THE CONNECTED AIRCRAFT: Improving Dispatch Reliability

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“Operational Excellence is critical for consistent airline profitability and employee morale. This means that anything that gets in the way of operational excellence must be dealt with immediately...” (Gordon Bethune, 2010)
DISMAL DISPATCH RELIABILITY

Yet, globally ...

• 1 out of every 3 flights arrives more than 5 minutes late
• 1 out of 10 flights arrives more than 30 minutes late
• 1 out of every 100 departures cancels altogether
DISMAL DISPATCH RELIABILITY

Definition:
• Dispatch reliability is percentage of flights that depart within a specific window after the scheduled departure time

Measuring dispatch reliability varies by world region
• Europe & North America
  • 15 minutes after the scheduled time for flight departures and an allowance of 14 minutes (A14) after the scheduled arrival time
• Middle East and Asia
  • For example Emirates uses +/- 15 minutes not A14
When measuring Dispatch Reliability, airlines *exclude* non-aircraft issues such as severe weather, air traffic control congestion, and delays driven by airport security.

But ... real-time aircraft data streaming from a Connected Aircraft can lead to better management of uncontrollable events through improved planning for and management of severe weather conditions and air traffic control congestion.
**Dismal Dispatch Reliability**

- Average dispatch reliability across the fleet operated by major US airlines was 79% on average from 2003 to today.
- An average of 80% of flights had an on-time gate arrival.
- The average gate departure delay was 11.7 minutes, and the average gate arrival delay was 12.6 minutes.
- When flights were delayed more than 15 minutes, the average delay was 55 minutes.

*US Carrier Dispatch Reliability Averaged 79%
Source: FAA ASPM Data Set (2003-2015)
n = 67.3 million flight records*
DISMAL DISPATCH RELIABILITY

Dispatch reliability on a trailing twelve-month average basis illustrates, both positive and negative trends:

- **2004-2007**, US carriers increased capacity, resulting in increasing delays and gate holds due to crowded ramp areas, congested taxiways and airspace delays.
- **2008-2012**, a combination of lower capacity and relatively benign winter weather contributed to a significant improvement in dispatch reliability.
- **2013 through present**, major US carriers attribute the clear decline in dispatch reliability to increased severity in winter and summer weather conditions and deteriorating operational performance due to factors such as crew scheduling.

**Graph**: Aircraft Dispatch Reliability, Trailing Twelve Months, All US Airports

- **Source**: FAA ASPM Data Set (2003-2015)
- **Data**: 67.3 million flight records

**Trends**:
- **2004-2007**: Deteriorating
- **2008-2012**: Improving
- **2013-2015**: Deteriorating
Dismal Dispatch Reliability

In the United States, about 1 out of every 5 flights is “unreliable”

- About 2/3 of late or cancelled operations are due to weather and airspace conditions
- But 1/3 of delays and cancellations are due to factors within an airline’s control, such as:
  - Aircraft are not available due to maintenance problems
  - Crew legality, i.e. exceeds allowable flight time
    - Flight crews that time-out due to limits on duty days, or that are out of position due to late inbound flights or missed connections
  - Lack of airport equipment or gate space to handle flights
  - Passenger service issues, such as baggage transfer, IT problems or catering issues
Flight cancellations – one component of dispatch reliability – varies by aircraft type and cause

**Percent Of Reported Flight Operations Cancelled For Controllable Reasons (Maintenance, Crew Availability) Versus Uncontrollable Reasons (Airspace, Weather And Security)**

Source: BTS YE 2013

<table>
<thead>
<tr>
<th></th>
<th>Cancelled Flights as % of Scheduled</th>
<th>Percent of cancelled flights due to cause:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Controllable (Crew, maintenance)</td>
</tr>
<tr>
<td>Turboprop</td>
<td>2.9%</td>
<td>33.5%</td>
</tr>
<tr>
<td>Regional jet</td>
<td>2.6%</td>
<td>31.0%</td>
</tr>
<tr>
<td>Narrowbody</td>
<td>1.0%</td>
<td>41.8%</td>
</tr>
<tr>
<td>Widebody</td>
<td>1.0%</td>
<td>57.2%</td>
</tr>
</tbody>
</table>
DISMAL DISPATCH RELIABILITY

Cost Of Cancellations Are Significant – And Vary By Type of Airline

<table>
<thead>
<tr>
<th>Cost per Cancelled Flight Segment (USD 2014)</th>
<th>Controllable Events (e.g. maintenance, crew)</th>
<th>Uncontrollable Events (e.g. weather, airspace)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Regional Jets</strong> Including CRJ, ERJ aircraft</td>
<td>$2,750 per flight</td>
<td>$1,050 per flight</td>
</tr>
<tr>
<td><strong>Legacy Narrowbodies</strong> Boeing 737 and Airbus 320 families by legacy airlines</td>
<td>$15,650 per flight</td>
<td>$4,930 per flight</td>
</tr>
<tr>
<td><strong>LCC Narrowbodies</strong> Boeing 737 and Airbus 320 families by LCC/ULCC airlines</td>
<td>$19,240 per flight</td>
<td>$710 per flight</td>
</tr>
<tr>
<td><strong>Small Widebodies</strong> Boeing 767/787 and Airbus 330 on 8-hr international routes</td>
<td>$29,690 per flight</td>
<td>$6,770 per flight</td>
</tr>
<tr>
<td><strong>Large Widebodies</strong> Boeing 777/747 and Airbus 340 on 12-hr international routes</td>
<td>$42,890 per flight</td>
<td>$13,140 per flight</td>
</tr>
<tr>
<td><strong>Average Cost</strong> Based on weighted average of events across U.S. fleets</td>
<td>$5,770 average per cancelled flight segment</td>
<td></td>
</tr>
</tbody>
</table>

Based on masFlight study of flight cancellation costs (supporting data sourced from DOT BTS Form 41, OAG)
DISMAL DISPATCH RELIABILITY

Looking at a Global Airline over the past 2 years ... a total of 1.95 million flights were scheduled, approximately 57,000 flights were cancelled, and 9,650 flights were diverted. Of the scheduled flights:

Cancellation and Delay Metrics: Major Global Airline
Source: GEE masFlight analysis of data for year ending June 2015

<table>
<thead>
<tr>
<th>Key Statistics</th>
<th>Turbo-Prop Aircraft</th>
<th>Small Regional Jets</th>
<th>Large Regional Jets</th>
<th>Narrow Body Aircraft</th>
<th>Wide Body Aircraft</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent of all flights</td>
<td>8.3%</td>
<td>37.1%</td>
<td>17.4%</td>
<td>33.1%</td>
<td>4.2%</td>
</tr>
<tr>
<td>Returned to gate</td>
<td>0.9%</td>
<td>0.9%</td>
<td>0.9%</td>
<td>0.9%</td>
<td>1.5%</td>
</tr>
<tr>
<td>Cancelled due to maintenance</td>
<td>2.0%</td>
<td>0.4%</td>
<td>0.8%</td>
<td>0.1%</td>
<td>0.3%</td>
</tr>
<tr>
<td>Cancelled due to flight crews</td>
<td>0.7%</td>
<td>0.1%</td>
<td>0.5%</td>
<td>&lt;0.1%</td>
<td>&lt;0.1%</td>
</tr>
<tr>
<td>Delayed due to maintenance</td>
<td>3.0%</td>
<td>4.1%</td>
<td>3.8%</td>
<td>3.6%</td>
<td>5.6%</td>
</tr>
</tbody>
</table>
AIRCRAFT AVAILABILITY

Aircraft availability is defined as all required maintenance is accomplished and the aircraft is airworthy, as defined by the regulations.

When an aircraft is either scheduled for maintenance or is not available due to unscheduled maintenance, it cannot perform revenue flight segments.

Aircraft availability is measured based on a percentage of days.
AIRCRAFT AVAILABILITY

To quantify the root causes of aircraft availability issues, the number of maintenance down days needs to be categorized into two broad categories:

Scheduled Maintenance (Planned)
  Airframe Line Maintenance
  Airframe Heavy Maintenance
  Engine Maintenance
  Refurbishment Activities

Unscheduled Maintenance (Unplanned)
  Systems or Components Inoperative
  Damage repair
  Emergency Airworthiness Directive
AIRCRAFT AVAILABILITY

As with dispatch reliability, it is essential that airlines have access to availability information consistently and accurately to provide a baseline of data for trend identification and predictive analytics

Aircraft Availability Report
Source: GEE masFlight Data July 2015
DISMAL DISPATCH RELIABILITY

In summary, dispatch reliability is a key metric with broad implications for operational profitability

- A maintenance fault that resulting in controllable flight cancellation can drive $35,000 or more of net cost to an airline – even after taking into account operational cost savings

- Each cancellation triggers a chain of events that creates real operational complexities for an airline

- The potential benefits from Connected Aircraft are material – using real-time aircraft data to prevent even one annual flight cancellation per aircraft justifies Inflight Connectivity (IFC) investments
CHALLENGES

Operational analysis systems use data to improve future planning, reduce operating cost and manage disruption.

Core data requirements:

• Reliable, complete, historical & real-time data
• Robust and scalable data storage infrastructure
• Tools to process, analyze, apply data to decision making

Three related challenges:

- Source & send data
- Store & link data
- Solve problems
IMAGINE...

Real-time data from the aircraft directly to the Analyst
- *Updates every 50 milliseconds*
THE VISION

Connect aircraft with analysts in real-time

STREAM OPERATIONS DATA FROM AIRCRAFT TO GROUND

• Revolutionary new data source to improve real-time decision-making, operations planning, and customer experience

PROCESS IN MASFLIGHT PLATFORM AND PROVIDE CRITICAL ANALYTICS

• Integrate with existing data sets to add meaning and context
• Timely information that informs real-time and near real time decision-making
• Actionable data that drive business decisions and results
OUR VISION: AIRCRAFT TO ANALYST CONNECTIVITY

Get Aircraft Data
- Current position
- Fuel burn
- Aircraft health
- Connect w/EFB

Transmit Air-to-Ground
- Prioritize data feeds
- Stream from aircraft
- Upload to aircraft
- *Platform independent*

Process, Analyze & Solve
- Add other data & context
- Analyze data & fill gaps
- Identify specific problems
- Find solutions

Interface between cockpit, avionics, cabin crew & in-flight connectivity
- Reads avionics data
- Presents on EFBs
- Transmits to IFC systems

Cloud-based platform to process, analyze and inform
- Data from dozens of sources
- Robust big data architecture
- Front-end apps & solutions
REAL-TIME AIRCRAFT DATA

ACARS: Unformatted, irregular, expensive, limited bandwidth
Using IFC: Higher volume, lower cost, faster transmission, privacy & easy integration

What are the critical enablers?
Transmission over in-flight connectivity (IFC) + cloud data warehouses

- INTERNAL AIRLINE DATA
- INDUSTRY-WIDE AIRLINE DATA
- AIRPORT, WEATHER & RADAR DATA
- AIRCRAFT DATA VIA CONNECTIVITY
- INTEGRATED CLOUD-BASED DATA WAREHOUSE
- PLANNING & ANALYSIS
- REAL-TIME OPS MANAGEMENT
## DIGITAL TRANSFORMATION

Next-generation aircraft generate terabyte-scale data

<table>
<thead>
<tr>
<th></th>
<th>Current Generation</th>
<th>Next Generation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Example Aircraft</strong></td>
<td>B737NG, A320ceo, B757/767, B777, B747-400, A330, A340</td>
<td>A380, A350, B787, B747-8i, B737MAX, A320neo</td>
</tr>
<tr>
<td><strong>Avionics bus</strong></td>
<td>Analog</td>
<td>Digital</td>
</tr>
<tr>
<td><strong>Streams of data</strong></td>
<td>20-40 discrete streams of avionics information</td>
<td>Sensor data – thousands of simultaneous streams</td>
</tr>
<tr>
<td><strong>Data generation per operating month</strong></td>
<td>5 gigabytes</td>
<td>30 terabytes (~30,000 gigabytes)</td>
</tr>
<tr>
<td><strong>Interfaces</strong></td>
<td>Requires analog-to-digital conversion through EFB or interface device</td>
<td>Native digital connectivity to installed inflight connectivity systems</td>
</tr>
</tbody>
</table>
**AIRCRAFT DATA CAPTURE**

Tapping DFDR/QAR bus enables real-time transmission of key operational information

<table>
<thead>
<tr>
<th>Flight Track &amp; Position</th>
<th>Equipment State</th>
<th>Events (Change in State)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Latitude &amp; longitude</td>
<td>Flap, gear, brake</td>
<td>Fault messages</td>
</tr>
<tr>
<td>Altitude &amp; Speed</td>
<td>Autopilot settings</td>
<td>OOOI times</td>
</tr>
<tr>
<td>Winds aloft</td>
<td>Engine settings</td>
<td>Doors open/closed</td>
</tr>
<tr>
<td>Ambient temperature</td>
<td>Thrust reverser settings</td>
<td>Autopilot on/off</td>
</tr>
<tr>
<td>Pitch and bank</td>
<td>Squat switch</td>
<td>Autothrottles on/off</td>
</tr>
<tr>
<td>Barometer</td>
<td>Trim settings</td>
<td>TCAS warnings</td>
</tr>
<tr>
<td>G forces</td>
<td>Fuel flow</td>
<td>Frequency changes</td>
</tr>
<tr>
<td>Transponder</td>
<td>Fuel on board</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cabin doors</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cargo doors</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cabin pressure</td>
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</table>
DATA PROCESSING & ANALYTICS

On-demand cloud warehouses and big data analysis systems offer terabytes of extensible storage and fast processing

- Cost effective to load all data collected in unified warehouses
- Interface through human, machine or application interfaces

Shift to SSDs (flash storage) driven 10x increases in performance, and cost gap narrowing quickly versus traditional HDD

1.2TB of data can be processed in under 10 seconds with Amazon Redshift – one month of 787 data crunched in 4 minutes
CONCLUSIONS

• Connected Aircraft impacts major cost categories across airline operations – with material benefit to dispatch reliability

• From aircraft to analyst, a system of end-to-end capability
  • Cockpit: transform sensor & avionics data into usable formats
  • Transmission: fast, real-time, global capability for air-to-ground
  • Processing: cloud and big data tools to collect and analyze data

GEE Operations Solutions

From aircraft to analyst: connectivity and analytics for aviation operations

Stand-alone: provide analytics & data solutions that are immediately useful

Platform neutral: EFB, connectivity, solutions partnerships increase utility

Next-gen capability: scalability to collect, use data from digital aircraft
Thank you!