Digital Transformation of Aircraft Maintenance and Management

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PRESENTED BY:

Tom Benson  Jon Dunsdon  Doug Stewart
CAMP Systems  GE Aviation  Satcom Direct
Speakers

Satcom Direct
Doug Stewart
SVP & Business Unit Leader – SD Software Solutions

GE Aviation
Jon Dunsdon
Commercial Chief Technology Officer

CAMP Systems
Tom Benson
Chief Strategy Officer

Moderator
GE Aviation
Elizabeth Bevacqua
Services Marketing Leader

Panelists
Agenda

• Notable trends affecting our industry
• Digital technologies and positive customer outcomes
• Industry reaction and adoption
• Emerging technologies
• Q&A
Transformational digital trends
Our industry is transforming into a digital ecosystem

<table>
<thead>
<tr>
<th>The past</th>
<th>Today and beyond</th>
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<tbody>
<tr>
<td>Informal reporting: “flying for the boss”</td>
<td>Formal reporting: “flying for corporate”</td>
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<td>1990s pre-Internet software architecture</td>
<td>Demand for wireless, responsive tech</td>
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<td>Weak business processes</td>
<td>Process-driven cultures</td>
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<td>Fleet-level maintenance</td>
<td>Predictive maintenance</td>
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<td>Remote, isolated flight departments</td>
<td>Integrated ecosystem of digital tools</td>
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With 300+ players, the digital ecosystem is expanding beyond aviation companies
Drivers of digital transformation

- Improvements in bandwidth, connectivity and data linkage
- Greater influence of corporate IT
- Corporate aircraft becoming larger
- OEMs creating, collecting, and integrating more data
- Higher expectations about connectivity and customer experience
- Greater data oversight and disclosures
Poll: which of these factors do you think is the most influential?

a. Improvements in bandwidth, connectivity and data linkage

b. Greater influence of corporate IT

c. Corporate aircraft becoming larger

d. OEMs creating, collecting, and integrating more data

e. Higher expectations about connectivity and customer experience

f. Greater data oversight and disclosures
Digital technologies and positive customer outcomes
Connectivity is the pipeline for digital aviation

43%
People are using more and more data
The average mobile user consumes 43% more data each year

NoGo
Passengers won’t fly without it
Connectivity has become a no-go item for travelers

It’s part of the aircraft’s value
It’s an expectation
It’s available for virtually any aircraft
It’s aboard thousands of aircraft
It’s a factory option at every major OEM
Purpose-built routers: A critical component of automated data delivery

- The hub aboard a connected aircraft – cabin and cockpit
- Manage multiple connections off the aircraft
- Aggregates flight data and analytics for flight ops and supporting systems
- Manage and deliver the in-flight experience
- Help capture aircraft performance information from onboard systems
- Provide seamless, affordable service to the ground
Process automation eliminates work

Automated Flight Logs

- Automated delivery of flight data, times and cycles
- Powered by datalink and router capabilities
- Intuitive management of flight log data reduces human error
- Shares accurate, real-time data to third parties
Live monitoring means knowledge moves faster

- 24/7 Network Operations Center
- Flight monitoring
- Tracking weather
- Network Management & Device monitoring
- Testing and Validation Labs
- Real-Time Global Threat Monitoring
- Proactively monitoring network outages
24/7 Network Operations Centers
Live monitoring means knowledge moves faster

- Flight Plan Deviations
- Full Flight replays
  - FOQA?
  - Oceanic Navlog?
- Route Alerts
- Device Drill Down
- Connectivity Status
Good decisions start with better data

Flight data recorder captures routine flight data continuously

- $4B investment in digital tools
- 150 million flight hours
- 20+ years experience

Wireless encrypted data transfer

Results published to customer's gatekeeper

- Checked for 140+ safety events
- Weather + navigation + terrain + location
- Faster and more consistent results
C-FOQA programs may reveal unknown safety risks

- Corporate Flight Operational Quality Assurance
- Measures aircraft performance over time vs an aggregate
- Determines effectiveness of current risk controls
- Reveals insights that can positively improve processes and culture

![Incomplete flight control checks](image)

Incomplete flight control checks (# events per 100 flights)

- Studied 140,000+ flights
- 73% reduction in incomplete checks (2016-2017)
- 14% reduction (2016-2017)
Aircraft Health Monitoring System

Real-time secure full flight data collection, analysis and visualization

- 200+ supported aircraft
- 600+ registered users
- 30,000+ flights
- 100+ billion FFD points

Customer successes
- In-flight notification and live data interrogation has avoided flight diversions
- Post-flight data analysis has:
  - Provided early warning of faults
  - Prevented costly maintenance
Engine health monitoring becomes predictive and more efficient

**Wireless** data collection means more efficient flight operations and faster insights

**Continuous** monitoring instead of snapshots

**Optimized** aircraft availability … planned removals versus unplanned events

**Predictable** budgeting when coupled with engine service programs
Traditional engine trend monitoring

- Catch small issues before they become expensive or dangerous
- Downtime / AOGs reduced
- Optimize Engine performance and life
- Enhance asset value

Operator benefits

Lingering issues

- Operator cannot see Engine Performance trend in context of MTX events
- Operator must go out of band to track recommended task and see associated procedures
- OEM is blind to whether or not action is taken
  - Limited ability to improve trending algorithms
  - Unknown PBH insurance risk exposure

Tracking, operations, and feedback loop is broken without integration with maintenance tracking
Engine health monitoring with CAMP: The complete loop

Operator benefits

- Catch small issues before they become expensive or dangerous
- Downtime / AOGs reduced
- Optimize Engine performance and life
- Enhance asset value
- Track EHM recommended actions like all other MTX tasks, plus see relevant Procedural documents
- See Engine Perf. trend in context of MTX events
- Submit engine data and access EHM status, trends, and recommendations from within the same trusted Compliance Management platform

OEM and service center benefits

- OEM: Confirmed status of recommended action
  - Increased ability to improve trending algorithms
  - Certainty of PBH insurance risk
- Service Center: Reduced AOGs limits “fire drill” MTX
The benefits of digital transformation

• Improved aircraft availability, reliability, and productivity
• One-stop access for digital tools
• Elimination of “air gaps” (human data entry or data capture)
• Digitized safety monitoring may reveal unknown risks
• Aircraft and engine health monitoring become predictive and more efficient
• Increased visibility of maintenance-related activity
• Frictionless workflow among operators and service centers
Industry’s reaction and adoption
Industry’s reaction and adoption

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<tr>
<th>Yesterday: Fear and skepticism</th>
<th>Today: Embracing and consuming data</th>
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<tbody>
<tr>
<td>• It’s too complicated!</td>
<td>• We want more data!</td>
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<tr>
<td>• It’s too expensive.</td>
<td>• We want it now.</td>
</tr>
<tr>
<td>• It’s more work.</td>
<td>• We’ll pay for it.</td>
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<tr>
<td>• Where’s our data going?</td>
<td>• What can we learn from it?</td>
</tr>
<tr>
<td>• Are we being tracked?</td>
<td>• There are benefits we didn’t expect.</td>
</tr>
<tr>
<td>• The results will only punish us.</td>
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Most data lives in the past … real-time insights provide significant advantages
Poll: on a scale of 1 to 10, what is your or your organization’s view of digital tools today?
Poll: on a scale of 1 to 10, where do you expect your or your organization’s view of digital tools to be in the future?
Emerging technologies
Closed-loop data delivery and aggregation

Networked aircraft with automation from launch to logs...

- Flight Requests
- Flight Plans
- Times & Destinations
- Numbers
- Weather
- Pax & Crew
- On/Off Position Reports
- Flight Deck Connectivity
- Air Gap
- Flight Details
- Route Alerts
- Expenses
- Discrepancies
- KPIs & Metrics
- FOQA Review
- EHM Trend analysis
- Times & Cycles
- Air Gap
- Mx Actions
- Media Server
- Aircraft & Engine Data

Scheduling

Flight Planning

Post Flight

Analytics

Actions

In Flight
The reality of digital twins at GE

- Digital twin is a unique model of each engine
- GE can identify parts-specific service recommendations
- May extend engine life and reduce costs
- Available on commercial engines today and on GE’s Advanced Turboprop in 2020
Current aircraft maintenance process is fraught with pain points

These Pain Points have the same Root Cause:
Users must leave one system and manually access and/or re-enter information in another system

- Must export data from CAMP to manually create RFQ in another system
- Can’t identify S/Cs with capabilities and availability to perform MTX on my schedule
- Can’t review quote in context of historical MTX costs and industry averages
- No visibility of progress as work is performed
- Work slows b/c of time consuming offline approval
- S/C or Operator must manually re-enter Compliance data that is already captured in S/C ERP system
Digital maintenance data enables an integrated ecosystem

Deeply integrated ecosystem drives valuable outcomes

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<th>Operators</th>
<th>Service Centers</th>
<th>OEMs</th>
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<tr>
<td><strong>Better Experience</strong> with MTX Services Process</td>
<td>Increased <strong>Operational Efficiency and Quality</strong></td>
<td>Access to <strong>More Fleet Data</strong></td>
</tr>
<tr>
<td>Increased <strong>Visibility</strong> of all MTX Related Activity</td>
<td><strong>Frictionless Workflow</strong></td>
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<td><strong>Frictionless Workflow</strong></td>
<td>Increased <strong>Customer Satisfaction</strong></td>
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Deeply integrated ecosystem drives valuable outcomes

- Operators: 20,000+ Aircraft, 31,000+ Engines
- Service centers: 250+ Service Centers, ~40% of MTX Transactions
- Component MROs: 1,300+ Parts MROs
Q&A
Thank you

Tom Benson - CAMP Systems
+1 603 595 0030
tbenson@campsystems.com

Jon Dunsdon - GE Aviation
+1 518 618 6425
jon.dunsdon@ge.com

Doug Stewart - Satcom Direct
+1 614 503 4584
dstewart@satcomdirect.com