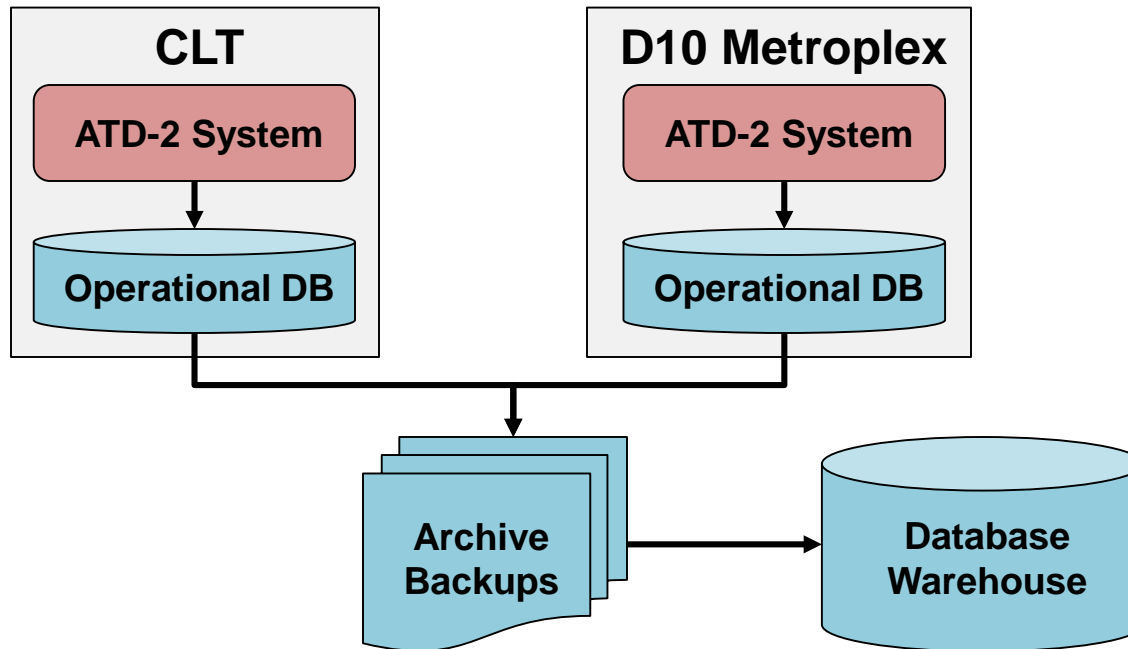




- PostgreSQL database
- All tables are partitioned based on timestamp
 - Improves query performance
 - Allows old data to be easily rolled off
 - Data is automatically rolled off daily
 - Data is stored long term in a warehouse
- Indexes on key data fields per table

- Operational systems store 5 day's worth of data
- Warehouses store archives of data long term for post-analysis
 - Data is archived nightly to allow post-analysis scripts to run overnight

Stats	CLT Warehouse	D10 Warehouse
Flight Count	~910,000	~1,285,000
Size	~15TB	~14TB



- Problem
 - Need to store new data fields with each release
 - Cannot delete data on operational system and start clean when new release is deployed
 - The new data fields will not exist in warehouse archives

- Solution
 - LiquidBase for tracking DB schema changes between versions
 - Schema changes are stored in XML
 - When new version is deployed, DB schemas are automatically updated
 - Archiving scripts read XML files and update warehouse prior to archiving new data

```
<changeSet id="fuserDataCapture-v3.1.2-20180406-1" author="atd2" runAlways="true">
  <validChecksum>ANY</validChecksum>
  <preConditions onFail="MARK_RAN">
    <tableExists tableName="matm_flight_summary"/>
    <not>
      <columnExists tableName="matm_flight_summary" columnName="departure_aerodrome_faa_lid"/>
      <columnExists tableName="matm_flight_summary" columnName="arrival_aerodrome_faa_lid"/>
    </not>
  </preConditions>

  <addColumn tableName="matm_flight_summary">
    <column name="departure_aerodrome_faa_lid" type="varchar" />
    <column name="arrival_aerodrome_faa_lid" type="varchar" />
  </addColumn>
</changeSet>
```



- Question:
 - ATD-2 needed to cancel flights based on TfmData
 - TfmData has multiple triggers for cancellation
 - Which triggers should ATD-2 use?

- Approach
 - Use TfmData tables to determine the percentage of flights with a cancellation message and later had track data

- tfm_flight_plan_cancel table

acid	departure_ airport	arrival_ airport	flight_ref	trigger	source_timestamp	...
EDV5575	KDSM	KLGA	100000348	FD_FLIGHT_CANCEL_MSG	5/1/2019 9:12	...
UAL1965	KTPA	KEWR	99911618	HCS_CANCELLATION_MSG	5/1/2019 9:15	...
DAL146	SCEL	KATL	99972860	HCS_CANCELLATION_MSG	5/1/2019 9:16	...

- Results (2019-05-01 08:00Z to 2019-05-14 08:00Z)

Trigger	Total Count	Track Count	Percent
UPDATE_INTERNATIONAL_CANCEL_TIMEOUT	79683	0	0.0%
UPDATE_CANCEL_TIMEOUT	27674	7128	25.8%
HCS_CANCELLATION_MSG	27098	15555	57.4%
FD_FLIGHT_CANCEL_MSG	11912	1009	8.5%
CANCEL_CMD	5962	75	1.3%
TMI_UPDATE	1293	178	13.8%
IADE_CANCELLATION_MSG	190	113	59.5%

- ATD-2 currently only uses FD_FLIGHT_CANCEL_MSG to mark flights as cancelled
 - HCS_CANCELLATION_MSG are used to track the cancellation of flight plans associated with a flight, but not to cancel the entire flight
 - ATD-2 has logic similar to TFMS timeout logic and so does not use timeout cancellations



- Question:
 - Prior to going live at CLT, there was a large push to resolve flight matching issues
 - Testers reported an issue where two aircraft icons were observed for a single arrival
 - What happened?
- Approach
 - Pull the data on the flight and all related flights from the GUF1 tables
 - Find when the first mismatch happened
 - Create a file with the GUF1 corrected for every entry
 - Run file through unit test tool to identify problem

- Use Excel mapping tool to quickly identify that ASDE-X data for arrival flight incorrectly matched to departure flight with the same callsign
 - JIA5485 from GSO to CLT
 - JIA5485 from CLT to TYS
- Determined root cause was that ATD-2 had received incorrect gate IN time message
 - Matching service marked flight as having arrived
 - ASDE-X matching logic would not match to a flight that had already arrived at the gate
- Updated logic to better handle case with incorrect gate IN time message

