Mosaic ATM Products, Techniques for Greater Efficiency

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Agenda

• Who are Mosaic ATM?
• Filling the gap between operators and ATC
• Fundamental shift – data sharing
• SWIM data
• Analytics
• Participating in CTOP
• Putting it all together
• Incorporated 2004
• Mission - To improve the effectiveness of complex aviation-related operations
• ~50 employees
• ~$10M annual revenue
• 2013 Air Traffic Control Association’s Small Business of the Year Award
• Commercial Focus: Help operators use ATC to advantage
Commercial Experience

• Serving commercial airlines since 2004
  – Major overnight cargo airline – SDSS customizations, 24x7x365 support, ADS-B augmentation, operational efficiency metrics
  – Another major overnight express shipment airline – SDSS + MSV, ADS-B augmentation, ADS-B primary-source surveillance
  – SWIM data services for major on-demand airline
  – 2nd tier components to industry providers of airline tools
  – CTOP collaboration with a major airline

• Strategic thrust to expand non-Government business in 2016

• Commercial mission: helping aviation organizations understand and work with ATM
Mosaic ATM

• Early research → prototype deployment → support operational use of deployed systems

• Bring together subject matter expertise, operations research, computer science, human factors, system engineering, and project management

Metroplex Simulation Environment
Mosaic ATM

• Original and applied ATM research and development for FAA and NASA

• Specialize in airport surface, TFM, Wx integration, SWIM applications including GUFI/flight matching

• Leverage knowledge from Government work to produce commercial products and services

• Customer-focused, agile approach yields practical solutions

Automated analysis of taxi segment usage and taxi delay location

8/3/2016
Strategic Arrival Reroute Tool

- ATM-Wx Integration
- Evaluates convection forecasts over arrival corridors
- Translates into hourly capacity predictions for corridor segments (stochastic)
- Visualize excess demand and available capacity

Phase I Prototype Evaluated by ZMA TMU (Summer 2013)
GDP Parameter Selection Model

• Applies stochastic forecast of SFO stratus clearing
• Identifies Ground Delay Program parameters that reduce unnecessary delays relative to historical performance
Collaborative Trajectory Options

• Several Mosaic employees involved in CTOP early on
• CTOP SBIR in 2011 generated an airline CTOP decision aid and simulation, which was subsequently used in global ATM work
• New CTOP NRA about to start, may help further develop parts of CTOP that have kept it from reaching its potential
• The FAA is transitioning all data exchange to SWIM
• Mosaic ATM has been working with SWIM since 2012
• A significant part of Mosaic ATM’s work is development of data standards for future FAA and international SWIM releases
• Our products anticipate and benefit from upcoming changes
Surface Decision Support System

- “TBFM for surface/departures”
- Research platform used by FAA and NASA for >15 years
- Invented by Mosaic ATM staff and developed/maintained by Mosaic ATM since 2004
- Operates 24x7x365 at several airports
- Backbone of NASA’s ATD-2 demonstration
At the heart of our tools is fast-time simulation.

- Identify current situation
  - Which aircraft is where?
  - Where is it going?
  - Applies at gate, on ramp, in the air, elsewhere.

- Predict how situation will evolve.
  - Mosaic Prediction Engine (MPE) – algorithms that predict what will happen, given operating procedures, resource capacity, etc;
  - Adaptation – configuration data that describe to MPE the airports, airspace, operating procedures, capacities, etc.
Adaptation

- Physical elements needed prior precursor to analysis or simulation
  - Airport base map
  - Links
  - Gates
  - Spots
  - Runways
  - Taxiways polygons
  - Arrival / departure fixes
- Procedural elements
  - Airport and airspace configurations
  - Runway assignment rules
  - Gate assignment rules
  - Taxi rules
  - Etc
Current Commercial Products

• Mosaic Situation Viewer (MSV)

• Collaborative Trajectory Options Program (CTOP) Decision Aid

• Analytics Suite

• All built on common cloud-based infrastructure – SWIM Gateway
Current Commercial Products

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SWIM Gateway

• Mosaic ATM has been a pioneer in surface and airborne flight tracking and matching with hosted connections to ASDE-X, ARTS, STARS, ETMS, ASDI systems since 2004.

• Mosaic ATM has been an early adopter of FAA SWIM Services
  – Starting with research services originally deployed on the FTI National Test Bed in 2012
  – In February 2015 we transitioned to operational SWIM (STDDS) services
  – Today we have access to most/all publicly available operational SWIM services

• Access to two NEMS Gateways connecting to:
  – R&D for developing against new services as they come online
  – FNTB (FTI National Test Bed) for certifying access to services
  – OPs for accessing operation services
Connectivity to FAA SWIM

8/3/2016
• Flight and Surveillance
  – SWIM Terminal Data Distribution System (STDDS) Surface Movement Event Service (SMES) sends derived surface movement events for all aircraft monitored at select towers. In addition, the service sends track positions for all aircraft and vehicles as well as generic flight plan data collected from towers associated with a Terminal Radar Approach Control. This service publishes position reports and surface movement events. *(36 Sites - Live ~1 sec updates)*
  – En Route Flight and Related Data or SWIM Flight Data Publication Service (SFDPS) • Proposed and active flight plans, including amendment information; track data associated with active flights; and arrival, departure, and cancellation information. *(NAS Wide - Currently Live 1 min updates transitioning to 11 sec updates fall 2016)*
  – Traffic Flow Management System (TFMS) Flight Data • Flight Plan Data, Departure & Arrival time notifications, Flight cancellations, Boundary crossings, and Track position reports. *(NAS Wide - Live 1 min updates)*
• Status and Constraint
  – Traffic Flow Management System (TFMS) Flow Information All Traffic Management Initiative (TMI) definitions, Air Traffic Control System Command Center (ATCSCC) advisories, Restrictions, Airport runway configuration and rates, Airport deicing status
  – Federal NOTAM System Distribution Service (FNS-NDS) provides the current digital (Aeronautical Information Exchange Model data format) and non-digital NOTAM messages
  – SWIM Terminal Data Distribution System (STDDS) Airport Data Service (APDS) publishes Runway Visual Range (RVR) data to consumers. Data includes runway visibility and trend for touchdown, midpoint and roll-out, depending on the instrumentation for the runway. Data also includes edge and center-line light intensity settings.
  – Integrated Terminal Weather System (ITWS) data services provides clients with a common interface to subscribe to a variety of weather products.
### NON-FAA Sources

- **Surveillance**
  - External/Third-party ADS-B (new option)
  - Mosaic ADS-B (2014)
  - Mosaic GPS

- **Airline**
  - Flight Data
  - Gate Data

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### Washington to Charlotte

**Thursday, June 16, 2016**

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Operated by PSA Airlines as American Eagle

**In flight**

- Scheduled 5:15 AM
- Terminal: --
- Gate: B71

- Scheduled 6:35 AM
- Terminal: --
- Gate: E22
- Baggage: E
• SWIM Gateway
  – Collects data from SWIM and other sources
  – Fuses disparate sources into consistent picture
  – Publishes results to customers and Mosaic apps
Current Commercial Products

• Mosaic Situation Viewer (MSV)

• Collaborative Trajectory Options Program (CTOP) Decision Aid

• Analytics Suite

• All built on common cloud-based infrastructure – SWIM Gateway
• The Analytics Suite Provides:
  – Fused flight data integrating multiple data sources to create a more complete picture of flight operations.
    o Integrating Surface, TRACON, and En Route sources that provide surveillance and flight planning information
  – Data Management
    o On-line data warehouse to simplify flight data access
  – Key Performance Indicators (KPIs)
    o Flight level metrics capturing flight, airport and airspace performance.
  – Data Mining Tools to Identify
    o Airport and Airspace metrics categorized by attribute and resource.
    o Grouping, graphing, flight track plotting and playback.
Mosaic Analytics Architecture

Surveillance and Flight Data
- Flight Data
  - Customer Gateway
    - SWIM Surveillance
      - Enroute
    - Cat 62
    - Cat 11
    - ADS-B / ACARS / Other
  - ODB
    - Raw Logs
  - Correlator
    - Correlated Logs
- Message Bus

Fused Data
- Correlator
  - Flight Data Archive
    - Archiver
    - Warehouse Utilities
    - Derived Processor
    - Airport Adaptation
  - Playback
    - Reporting
- Message Bus

Metrics & Storage
- Flight Data Archive
- Derived Processor
- Airport Adaptation

Reporting & Analysis
- Reporting
- Playback
Graphical Reporting Capabilities

Active inbound Tracks - ATL

Arrival Runway Usage (Last Hour)

Departure Runway Usage (Last Hour)

Arrival Runway Usage

Departure Runway Usage

Airport Traffic by Operation (Last Hour)

Average Departure Taxi Time by Runway

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MOSAIC ATM
Innovators for the Next Generation of Aviation
Graphical Reporting Capabilities

Scalable views integrated with metrics results
Questions

• Show of hands:
  – Who has questions that need data to answer?
  – Do you have a group in-house who uses Analytics tools?
  – Do you rely on external analyses?

• What’s your biggest unanswered operational question?
Current Commercial Products

• Mosaic Situation Viewer (MSV)

• Collaborative Trajectory Options Program (CTOP) Decision Aid

• Analytics Suite

• All built on common cloud-based infrastructure – SWIM Gateway
Without CTOP:

• FAA issues FCA’s
• Flights going through FCA’s take delay

With CTOP:

• FAA issues FCA’s
• Flights are given the option to route around FCA’s (extra fuel) or go through (delay)
• Operator can specify preferences in advance via Trajectory Options Set (TOS)
Interacting with CTOP

• To benefit from CTOP, users need to manage multiple routes, valid times, and preference information - RTC’s – comprising the Trajectory Options Set (TOS)

• Dispatch is already busy

• The Mosaic ATM CTOP system interfaces with user and FAA systems to streamline the process and ensure user objectives are met
CTOP System Benefits

• The Mosaic ATM CTOP System squeezes advantage from CTOP’s, yet requires very little workload
  – Unique ability to automatically generate route options appropriate to the FCA’s
  – Calculates meaningful Relative Trajectory Cost (RTC) information for each trajectory option, based on flight-specific information
  – Manage the process by exception: monitor and guide with minimal workload

• It would be extremely difficult to do this well without the Mosaic ATM CTOP system
Current Commercial Products

- Mosaic Situation Viewer (MSV)
- Collaborative Trajectory Options Program (CTOP) Decision Aid
- Analytics Suite
- All built on common cloud-based infrastructure – SWIM Gateway
Products -> MSV

• Mosaic Situation Viewer (MSV) is a versatile central part of the product suite
  – En Route and Airport-Centric views in one display
  – Tabular flight details
  – Supports display of advanced predictive and derived data features

• Mosaic Prediction Engine (MPE) “understands” how airports, airplanes and airspace work
  – Uses all information sources (SBM) to build the current picture: where are flights, what configurations are in use, etc
  – Predicts progress of flights through the system, based on current situation and fundamental separation constraints, flow restrictions, etc
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**Flight Information**

**Flight Details**

**JFK Timeline**

**Map Overview**

**Diagram**

**Data**

**8/3/2016**
What Use?

• Looking at pictures is nice
• Knowing when things will happen so your organization can take early action is nicer
  – Data can be integrated into airline’s existing tools
  – Or, presented through MSV
• Let your customers know earlier?
Flight status

New York to Richmond
Thursday, July 28, 2016

3993  American Airlines
Operated by Air Wisconsin as American Eagle

Delayed: Awaiting takeoff

Flight status

> Back to search

New York to Richmond
Thursday, July 28, 2016

3993  American Airlines
Operated by Air Wisconsin as American Eagle

Actual
8:38 AM
LGA
Scheduled 7:59 AM
Terminal C
Gate C36
Diversion Management

• Two Diversion Management Components
  – Alerting of holding by arrival airport
  – Alerting of significant changes in ETA / Predicted Arrival Time that could lead to diversion

• Holding detection algorithm identifies tracks that enter hold
  – On recognition, sends alert
  – Early warning of impending capacity changes, e.g. for snow removal
Diversion Management

- Alerting of approach of Predicted Arrival Time to “Bingo” that could lead to diversion
  - Once capacity and demand are known, predictions incorporate congestion
  - Most accurate if operator provides bingo time directly
Tarmac Delay Monitoring

- Tarmac Delay Monitoring computes time since boarding / door closed event through predicted off time OR on time through predicted in event
  - At non-MPE airports, only actual elapsed time shown
- Numerous paths to connect to event of choice
- Result shows as column in flights table within MSV and selectable in data tag
- Alerts can be driven and configured from calculated data element
Questions

• Show of hands:
  – Whose tools would benefit from predictions?
  – Who is interested in participating / guiding our research?
QUESTIONS?