Opening Remarks

Chris Markou, Head Operational Cost Management, IATA
Skywise & Predictive Maintenance by aiming to be the data platform used by all major aviation players

Frederic Sutter, Digital Transformation Leader, Airbus
Skywise: a collaborative ecosystem across the aviation industry

Frederic SUTTER
Digital Transformation Leader, Airbus
The Fundamental Problem
Eliminating industry wide friction costs can generate significant value

- **Internal silos**
- **Industry silos**
- **Value chain silos**

**Examples**
- Poor ops data feedback for product def. / improvement
- Limited data sharing on issue identification / root cause analysis
- No real time optim. of routes / fleet / crew
- No bench-marking vs. best in class players
Data is THE foundation
Solving the data problem through integration, first

From static, heterogeneous systems...

...To extracted, curated and actionable data
Skywise: Delivering value inside Airbus

- A350 maturity acceleration
- A350/A320 quality
- A350/A320 production
- Bill of Materials
- Time to get a fix
- Industrial processes monitoring
- Supplier monitoring portal
- Procure to Pay
- Predictive maintenance
- Product Control Tower
- Smart Repair Wizard
Skywise: Delivering value for airlines

Defect management
Fleet wide reliability
Root cause analysis
Operational safety investigations
Warranty claims automation

Digital Services
Skywise for Supplier – RCA collaborative environment use case

Issue data collection and selection

Share anonymized dossier with supplier

Supplier anonymized issue dossier

Event analysis based on anonymised time series

Define test conditions to reproduce the issue

Issue key drivers identification
Skywise: Delivering value for suppliers

Quality

With Skywise Quality, I can now reproduce the failures exactly as they occurred in the Airbus production line, with a full understanding of the root cause and how to eradicate it

QUALITY ENGINEER AT SUPPLIER

Helps quality engineers quickly contain sudden quality issues and eradicate recurring defects in the long term
Skywise Partners
Unleashing the potential of data. Together.

We believe in opening the Skywise platform to seamlessly integrate cutting-edge developers with aerospace data will create even greater value.

With our partners, we provide collaborative power that unleashes potential and increases utility of data to create impactful, high quality solutions with a shorter time to market.

The program is dedicated to everyone in the aerospace ecosystem who wants to make the best possible use of data.
Skywise Today

Skywise Partners

Airlines

Suppliers

Aircraft

Unique Monthly Users

Maintenance Actions

Systems Integrated

5+

10+

80+

10000+

6500+

120+

35M+
Building an open data platform for aviation

**AIRLINES**
Services for improved flight operations, maintenance, asset utilisation, disruption mgmt.

**LESSORS**
Asset utilisation optimisation

**SUPPLIERS**
Predictive maintenance
Improved component design

**MROs**
Optimised issue identification with in-flight data

**AIRPORTS**
Services for optimised air/ground traffic mgmt.

**Air Traffic Control**
Real time visibility on flight status

**AIRWORTHINESS**
Accelerated certification process

**THIRD PARTIES DEVELOPERS**
Market for value-added services

**AIRBUS INTERNAL**
Higher operations efficiency and productivity
Improved aircraft design
Skywise: A robust and sound approach to data

- Airlines own and control their data
- Shared value – participating in Skywise and sharing data is a choice
- Airlines cannot see each others’ data but benefit from anonymised aggregated data
- Skywise supports the full breadth of airline operations – “private area” can host operation sensitive or non-Airbus multi-fleet data
- Open by design to airlines and 3rd party Developers through APIs
- First Skywise Partners announced in PAS 2019
- Built-in data governance and cyber security
<table>
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<th>Myths</th>
<th>v/s</th>
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<tr>
<td>In aviation, digital is challenging to apply and to benefit from</td>
<td>WRONG! We have achieved 2-digit improvements in over 60 implementations</td>
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<tr>
<td>Our current business models will be difficult to challenge and will ultimately prevail</td>
<td>WRONG! New paradigms such as ‘zero aircraft on ground’ (Zero-AOG) will emerge</td>
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<tr>
<td>Data science creates business value by itself</td>
<td>WRONG! Only the right blend of digital capabilities and domain knowledge, with specific process, delivers industrial value creating use cases</td>
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<tr>
<td>EXCLUSIVE Data OWNERSHIP is the path to value</td>
<td>WRONG! SHARING data creates common value, enabled by technology with no compromises on security</td>
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Thank you!
Predictive Maintenance Already Providing Benefits to Operators?

Rodolphe Parisot, VP Digital & Innovation, Air France Industries KLM Engineering & Maintenance
PREDICTIVE MAINTENANCE
ALREADY PROVIDING BENEFITS TO OPERATORS?

Rodolphe Parisot – VP Digital & Innovations

IATA Aviation Data Symposium 2019
BIG DATA: OPTIMIZE MAINTENANCE OPS
THE PROGRESSION OF ANALYTICS
BIG DATA: OPTIMIZE MAINTENANCE OPS
THE PROGRESSION OF ANALYTICS

From Information…

Data Analytics Sophistication

Business Value

What happened?

Why did it happen?

What will happen?

Why will it happen?

Classic health monitoring (ACARS, Snapshots…)

Predictive Analytics

Enhanced Diagnostics (continuous / full flight data)

Predictive Maintenance

… To Optimization

Reports > Correlations > Predictions > Recommendations
OPERATION NEEDS VS. MARKET OFFER
WHY DOES AIR FRANCE KLM DEVELOP ITS OWN PRODUCTS?

OEM AHM tools: advanced users (pilot airline for development)
- Agnostic solutions?
- Predictive capabilities?
- Focus enough on operator’s concerns?

APU condition Monitoring tools
- ?
- Agnostic solutions?
- Advanced analytics?

ECM tools
- Agnostic solutions?
- Advanced analytics?
- Customization of algorithms?

Remaining Operational Disruptions
- Predict failures before occurrence (MMSG)
- Use of Full Flight Data (x10^7 more data!)
- Business value? Feasability?
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<th>Beyond Value</th>
<th>Goals</th>
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<td>• Curative / preventive limitation</td>
<td>• Improve operations / aircraft dispatch</td>
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<td>• Agnosticity</td>
<td>• Limit technical delays</td>
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<tr>
<td>• No existing solution available</td>
<td>• Avoid flight cancellations</td>
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<td>• Need of (more) anticipation</td>
<td>• Reduce unscheduled maintenance</td>
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<tr>
<td>• Focus on multiple systems ranked by operational impact</td>
<td>• Prevent NFF by more accurate monitoring of system performance with full flight data</td>
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<td>• Use of data generated by new and legacy aircraft</td>
<td>• Reduce troubleshooting duration by targeting the exact failing parts</td>
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<td>• Contribute to Operations Integrity</td>
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<td>• Improve stock management</td>
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PREDICTIVE MAINTENANCE: MORE THAN YOU ALREADY KNOW
PROGNOS PREDICTS AND AVOIDS FAILURES

Prognos® for AIRCRAFT

Prognos® for ENGINE

Prognos® for APU
**PROGNOS FOR APU**

**PREDICTING AND AVOIDING FAILURES**

- Advanced health monitoring based on big data
  - helps airlines maintain maximum control over their APU assets
  - keeping them operating for as long as possible with minimal effort.

- Features
  - APU start time, exhaust gas temperature, bleed system, oil system, generate load
  - Life limit parts monitoring, fleet average
  - Smart dashboard, degradation model

- Available for
  - Airbus 319-321, 330 and 340
  - Boeing 777, 737 and 787
  - Embraer 175 - 190
PROGNOS FOR APU
CONCRETE USE CASE – BOEING 787 APU

Normal behaviour:

APU “X” behaviour:

APU Engineer noticed abnormal behaviour and advise the airline to plan inspection of the oil filter.

“Generator” started to fail which contaminated the gearbox. The APU was removed serviceable and failure was prevented. That resulted in preventing repair of the powerhead.

Extra cost if APU was not removed = €

Repair cost = €

Particles were found
PROGNOS FOR ENGINE
PREDICTING AND AVOIDING FAILURES

• Advanced Engine Health Monitoring solution
  • Agnostic solution
  • 1600+ assets monitored

• Predict engine defects to drive maintenance operations more precisely than ever

• 3 different usages
  • Daily monitoring: if “No Data” or any other Urgent Alerts.
  • Weekly monitoring: Normal Alerts, trend review per fleet, email reports
  • Monthly monitoring: Degradation Trends and Predictive Maintenance Planning

• Advisory view: alert status with comprehensive workflow.
• Charts of Engine data: analysis of parameters to assess Engine Condition Monitoring.

• More advanced monitoring
  • Monitoring and alert setting combine many sensors
  • Monitoring is customized by engine models
  • Tailored to operating environment
  • Solution learns what is normal behavior for a specific ESN (self adaptation)
  • Increase trend accuracy

→ better identification issues / impeding failures !
#1: Pneumatic pipe failure – CFM56-5B

Alerts triggered before any impact on Ops integrity
Operational disruption prevented, Maintenance visit was planned. Extensive engine damage prevented.
Defects not seen by other ECM products!

#2: HPC airfoil defects – GE90-115
PROGNOS FOR ENGINE
CONCRETE USE CASES

#3: 787 GEnx OGV piston ring liberation

EGT sector shift observed in early stage

Compressor efficiency diverted from the estimate.

BSI showed OGV piston ring in flow path.

☑ Alerts triggered before any impact on Ops integrity

👍 Operational disruption prevented, Maintenance visit was planned. Extensive engine damage prevented.

🔍 Defects not seen by other ECM products, and no CNR’s received (7 cases)
Get recommendations to avoid delays and flight cancellations from **30 to 50 flights ahead**

By collecting and recording data from the aircraft, and then processing and analyzing them, **PROGNOS detects failures before it happens**

**PROGNOS FOR AIRCRAFT**

**WORFLOW OVERVIEW: COLLECT, PROCESS, ANALYZE, PROVIDE RECOMMENDATION**

- Parameters selection
- Data recording
- Maintenance Control Center – CDG / SPL
- Alerts analysis
- Tasks scheduling
- Maintenance tasks
- Scheduled ground time
- Alerts generated in 30 min
- 30 to 50 days anticipation

**Cloud Data Center**
- Secured Storage
- Controlled access
- Data Processing
- Alerts generation
- No impact on operations
AGNOSTIC SOLUTION TO ADDRESS OPERATORS CONCERNS
CONCRETE USE CASE 787
ATA 21 SUPPLEMENTAL COLLING UNIT (SCU) + SCU MOTO CONTROLLERS (MC)

Avoid operational impacts / D&Cs / restrictive MEL + dry ice

Much better anticipation of SC needs (very expensive parts) +
very effective Troubleshooting

100% accurate (no NFF so far) and highly sensitive (prediction rate)
CONCRETE USE CASE A320
ATA 21 AIR COOLING SYSTEM

Avoid operational impacts / Quick Return and delay. 34500Ft flight limitation and no Etops and risk of Emergency descent in case of inflight failure

Much better anticipation + very effective Troubleshooting

First results show very good sensitivity
CONCRETE USE CASE A320
ATA 32 BRAKES TEMPERATURE SENSORS

Avoid operational impacts / Quick Return and delay. Restrictive MEL (D&Cs)

Better anticipation, also from SC perspective (improvement to come)+ very effective Troubleshooting

High accuracy (still no NFF) and good sensitivity
KEEP YOUR AIRCRAFT FLYING!
OPERATOR BENEFITS

- **Combining** big data and engineering **expertise** with operator **experience** → develop **focused** solutions

- Brings the best of **Health Monitoring and Predictive** capabilities to airlines
  - Increase operational performance (delays and cancellations)
  - Increased operational reliability
  - Improve operations Integrity (decrease MEL items and PIREPS)
  - Improve aircraft availability & trouble-shooting procedures
- **100% accuracy**: 200+ removals / no NFF (with tests performed by OEM)
- Very high **prediction rate** (65%+, still improving with experience acquired)
  - No unscheduled Engine/APU Shop Visits or removals through event prediction

- **Agnostic**

- Rely on a **potent Supply Chain** to extend analytics **value** beyond Ops benefits
  - Reduce Safety Stock
  - Reduce unnecessary removed components and number of NFF

- **Easy** implementation & **Secure data** environment and delivery
THANK YOU FOR YOUR ATTENTION

Follow us

• www.afiklmem.com
Operational efficiency driven by data & analytics

Rita Barata Silva, Head of Data & Analytics, Vueling Airlines
HOW DATA & ANALYTICS IS AN OPERATIONAL EXCELLENCE FOR VUELING

IATA Data Symposium
26th June 2019
**IAG & VUELING: being part of one of the worlds’ largest airline groups**

<table>
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<tr>
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<th>IAG</th>
<th>vueling</th>
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<tr>
<td>Aircraft (2019)</td>
<td>573</td>
<td>118</td>
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<tr>
<td>Passengers</td>
<td>c.113M</td>
<td>c.33M</td>
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<tr>
<td>transported in LTM</td>
<td></td>
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<tr>
<td>Total employees</td>
<td>c.64.300</td>
<td>c.4000</td>
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<tr>
<td>Destinations</td>
<td>268</td>
<td>+120</td>
</tr>
<tr>
<td>Revenues (2018)</td>
<td>24.406 M (+6.7%)</td>
<td>2.398 M (+6.7%)</td>
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VUELING CONNECTIVITY:
VY is the #1 airline in domestic flows in Spain and within France & Spain

SPAIN - Leader Domestic Traffic
31% Market Share

FRANCE - Leader flows with Spain
30% Market Share

ITALY - Second flows with Spain
23% Market Share

SPAIN - Second in all flows
16% Market Share
TOURISM is key for the Spanish economy growth

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<th>Description</th>
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<th>Year(s)</th>
<th>Source(s)</th>
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<td>Tourists in 2018</td>
<td>82,8 millions</td>
<td>1</td>
<td>(1) 2018: Estadística de movimientos Turísticos en Fronteras (FRONTUR). INE</td>
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<tr>
<td>Growth vs. 2017</td>
<td>+1,1%</td>
<td>(2)</td>
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<tr>
<td>Tourists by plane</td>
<td>+80%</td>
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<tr>
<td>Total foreign spending</td>
<td>81.857 millions €</td>
<td>(3) 2018: Encuesta de Gastos Turísticos (GASTUR). INE</td>
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<td>Growth vs. 2017</td>
<td>+3,3%</td>
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<td>Average / tourist</td>
<td>1.086 €</td>
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<tr>
<td>Tourism represents</td>
<td>11,7% GDP</td>
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<td>Main destinations</td>
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<td>(1) Foreign tourist</td>
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<td>2</td>
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<td>3</td>
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(1) Foreign tourist
(1, 2) Source 2018: Estadística de movimientos Turísticos en Fronteras (FRONTUR). INE
(3) Source 2018: Encuesta de Gastos Turísticos (GASTUR). INE
VISION
unlock the potential of our people

Gain competitive advantage
Flawless execution
Personalization
Real time pain points
Risk management & quantification
Uncertainty reduction

OPERATE BETTER
OPERATE SAFER
OUR FLIGHT PATH
From MS Excel to data-driven

Highly diverse, hands-on and collaborative team...

... working toward delivering insights and value to Vueling (especially quick wins)

Gartner Maturity Score 3.35
What is the question, business problem or target outcome?

What data is involved?

Where is the Data?

What analytical or data science methods are?
ANALYTICS CENTER OF EXCELLENCE
a Hub & Spoke model

IMPROVEMENTS ACHIEVED

- Single version of truth
- Breaking silos
- Advanced analytics
- Real time
- Self-service
- Automation
PLANNING 2.0
A new feedback-based paradigm

Data & Analytics Layer

- Real time
- Sensorized

Measure:
- Network planning
- Crew planning
- Aircraft assignment
- OCC

Prescribe:
- Workforce augmentation

Predict:
- AI & ML
- Predictive & risk models
- Optimization models
LCC trade-off

TOTAL COST

INVESTMENT IN RESILIENCE

DISRUPTION COST

RESILIENCE RESOURCES COST

OPTIMAL COST
• Break silos: crew info, network info, flight ops & maintenance restrictions,
• Build a Single source of Truth (flights status & delays)
• Real time tracking of operational KPIs
• Historify every minute of operational status, decisions & resources
• Customer 360 vision improving service, commercial offers and disruption management
• Network Simulator
• Dynamic Allocation (maintenance tasks and ops feasibility, stand optimization, intelligent buffer allocation, fuel efficiency)
- Disruption management (flight, crew and passenger reaccommodation)
- Flight Plan optimization to avoid regulations minimizing costs
- Post-operations analysis and technical specs optimization
- ATC forecast
- Self service capabilities and tools
- Maintenance program optimization
- Crew Control Monitoring and Automation
- Crew stand-by allocation model
- Handling monitoring and performance KPIs
- Handling resource allocation optimization (ex. Checkin counters)
In a competitive, fast-paced and challenging world...

We need to develop strong in-house capabilities...

... at the same time that we learn from external accelerators

- Advanced analytics, Artificial Intelligence and Machine Learning
- Scalable and reliable technology & architecture
- Data quality & Governance
- Influence business processes

Gartner
Google
Amazon Web Services
Jeppesen
Airbus Group
Aena
Enaire
Eurocontrol
ESADE Business School
At Vueling, we truly believe technology is a real game changer...

...TO HELP OUR OPERATIONS COLLEAGUES AND LOOK AFTER OUR CUSTOMERS.
THANKS!
Using data for Preventive Maintenance for Embraer E190 aircraft

Yuliya Gerasymchuk, Financial Manager and Head of PMO, Ukraine International Airlines
USING DATA

Preventive Maintenance for Embraer 190/195
Vadym - Chief Engineer, Avionics Systems

Andrey - Captain, E190 Technical pilot
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<th>LH HP50V closed</th>
<th>AFT PAX door L/D (last seq reconn)</th>
<th>EDP 1 PRESS SW/SPDA2/LRM3/MAU2/GIO2</th>
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<td>OK</td>
<td>OK</td>
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<td></td>
</tr>
</tbody>
</table>
AIRLINE COST MANAGEMENT GROUP

New Vision for Airline Cost and Operational Data

Today airlines’ data-driven strategies require a trusted data source to keep a tight control over cost and performance data. Unlike passenger and cargo sales data, there is no standard for consolidating this data across different areas within an airline.

With the endorsement of the Airline Cost Management Group (ACMG), a group of 65 airlines focusing on matters concerning airline costs and measures to optimize them, IATA is moving cost management activities into a next generation. The Airline Cost Center will become a unique source in the industry for **benchmarking airline cost and performance data**, a business intelligence solution of global reach.
COST STRUCTURE

Airline Cost Structure (MEDIUM) - FY2017

- Total = $18.8 Billion
  - (19 airlines)

- Aircraft Ownership: 15.6%
- Fuel and Oil: 22.6%
- Maintenance and Overhaul: 12.4%
- General and Administrative: 8.0%
- Reservation, Ticketing, Sales, and Promotion: 7.2%
- Station and Ground: 6.9%
- Flight Deck Crew: 6.3%
- Airport Charges: 7.0%
- Passenger Service: 4.6%
- IT and Communications: 1.1%
- Flight Equipment Insurance: 0.2%
- Cabin Attendants: 3.7%
- Navigation Charges: 4.5%

Source: ACMG 2017 Annual Report
## Cost Structure

<table>
<thead>
<tr>
<th>Cost Structure</th>
<th>FY2017 ACMG Airlines</th>
<th>UIA 2017</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>US Cents/ASK</td>
<td>$/FH</td>
</tr>
<tr>
<td>Fuel and Oil</td>
<td>1.69</td>
<td>2.40</td>
</tr>
<tr>
<td>Aircraft Ownership</td>
<td>0.91</td>
<td>1.29</td>
</tr>
<tr>
<td>Maintenance and Overhaul</td>
<td>0.77</td>
<td>1.09</td>
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<tr>
<td>Reservation, Ticketing, Sales and Promotion</td>
<td>0.52</td>
<td>0.74</td>
</tr>
<tr>
<td>General and Administrative</td>
<td>0.53</td>
<td>0.76</td>
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<tr>
<td>Station and Ground</td>
<td>0.48</td>
<td>0.69</td>
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<tr>
<td>Flight Deck Crew</td>
<td>0.47</td>
<td>0.67</td>
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<tr>
<td>Airport Charges</td>
<td>0.43</td>
<td>0.61</td>
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<tr>
<td>Passenger Service</td>
<td>0.36</td>
<td>0.51</td>
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<tr>
<td>Cabin Attendants</td>
<td>0.35</td>
<td>0.50</td>
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<tr>
<td>Air Navigation Charges</td>
<td>0.30</td>
<td>0.43</td>
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<tr>
<td>IT and Communications</td>
<td>0.08</td>
<td>0.11</td>
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<tr>
<td>Flight Equipment Insurance</td>
<td>0.01</td>
<td>0.15</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>6.90</strong></td>
<td><strong>9.92</strong></td>
</tr>
</tbody>
</table>
PRIORITIZING

- Fuel
- Maintenance
- Irregular Operations
- ...

Ukraine International Airlines
TEAM

Project Leader – Chief Engineer

- Engineering
- Pilots
- MCC
- OCC/Planning
- IT
- Finance
HOW CAN WE HELP?

• Get connectivity for online
• Upgrade Aircraft software
• Setup analytical software
• Update internal processes
CLOSING THE LOOP

• Setup completed Oct 2018
• CAS/CMC Information
• Systems Trend Information
1. SINGLE-BLEED OPERATIONS

- **DMIs**
  - 2016: 17
  - 2017: 6
  - 2018: 7
  - 2019: 2

- **Days**
  - 2016: 134
  - 2017: 72
  - 2018: 63
  - 2019: 3

- **Costs reduction, $**
  - 2016: $53,000
  - 2017: $28,000
  - 2018: $25,000
  - 2019: $1,200
2. ENGINE FADEC

Full Authority Digital Electronic Control System controls the operation, performance and efficiency characteristics of the engine through full authority control over the entire engine fuel metering unit, variable stator vanes, operability bleed valve, T2 sensor heater, thrust reverser actuation, engine starting, ignition and also providing engine limit protection during ground starts.
2. ENGINE FADEC

- Engine FADEC 1 (no dispatch) <=> FADEC 2
- 7 days both worked properly
- A new fault message appeared (FIM executed → wire and sensor both ok, so only FADEC according to FIM)
- Solution – to replace FADEC?
2. ENGINE FADEC

- Reviewed and decided to replace sensor
- ~2k $ vs ~ 50-60k $
3. APU FAIL

- Failure of oil pressure sensor
- Failure of APU FADEC
- Defective HARNESS
3. APU FAIL

- Sensor was switched EMC <=> EMB (problem occurred and sensor was replaced)
- APU FADEC was switched (100% not the problem)
- After this EMC 10 days was okay, then fault was reported again
- Decision was to replace APU Wire (at ~100k $)
- Additional troubleshooting was performed and decision to replace sensor (~12k $) first was made
- And it worked!
4. BLEED FAIL

- “Bleed 1 fail” message
- HPSOV (High-stage pressure shut-off valve)
- Checked FHDB
4. BLEED FAIL

<table>
<thead>
<tr>
<th>Main</th>
<th>SAS5536</th>
<th>1000,219,0,0,ACTIVE,03/11/2019 10:03:04,3,2,PREFLIGHT,BLEED 1 FAIL,CAUTION,,</th>
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</tr>
</tbody>
</table>
4. BLEED FAIL

- Apparently there were multiple EICAS & maintenance messages, some resets (not during acceptance flight though)
- Situation was reported to lessor
- Valve at lessor’s cost (~30k $)
IS THE LOOP REALLY CLOSED?

- Logistics
- Analytics
- Internal procedures & Ownership
- Promotion
- Value
- Scale
SUMMARY

- Passion
- Hard work
- Constant challenge
Networking Break
Opening Remarks

Chris Markou, Head Operational Cost Management, IATA
Digital Collaboration – From insights to scalable value

Andrew Hutson-Smith, Director of Business Development, R2 Data Labs, Rolls-Royce Plc
Digital Collaboration
From insights to scalable value

Andrew Hutson-Smith
Director, Business Development, R² Data Labs
**Group wide digital strategy**
- Re-invent with Digital
- Outside in thinking

**Digital Organisation 3.0**
Decentralised and Networked
- Guilds
- EcoSystem
- Academy
- Disruptive thinking
- Collaboration

---

**Rolls-Royce Analytics journey**

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Generation 1</th>
<th>Generation 2</th>
<th>Generation 3</th>
<th>Generation 4</th>
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<tbody>
<tr>
<td>Health</td>
<td>Deployed</td>
<td>Centralised</td>
<td>Self-learning</td>
<td>Federated</td>
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<tr>
<td></td>
<td>Product</td>
<td>Intelligent</td>
<td>and Predictive</td>
<td>and Collaborative</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Digital Organisation</th>
<th>Org 1.0</th>
<th>Org 2.0</th>
<th>Org 3.0</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>JV – IT Services and Industrial</td>
<td>Central Specialist Group</td>
<td>Decentralised Networked</td>
</tr>
</tbody>
</table>

---

**Project Melwood – Digital Future**

- Q1: Increase value and pace
- Q2: Digital platform needs
Innovation Example

Flight Efficiency

- Complex data sources
- Cross organization value
- Spectrum of analysis
- Spectrum of deployment methods

Discovery

Novel analysis and visualization

Pilot

Focus on decision flow and change management

Planner

Customize contingency figure to route

Operations Control Centre

Prediction / automation - fuel and on-time performance
Rather than monolithic products, companies will begin to manage and release value at a more granular level.

Knowledge Driven
- Data understood
- Known opportunities
- Known initiatives
- Known physics and equipment

Data Driven
- Data structures unclear
- Unknown issues and trends
- Emergent risks and opportunities
- Environmental and human factors

Execution
- Value
  - Insights to action
  - Initiative management
  - Change management
  - Human factors

Discovery
- Sensor data
- Environmental data
- Configuration data
- Unstructured data

IP/$/K
- Knowledge
- Data
- Value

There are a spectrum of approaches and deployment needs.
Applications
1. Safety and compliance
2. Operational efficiency
3. Availability
and their interactions

Innovation to integrity service process and platform

Innovation process

Applications Opportunity Hopper

Filter =
Value
Aircraft fleet
Data
Complexity
Market

Prime airline(s) data

Discovery and Prototype

Visualisation & analytics techniques

T1 T2
T3 T4
T5 T6

Minimum Viable Product

Validate and shape

Ecosystem

Software Applications

Templates, Data, Algorithms

Distribution Subscription

Collaboration and Distribution Platform
Enabling the network of value

Convergence enables increased value and access

Distributed value where many parties contribute

Adjacent examples
- Marine
- Automotive
- Pharmaceutical
- Telecoms
- Banking

IOT

Convergence

AI/ML

Trust

Distributed data and insights

Structured data (Industry or Initiative)

Marketplace structure
Networked producers and consumers

Efficient commercials
and modern digital business models

Airline
OEM
MRO
ISV
IDV
Eco

Non-Confidential © 2019 Rolls-Royce
Not Subject to Export Control
Conclusion

1. Enable distributed value
2. Networked effect & collaboration
3. Choice of analytics solutions
4. Controlled federation
5. Simplified commercial structures

Lifecycle management of above

Project Melwood - A platform view

- Digital stakeholder engagement
- Collaboration
- Distribution and Marketplace
- Analytics platform A
- Analytics platform B
- Analytics platform X

Industry & initiative data structures & marts
Best practice commercial structures and contracts
Using data technologies to keep airline schedules on time

Margrét S. Otterstedt, Data Analyst, Operations Support, Icelandair
ICELANDAIR
Using data technologies to keep airline schedules on time

Margrét Sesselja Otterstedt
Aviation Data Symposium
Athens, Greece
June 2019
ABOUT ICELANDAIR

• Icelandair was founded in 1937

• Icelandair connects 23 gateways in Europe with 19 gateways in North America, through Iceland as a hub

• The network is based on 24-hour rotation, with connecting flights leaving Iceland in the mornings and afternoons

• The department Operations Support was founded in 2018 to connect Operations and drive operational improvements across departments
OTP Project Launched in 2018

Boeing 737 MAX grounding in 2019

OTP (A15) 2017-2018
OTP (A15) 2018-2019
OTP Goal
WHICH CONTRIBUTORS TO FOCUS ON?
WHICH CONTRIBUTORS TO FOCUS ON?
WHICH CONTRIBUTORS TO FOCUS ON?
WHAT ARE THE GOALS?

+ Optimize the entire business instead of individual units
+ We are all pieces of the same puzzle
+ Increase communication
+ Centralize data flows
+ Use data to eliminate doubt
+ Fight Systematic Risk
IMPROVING LONG TERM PLANNING

1. **RETROSPECTIVE ANALYSIS**
   - Operation Support
   - How Did We Perform in the Last Period?
   - What Were Our Greatest Challenges?

2. **PLAN THE NEXT PERIOD**
   - Scheduling
   - Which Changes Do We Need to Make?

3. **FLIGHT HEALTH CHECK**
   - Operation Support
   - Are All the Necessary Criteria Met?

4. **ITERATE FLIGHT SCHEDULE**
   - Scheduling
   - How Can We Update Our Flight Schedule In Order To Meet Our Constraints?

[Diagram showing flow from Retrospective Analysis to Iterating Flight Schedule]
IMPROVING REAL TIME EXECUTION

Documenting Daily Tasks

Airport Cooperation
IMPROVING REAL TIME EXECUTION

Documenting Daily Tasks

Airport Cooperation
# Improving Real Time Execution

<table>
<thead>
<tr>
<th>Supervisor</th>
<th>Time</th>
<th>TEL</th>
<th>Radio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Employee no. 9</td>
<td>05:30-17:30</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Reception // Assist with Crew check in</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Employee no. 10</td>
<td>05:00-17:00</td>
<td>2</td>
<td>2</td>
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<tr>
<td>Check in</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Employee no. 11</td>
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<td>3</td>
<td>3</td>
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<tr>
<td>Check in</td>
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<td></td>
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<tr>
<td>Employee no. 12</td>
<td>05:30-17:30</td>
<td>4</td>
<td>4</td>
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<tr>
<td>Zone A - C</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

![Calendar and Time Table](image-url)
IMPROVING REAL TIME EXECUTION

Documenting Daily Tasks

Airport Cooperation
IMPROVING REAL TIME EXECUTION

Documenting Daily Tasks

Percentage of Contact Gates

- Jun-17
- Jul-17
- Aug-17
- Sep-17
- Oct-17
- Nov-17
- Dec-17
- Jan-18
- Feb-18
- Mar-18
- Apr-18
- May-18
- Jun-18
- Jul-18
- Aug-18
- Sep-18
- Oct-18
- Nov-18
- Dec-18
- Jan-19
- Feb-19
FINDING THE RIGHT MOTIVATION

- Greater company performance awareness
- Positive feedback
- Gamification
- Performance bonuses
- Consensus regarding our main KPI’s - what counts as success?
GOING FORWARD

• Digitalization
• Data-Driven Decision Making
• Clearer Business Processes
• Increased Cost Awareness
• Focus on Continuous Improvements
Any Questions?
Avoiding turbulence and disruptions: a new collaborative approach

Martin Gerber, Technical Pilot Airbus A320, Swiss International Air Lines
Avoiding turbulence and disruptions
A new collaborative approach

Martin Gerber
Technical Pilot
Swiss International Airlines
Flight Operations Engineering, ZRH AO/PB-E
Lufthansa Group

Presented to IATA Aviation Data Symposium
26 June 2019, Athens, Greece
Avoiding turbulence – a new collaborative approach

Agenda

1) Motivation – Turbulence impact on operation

2) Stakeholders affected by aviation turbulence

3) Turbulence reporting yesterday and tomorrow
   - Energy Dissipation Rate (EDR)

4) The IATA Turbulence Aware Project

5) Application for objective EDR data sharing

6) Extension of EDR measurement capability to more airlines
Avoiding turbulence – a new collaborative approach

Motivation - Turbulence impact on operation

Turbulence Injury Count

<table>
<thead>
<tr>
<th>Year</th>
<th>Crew</th>
<th>Passenger</th>
</tr>
</thead>
<tbody>
<tr>
<td>Serious</td>
<td>82</td>
<td>20</td>
</tr>
<tr>
<td>Minor</td>
<td>126</td>
<td>212</td>
</tr>
<tr>
<td>Total</td>
<td>208</td>
<td>232</td>
</tr>
<tr>
<td>Grand Total</td>
<td>440</td>
<td></td>
</tr>
</tbody>
</table>

Total Injuries over 10 Year Period

Source: IATA, Search only included FAR Part 121 Operators (U. S. airlines)
Avoiding turbulence – a new collaborative approach

Motivation - Turbulence impact on operation

Clear Air Turbulence (CAT)

Mountain Wave Turbulence (MWT)

Low level Terrain-induced Turbulence (LLT)

Cloud-induced or Convectively-induced Turbulence (CIT)

In-cloud Turbulence

Avoiding turbulence – a new collaborative approach
Stakeholders affected by aviation turbulence

**Flight Crews**
- Multiple data sources (ATC “chat” room, dispatchers, company-specific forecast products, on-board radar)
- Reporting subjectivity, inaccuracy
- Cabin management, tolerance for risk

**Cabin Crews**
- Cabin management
- Insufficient info from flight crews
- Obligation to continue duties when seatbelt sign is on
- Uncooperative passengers

**ATC**
- No access to real-time turbulence data at work area
- PIREPs communicated via “sneaker net”
- Altitudes “blocked” out with repeated turbulence reports, can persist for hours

**Research / Forecaster / Dispatcher**
- Deterministic forecast models, not validated in real-time
- Limited access to turbulence information
- Limited communication with crew

Source: Tammy Farrar, FAA NextGen, Aviation Weather Division
Avoiding turbulence – a new collaborative approach

Turbulence reporting yesterday and tomorrow

Yesterday: PIREP

“If you can still drink your coffee, it’s light turbulence.”

Tomorrow: Automated EDR Reports

→ subjective, aircraft dependent

→ objective, aircraft independent
Avoiding turbulence – a new collaborative approach

Energy Dissipation Rate (EDR)

- ICAO Annex 3 metrics for turbulence
- Measuring the state of the atmosphere around the aircraft in flight
- Aircraft independent absolute value
- Simple software installation

Source: IATA

Source: Ships on a Stormy Sea by Johannes Christiaan Schotel, 1826
Avoiding turbulence – a new collaborative approach

How to calculate EDR

1. Angle of Attack (min. 8 Hz)
2. True Airspeed (min. 8 Hz)
3. Algorithm (NCAR, DLR)
4. ACMS, or EFB with AID
5. Connectivity (ACARS, ...)

- Headwind
- Vertical Wind

12 Vertical Wind Spectra (mean = 0.10; peak = 0.16)
Avoiding turbulence – a new collaborative approach

The IATA Turbulence Aware Project

Source: IATA, Turbulence Data Sharing Project, K. Vashchankova, 2019
Avoiding turbulence – a new collaborative approach

The IATA Turbulence Aware Project

Existing turbulence data is often not shared

Fragmented data pools limit benefits

Airlines need to see beyond their own data to mitigate turbulence

Importance of global data coverage

Source: IATA, Turbulence Data Sharing Project, K. Vashchankova, 2019
Avoiding turbulence – a new collaborative approach
The IATA Turbulence Aware Project
Avoiding turbulence – a new collaborative approach
The IATA Turbulence Aware Project: Web Viewer

Latitude
42.74100

Longitude
-86.80600

Severity
Light Aircraft: Severe

Peak EDR
0.384

Mean EDR
0.18

Wind
309° / 121 kt

Static Air Temperature
-52.0°C
Avoiding turbulence – a new collaborative approach
The IATA Turbulence Aware Project: Data Visualization

Source: Ian Painter – Snowflake Software
Avoiding turbulence – a new collaborative approach

The IATA Turbulence Aware Project

Swiss 777 EDR Turbulence Observations 3/1/19 to 5/16/19
Avoiding turbulence – a new collaborative approach
Application for objective EDR data sharing

Flight Crews

- Display of nowcast turbulence forecast
- Enhances pilot’s ability to anticipate and react to possible turbulent conditions
- Better decisions based on not only cabin safety, but ride comfort and fuel-burn efficiency (reduced emissions)

Sources: GTD (top left) LSY, AerLingus (top right) PACE (right)
Cabin Crew

- The cabin crew and passengers are warned and secured in time
- The service can be scheduled around the time of increased turbulence activity
- Less injuries
- Airline reputation
Avoiding turbulence – a new collaborative approach
Application for objective EDR data sharing

Researcher and Forecaster

- “Turbulence Forecasting remains one of the last great challenges of numerical weather prediction.” 1)

- Roadmap for WAFS calls for the WAFC to implement turbulence forecasts utilizing EDR during the Aviation System Block Upgrades (ASBU) time frame (2019-2024). 2)

- Improve numerical weather prediction models

2) 4th Meeting of the Meteorological Panel (METP), Montréal, 10 to 14 September 2018

Sources: T. Rahmes, Boeing – B. Sharman, NCAR
A. Barleben, Deutscher Wetterdienst DWD
Avoiding turbulence – a new collaborative approach
Application for objective EDR data sharing

ATC

- Reduction in ATC workload: Less requests for altitude changes
- Improved airspace capacity
- Less reroutes, delays, diversions, cancellations
- Turbulence Avoidance Modeling (TAM): Developing predictive models of pilot behavior in response to turbulence encounters

Source: Rafal Kicinger and Christina Bittle, Metron Aviation, Turbulence Impact Mitigation Workshop 3, 5-6 September 2018, Mclean, VA.
Avoiding turbulence – a new collaborative approach

Extension of EDR measurement to more airlines

IATA Turbulence Aware

• A global platform for sharing automated EDR turbulence reports in real-time
• Data is collected from airlines, business aviation or third party ground servers in real-time
• Data processing through the platform is max. 30 sec
• Airlines can use their own flight planning and in-flight tools to display the data, or use IATA Turbulence Aware viewer in-flight via Wi-Fi

→ Global collaboration is the key to success!
Thank you
The adoption of network-centric data sharing in Air Traffic Management: The case of SWIM

Marina Efthymiou, PhD, Course Director for M.Sc. in Aviation Leadership, Assistant Professor in Aviation Management, DCU Business School
Agenda

• Problem statement

• SWIM fundamentals

• What do the different parties think about SWIM?

• The case study of A-CDM at Dublin airport
EUROCONTROL, 2019

15 mins Arrival Punctuality

75.8%  
-3.9%pts vs. 2017

Flights arriving > 15 minutes ahead of schedule

Early Arrivals

9.5%  -0.2%pts

Main Delay Causes 2018 in mins/flight

Reactionary  6.7
Airline  3.6
ATFM En-Route  1.7

2018 Departure Delay  
(from all causes)

14.7 mins/flight  
+2.3 mins vs. 2017
Need for new (or optimised) technologies to improve the overall performance of the network

- Evident possibilities:
  - Optimized aircraft separation
  - Real-time airborne fleet adjustment
  - Congestion prediction and holding pattern elimination

Enablers:

- Data science and analytics
- Artificial intelligence
- Cloud storage
- Cybersecurity
- IoT
- Blockchain

Digitalisation Technologies
System Wide Information Management concept (SWIM)

• **GOAL:** provide a platform for open sharing of all information between operators, airports, ANSPs and meteorology services.

• **Major drivers/factors:**
  
  ➢ Availability and penetration of the required level of technology within the airborne fleet and ground infrastructure; and
  
  ➢ Willingness and possibility of actors to share their operational data with potential competitors.
What do the different parties think about SWIM?

**Exploratory study and In-depth interviews** with 14 senior experts working for:

- Airbus
- Boeing
- COOPANS
- ANSPs
- Airports

**Themes of research:**

- SWIM status
- Data analysis
- Barriers to implementation
- Drivers to change

**Analysis:**

- 411 data points
- 125 excerpts
Barriers to implementation

- **Difficulty to negotiate agreements with the pilots’ trade unions** to allow data gathering.
- **Cost** and the **lack of a positive business case evidence**.
- The need to upgrade the ground and airborne systems to fix a problem that does not exist today – they can quite effectively communicate and operate with the existing technology.
- The **maturity of the concept** with concerns on data validity and cyber security as a potential blocking point to stakeholders.
- **Natural resistance to change** safety and operational perspective.
Drivers of change

• Clarity of communications

• Transparency

• Ability to be more agile and to quickly and economically integrate new functionalities and stakeholders

• Obsolescence of technology

• Regulations
A-CDM: Dublin Airport

• A-CDM requires organisational culture changes, handling of sensitive data, procedural changes and understanding of all A-CDM partners.

• The concept relies on improved messaging between the airport, airlines, ground service providers, ANSP, and the network manager, ensuring improved awareness for all these stakeholders.

• **Local benefits:**
  • improved efficiency of stand allocation;
  • improved aircraft sequencing and shorter taxi times yielding fuel economy;
  • improved availability of ground handling services.
A-CDM: Barriers to success

• **Ability to re-sequence** aircraft on ATC request: DUB however has a primarily single taxiway infrastructure = no re-sequencing is possible for aircraft that have been pushed back from the stand

• substantial **cultural** issue with A-CDM: All respondents claiming that the main beneficiary of A-CDM is one of the other stakeholders

• **Different needs** are not aligned: No cost burden sharing with the other stakeholders.

• **Stakeholders questioning the validity of the A-CDM model mandate:** only airports exceeding 77K movements are required (and subsidized) to implement A-CDM; Compatibility of the concept with the operational reality of ATC
A-CDM: Drivers of change

- Benefits of **network predictability**
- Benefits on capacity optimization
- **EU mandate** and availability of funding
Conclusions and Recommendations

- The potential of data sharing in aviation is substantial.

- Command and Control regulations vs Performance Regulation
- Effective stakeholder management to gain buy-in from all participants.
- One of the biggest constrains of SWIM is the cost of investment.
  - R&D investment in the area of airspace harmonisation, technological innovations and especially IoT
  - Subsidisation of technology adoption for airlines, airports and ANSPs
Networking Lunch

IBM