HONEYWELL FORGE FOR AIRLINES

BIG DATA: WHAT, WHEN AND HOW

APATS SEPTEMBER 2019

Honeywell

Honeywell is integrating the physical world with the digital world
To provide effective, economical solutions to the challenges of modern society
This effort is based on connectivity and applications of Big Data
Connectivity that reaches far beyond smart phones and computers,
Honeywell's connected solutions make cities smarter, aircraft fly more efficiently, factories that operate better, and makes workers safer.

These solutions are wrought in the forge of Honeywell's primary businesses:
Homes and Buildings;
Process Solutions;
Specialty Materials; and
Aerospace

The Future is What We Make It.

DISCLAIMER/EXPLAINER

- **Honeywell is not a simulator manufacturer and we do not intend to get in to the simulation business.**
- **Honeywell is not a training company but we do provide training for the sophisticated equipment and services we design and provide for the aviation industry.**
- **All of our equipment design, manufacturer, troubleshooting, maintenance, overhaul, repair and life-cycle planning relies on the application of data.**
- **Application of the right data to address the right questions to get the right answers is critical.**

IN THE EARLY DAYS…LOW TECH

We did the best we could with what we had and we made it work…always with an eye to safety first!

TO BE SURE WE PERFORMED AND PROVIDED SAFE CONVEYANCE…

We doubled and tripled everything

EQUIPMENT SUPPLIERS HAVE BECOME MORE SOPHISTICATED

- **Suppliers of airborne equipment products, particularly highly evolved avionics and integrated aircraft systems, are required to prove that their products meet agreed-to Design Requirements**
- **The question the customer asks is, "How do I know your equipment has been designed to meet the requirements of my aircraft and meet the integrity, design assurance, and fault monitoring and reporting characteristics required by the certification authorities? Show me the data!"**
- **It starts with engineering design discipline**
  - **Top level requirements (which are parsed in to)**
  - **Detailed requirements (which are then parsed out to become)**
  - **Statements of Work (meant to be conducted by integrated/separate teams)**
- **It devolves to structured methods of design/test/validation/verification**
  - **Mathematical modeling is a must, but insufficient**
  - **Individual LRU testing is inadequate**
  - **Subsystem testing only gets us part way there**
- **Show compliance to ARP-4754X/DO-254X/DO178X/other Industry Guidance**

Data enables us to prove we did what we said we were going to do—Data Is King!

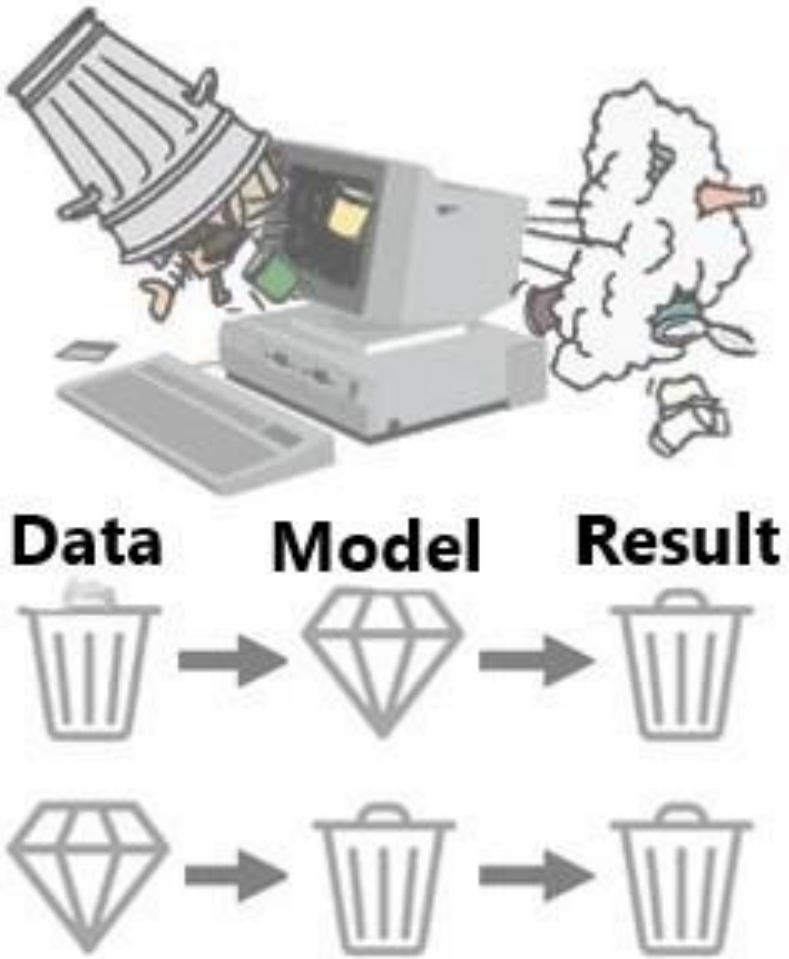
APPLICATION OF DESIGN DATA FOR AIRBORNE SYSTEMS CAN BE USED TO TRANSFORM AIRLINES OPERATIONS PRODUCTIVITY

TechOps (Maintenance)		Ground	FlightOps	
				
DELAYS & CANCELLATIONS	**MAINTENANCE**	**GROUND HANDLING**	**FLIGHT OPTIMIZATION**	**FUEL COSTS**
Too many unplanned disruptions, AOGs and ADDs*	**Maintainer and planner inefficiencies. Limited number of experts on staff.**	**Speed of turn of aircraft must meet service levels; resource turnover**	**Taxi and vertical climb procedures, routes determined by pilot know-how (intuition) vs. data (includes weather)**	**Fuel is ~30-40% of annual OpEx. Older aircraft not as fuel-efficient; newer aircraft still require fuel management**
In-house methods with data only for certain elements OR points solutions of varying quality		**Paper-based systems**	**Highly capable airlines have experts with fuel programs to monitor min. loads, pilot single engine taxi (labor intensive). Others use available data with trial and error**	

*** AOG: aircraft on ground; ADD: aircraft dispatch delays**

Value at stake: $2B per point of non-crew productivity

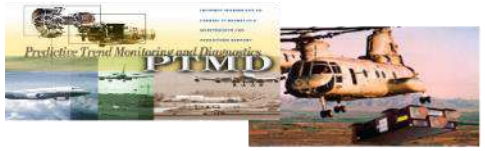
SUCCESSFUL APPLICATION OF DATA, PROCESSING, USE-ABILITY IS NOT ALWAYS STRAIGHT-FORWARD



The old adage is perhaps more relevant in today's Big Data world than it ever was

AIRLINE SOURCE DATA IS MORE AVAILABLE TODAY THAN IT EVER HAS BEEN, BOTH IN VARIETY AND VOLUME

Aircraft Health Monitoring Systems



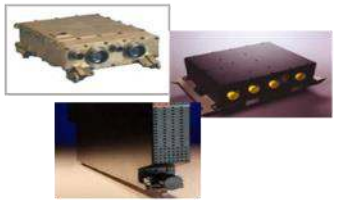
Test Benches

Repairs/Warranty claims/parts inventory

Social Media

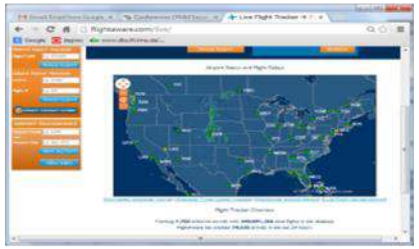
Facebook,
Twitter, WeiBo, WeChat
…

Flight Data/FOQA



Airborne recorders

Flight tracking/ Weather Information



3rd Party Data Warehouses

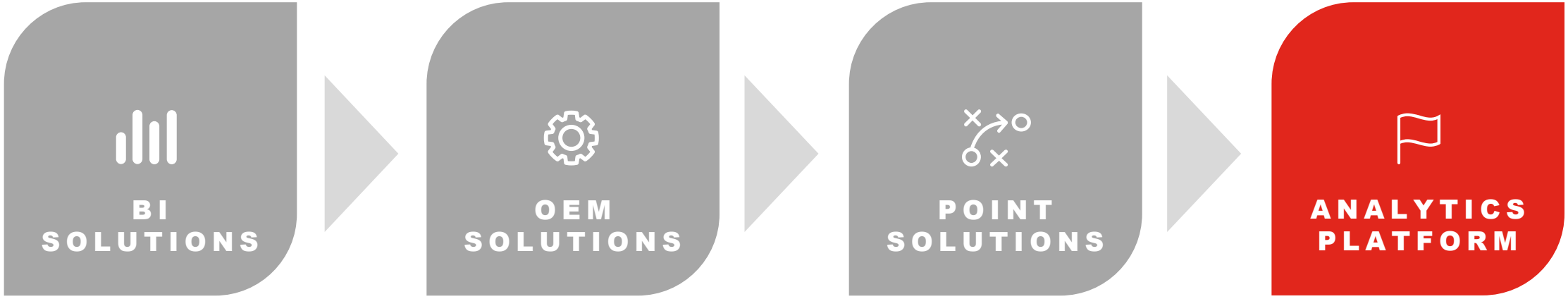
Regulatory Agencies

FAA/NASA/CAAC Reporting

Big Data Tools Allow Us to Address Opportunities to Solve Problems and Create Value

DATA SOLUTIONS ARE EVOLVING/BEARING GREAT PROMISE

EXTRACTING VALUE FROM AIRLINE DATA



BI SOLUTIONS

- Great for processing and reporting data (financial and ERP)
- Cannot address the complexity of flight operations

OEM SOLUTIONS

- Detailed insight from OEM data
- Difficult to extend to non-OEM data

POINT SOLUTIONS

- Custom-built to address a specific problem area
- Architecture limits the use cases to one area

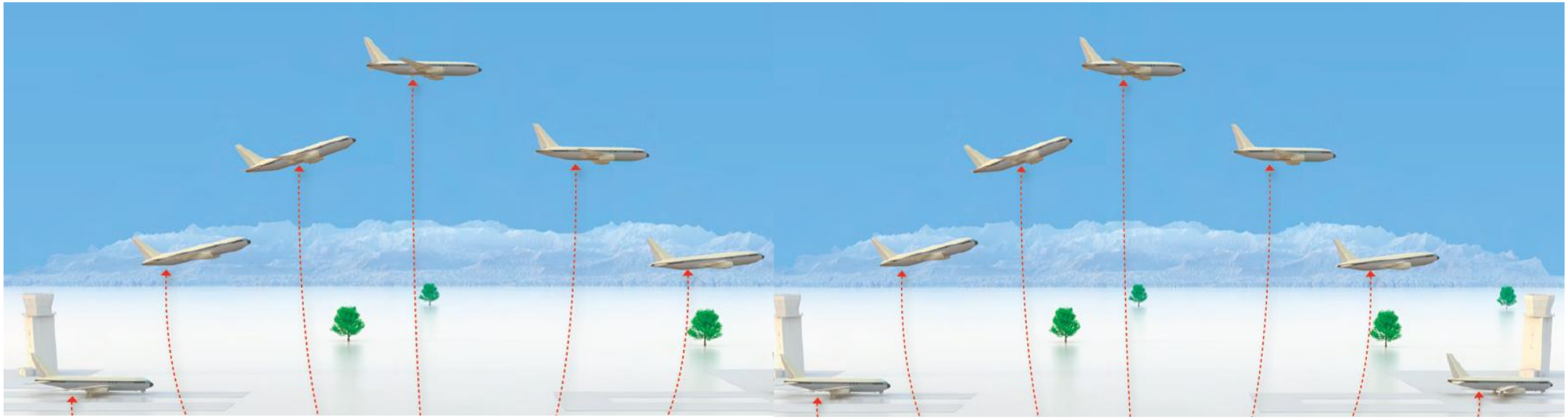
ANALYTICS PLATFORM

- Combines all the advantages; without limitations

AN OPPORTUNITY FOR ENHANCED FLIGHT EFFICIENCY

THROUGHOUT THE DAY OF OPERATIONS

UTILIZE ANALYTICS TO ACHIEVE THE FOLLOWING GOALS



GROUND TIME — **BLOCK TIME** — **GROUND TIME** — **BLOCK TIME** — **GROUND TIME**

1. Well-defined procedures save time and fuel
2. Reduce need to throttle to make up time in air
3. Ground crew & equipment in place every time needed
4. Avoid downstream impact of flight delays at hubs
5. Parts/Mechanics available to prevent delays & cancelations

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PROVIDING DATA-DRIVEN GUIDANCE TO FLIGHT OPERATIONS

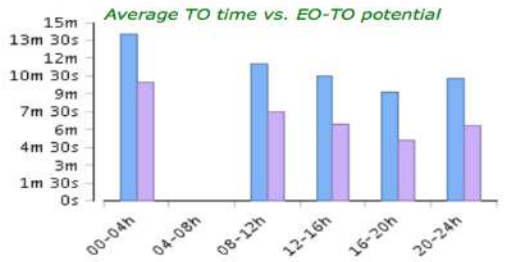
Pilot briefing: AVI1234 / HRG-BRU / A320

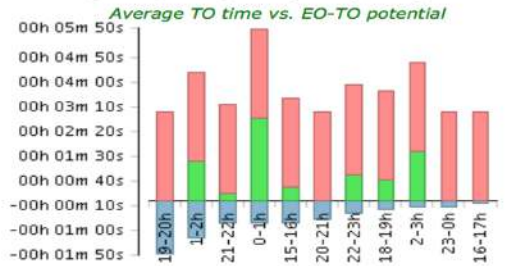
Common information

Average flight time:	04h 59m	HRG-BR
Actual vs. Planned flight time	104.18%	
Average contingency fuel (kg):	380kg	

Taxi out

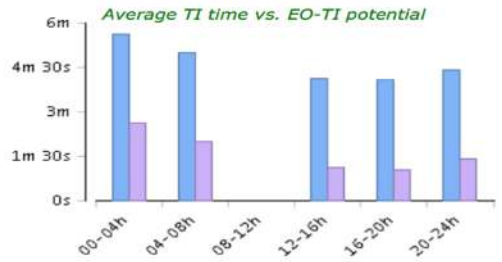
Average taxi-out time: 10m 7s
Engine-out taxi-out 6m 7s

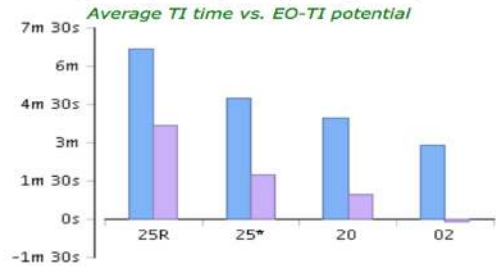




Taxi in

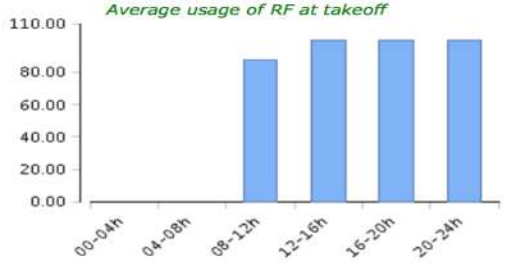
Average taxi-in time: 4m 30s
Engine-out taxi-in 1m 30s





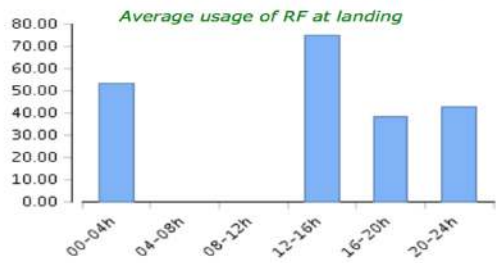
Reduced flaps at takeoff

Average usage of RF at takeoff (%): 98.11%



Reduced flaps at landing

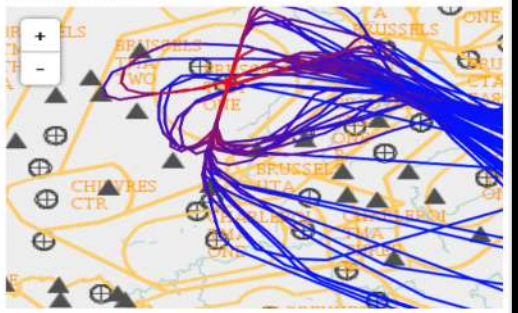
Average usage of RF at landing (%): 47.17%



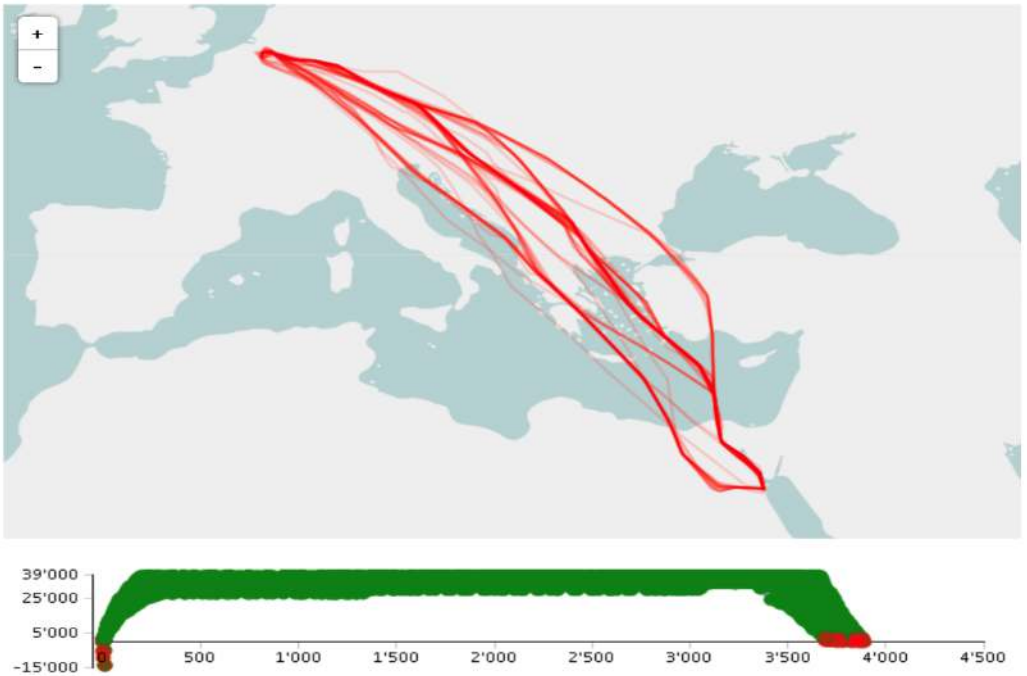
Pilot briefing: AVI1234 / HRG-BRU / A320

Departures

Arrivals



Flight profile



MAINTENANCE

PREVENTING UNSCHEDULED MAINTENANCE

MAINTENANCE ENGINEERING

Know which parts to repair and how to repair

How does it work?

- Flight Planning System
- Flight Scheduling System
- QAR / FDM / FOQA
- ACARS / ACMS
- Tech Log / MEL
- M&E System (AMOS)
- Other: Wx, Shop Data, Sabre, Amadeus, etc.

Predictive Maintenance

What will fail and what action needs to be taken to avoid it

Cognitive Diagnostics

What has failed and what action should be taken to correct it

NOTIFICATION

Prescribed maintenance action to prevent failure
Can integrate with M&E system

VISUAL INSIGHTS

Portal for health status, existing and impending issues

CORRECTIVE ACTION

Diagnostic troubleshooting steps on mobile devices

MAINTENANCE

PREVENTING UNSCHEDULED MAINTENANCE

Predictive and Prescriptive Maintenance Alerts

MAINTENANCE ENGINEERING

Know which parts to repair and how to repair

ADVANTAGES TO MAINTENANCE DEPT

Prescribed Maintenance action to avoid an impending failure

Includes P/N, component designation and AMM reference

Eliminates the need for human monitoring and interpretation of data

Recommendations

Operators may use discretion in determining the actual procedures used and the order in which these steps are applied

Timing: Within 3 days from date of this notification.

1. Replace the APU Bleed Valve (P/N 979786-5) as per AMM 49-51-51

Honeywell

Predictive Maintenance Notification

Component Reliability Program

Customer		**Aircraft Type**	A330
Date	23-Jul-2018	**Aircraft Reg**	
Priority	Routine	**ATA Chapter**	4900
PMN Ref	2018-085	**Component**	APU

Observation

Honeywell's Predictive Maintenance analytics have identified an abnormal pattern of ACMS fault messages of the type "APU BLEED VALVE (59KH7)". Previous experience has associated this to a developing fault condition with the APU Bleed Valve.

Analysis

Previous Honeywell experience shows that replacement of the Bleed Valve will reduce the risk of adverse impact to airline operations resulting from potential APU Inoperative or APU Bleed Inoperative conditions.
The first relevant fault message was generated on 23-Jul-2018.
The most recent relevant fault messages are shown below.

Fault Message	Class	Flight Phase	Date/Time	Flight #
APU BLEED VALVE (59KH7)	1	02	13 Jun 2018 11:26	KA482
APU BLEED VALVE (59KH7)	1	02	23 Jul 2018 02:28	KA950
APU BLEED VALVE (59KH7)	1	02	23 Jul 2018 07:09	KA951

Recommendations

Operators may use discretion in determining the actual procedures used and the order in which these steps are applied.

Timing: Within 3 days from date of this notification.

1. Replace the APU Bleed Valve (P/N 979786-5) as per AMM 49-51-51

DATA ANALYTICS CAPABILITIES DESIGNED FOR ALL TO LEVERAGE

KEEP AIRCRAFT OPERATIONAL

DIRECTOR OF MAINTENANCE

Prevent unplanned maintenance; optimize MRO

MAINTENANCE ENGINEERING

Know which parts to repair and how to repair

SCHEDULE ADHERANCE

BLOCK SCHEDULER

Allocate the right time for on-time performance

GROUND OPERATIONS

Allocate resources and track status to minimize turn times

SAFE, PROFITABLE FLIGHTS

TECHNICAL PILOT

Build effective training and feedback systems

FINANCE LEADER

Pull the right levers to improve RA SM/CA SM and KPI's

SAVE TIME, FUEL, DISTANCE

OPERATIONS ENGINEER

Identify, quantify and track efficiency opportunities

FLIGHT PLANNING

Plan right amount of fuel; build optimal route

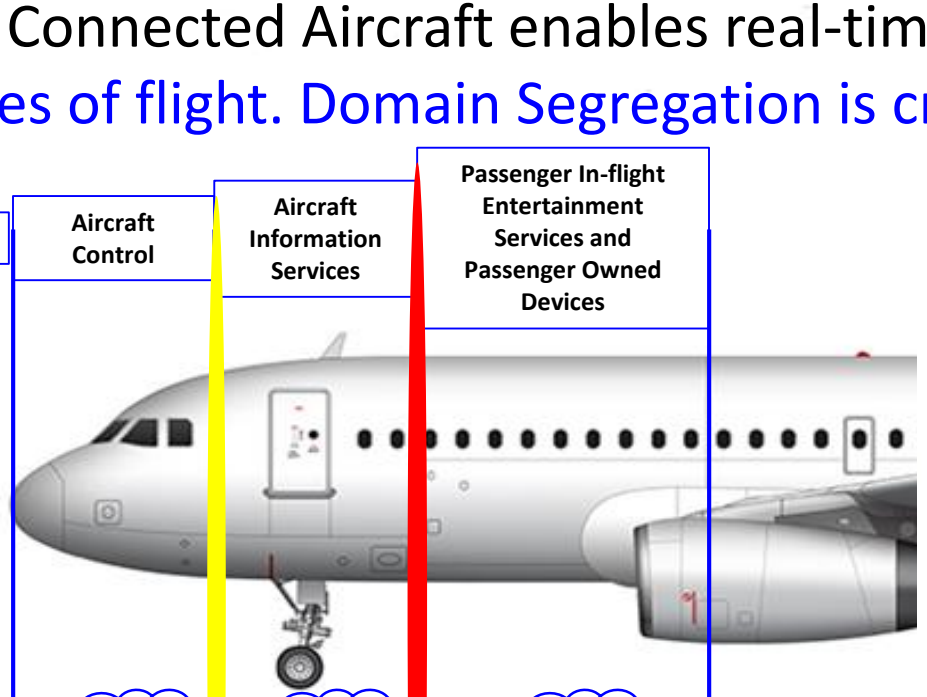
CHALLENGES OF INTEGRATING THE PHYSICAL WORLD WITH THE DIGITAL WORLD

IMPERATIVE: FOCUS ON CRITICAL FACTORS FOR USE-ABLE DATA

- **High Speed (faster is better, but timely is best)**
  - Available within area of operation, seamless delivery, multiple media—satellite/4-5G/ATG/etc.
  - Datalink challenges: deliver what to where, when, in which format
- **Data volume and content considerations**
  - Obtainable
  - Ownership (who does it belong to)
  - Timeliness, accuracy, use-ability
  - Format
  - Cleanliness/completeness
  - Appropriateness/applicability

DATA DOMAIN CYBER SECURITY CONSIDERATIONS

- The Connected Aircraft enables real-time bi-directional transfer of data during all phases of flight. Domain Segregation is critical but likely not enough.



Domains	Aircraft Control	Aircraft Information Services	Passenger In-flight Entertainment Services and Passenger Owned Devices
Wi-Fi, Wired	Datalink & SATCOM	Flight Ops & Maintenance	Apps & Services
Applications	- EFB - Fuel Efficiency - Network Services - Weather Services	- Ground Handling - Database Loading - Maintenance - Database Distro.	- Cabin Services - Media - Voice - Routing
Networks	Closed	Private	Public
Severity	Very High	High	Medium
Probability	Lower	Medium	High
Occurrence	Lower	Lower	High

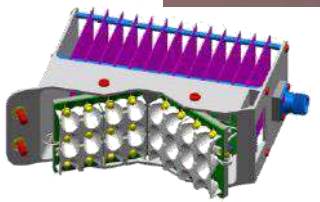
Could be huge $'s (even significant loss of life) in a simultaneously executed cyber attack.

Cyber-related Risks = Severity x Probability x Occurrence

EQUIPMENT THAT MAY BE OUTSIDE OF OUR CURRENT PREDICTIVE ANALYTICS CAPABILITIES









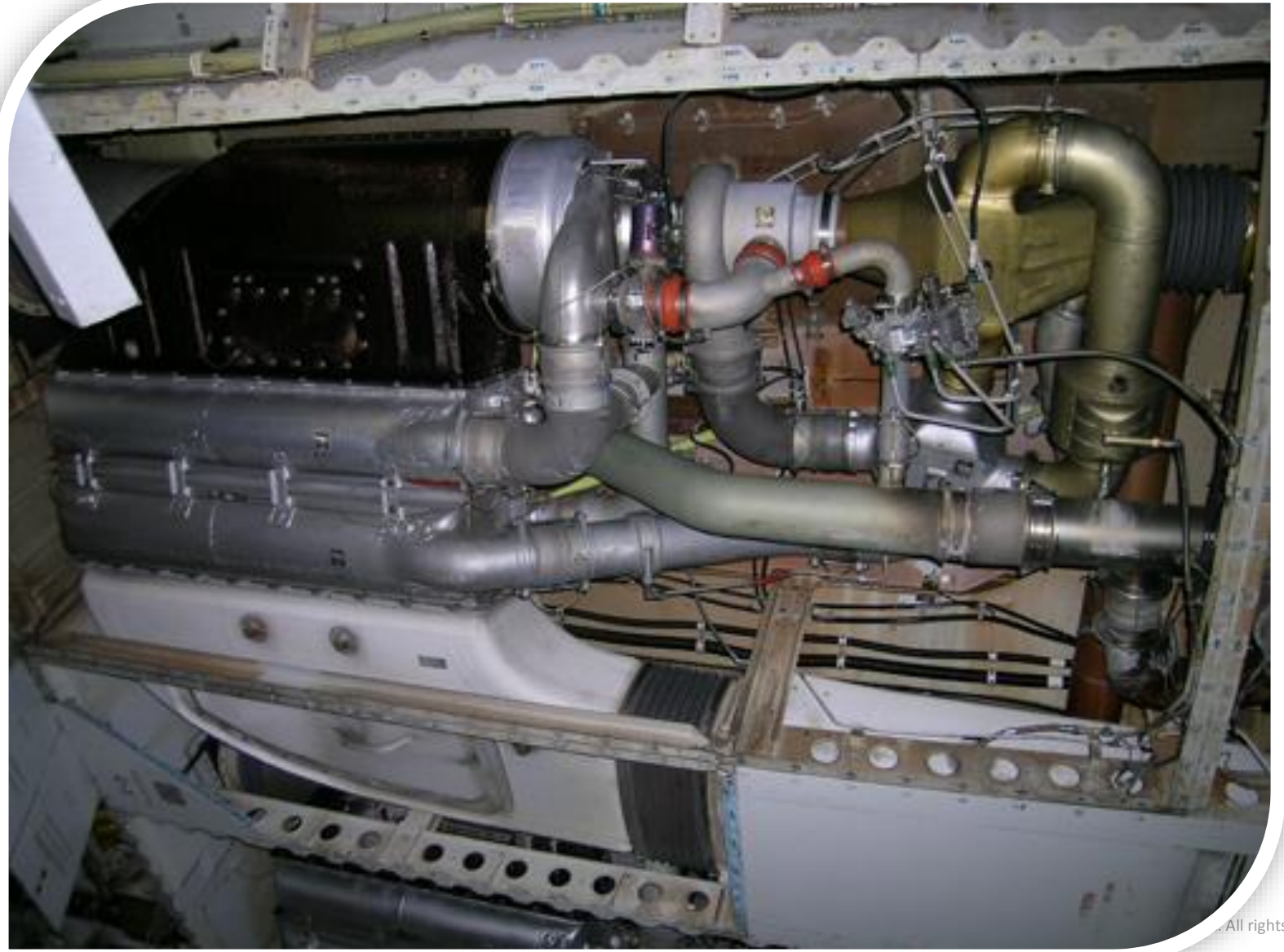




A SICK AIRCRAFT SIX WEEKS ON

BRAND NEW B747-400 DISCOMFITED ON BEIJING AIRPORT RUNWAY

UH YEAH, ALREADY CHANGED THAT OUT THIS MORNING



ENTERPRISE PERFORMANCE MANAGEMENT

HONEYWELL FORGE™

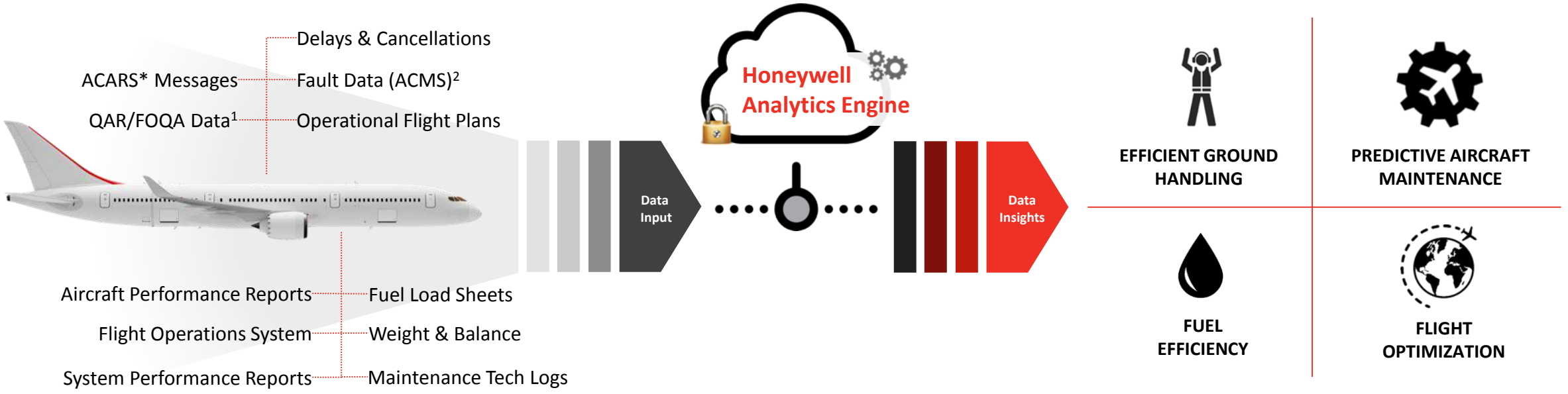
- Unifies disparate systems to maximizing current investments
- Helps you manage and control your operations technology (OT) security with ease
- Intelligent models help you make every day your best day of operations
- API as a Services (APIaaS) extends the solution to meet your needs
- Ease of use drives adoption and greater ROI

COMPREHENSIVE SOLUTIONS, DESIGNED TO MAXIMIZE THE VALUE OF YOUR BUSINESS

HONEYWELL FORGE FOR AIRLINES

AN INTELLIGENT DATA-DRIVEN PLATFORM

A secure **nose-to-tail** data ingestion platform for Airline operations, that analyzes and unlocks critical performance and operational indicators in fuel and flight efficiency, maintenance, safety, block time analysis, and ground turn optimization, enabling airlines to rapidly make improvements to operational inefficiencies.



*Aircraft Communication Addressing & Reporting System
[1]Quick Access Recorder; Flight Operations Quality Assurance
[2]Aircraft Condition Monitoring System

OBJECTIVE

DRIVE MARGIN EXPANSION

AIRLINE CHALLENGES

Negative trend
DELAYS
Double previous years
$25B

Fuel, crew, and schedule adherence
OPERATING COSTS
comprise
OVER 50% OF TOTAL

Each flight
DELAY
from unplanned maintenance events costs an airline
$6-12K AN HOUR

For mixed fleet of 50 tails, a 0.5% improvement in
FUEL EFFICIENCY
equals
$22M YEARLY

OPPORTUNITIES

ON-TIME PERFORMANCE

Trade-Offs

- Pad blocks but decrease asset utilization
- Risk ground crews not in position
- Throttle it to make up time but waste fuel

AIRCRAFT UTILIZATION

Decisions

- Fly MEL conditions but use excess fuel
- Maximize payload while maintaining CG
- Preventing unplanned maintenance events

RESOURCE OPTIMIZATION

Enough Not Excess

- Engine and exterior wash frequency
- Part availability vs inventory hold
- Maximizing ground crew and equipment

RASM(K)
Revenue per Available Seat Mile

CASM(K)
Cost per Available Seat Mile

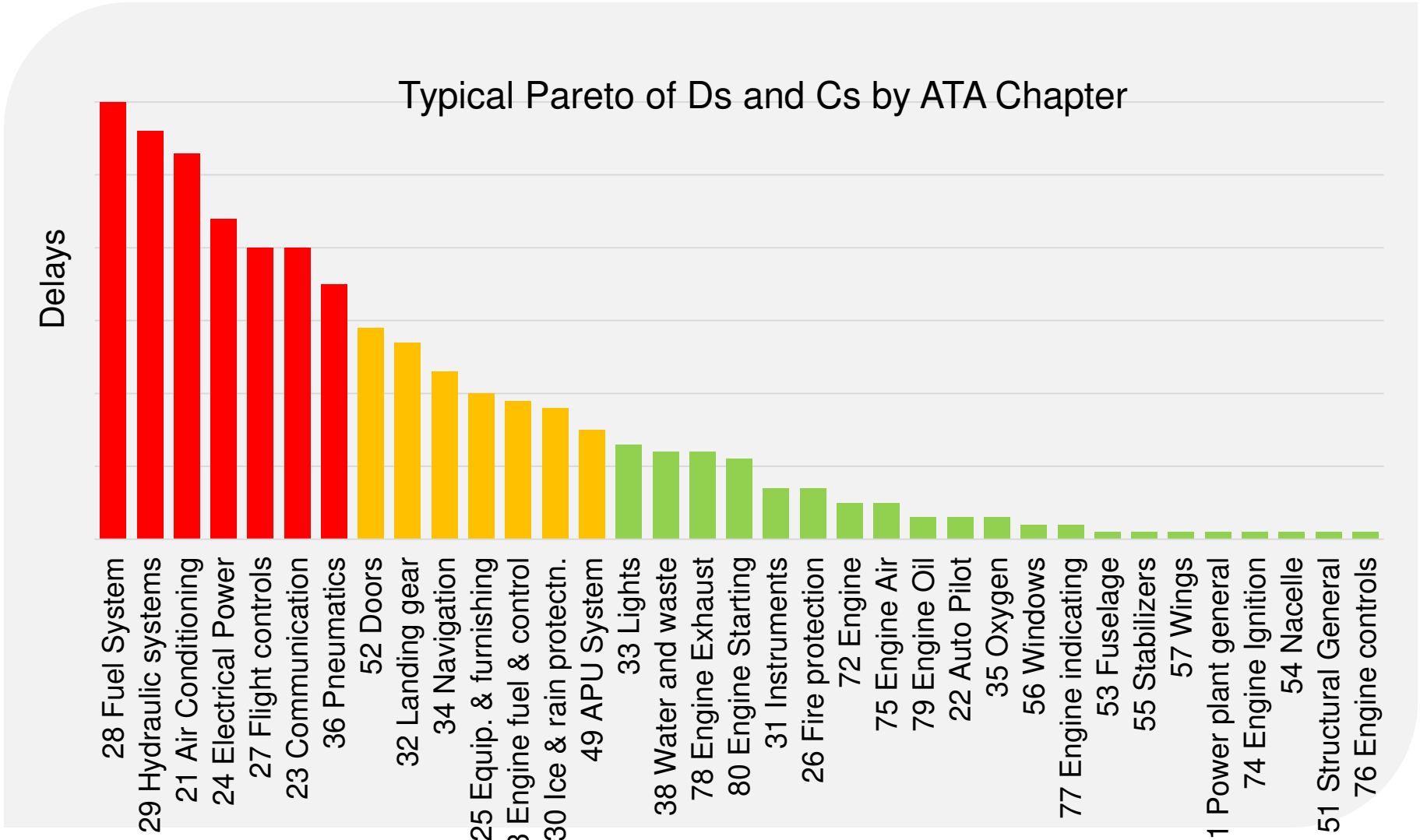
MAINTENANCE

PREVENT UNSCHEDULED MAINTENANCE

Focused on top Operational Impact Drivers

MAINTENANCE ENGINEERING

Know which parts to repair and how to repair



RESULTING IMPACT

- Mechanical Systems are generally worst offenders
- Troubleshooting challenges, return to gate events, high NFF rates, repetitive failures and misdiagnosis
- Increased inventory and deferred defects

*Target improvement

MAINTENANCE

PREVENT UNSCHEDULED MAINTENANCE

Predictive and Prescriptive Nose to Tail

MAINTENANCE ENGINEERING

Know which parts to repair and how to repair

HOW IT WORKS ?

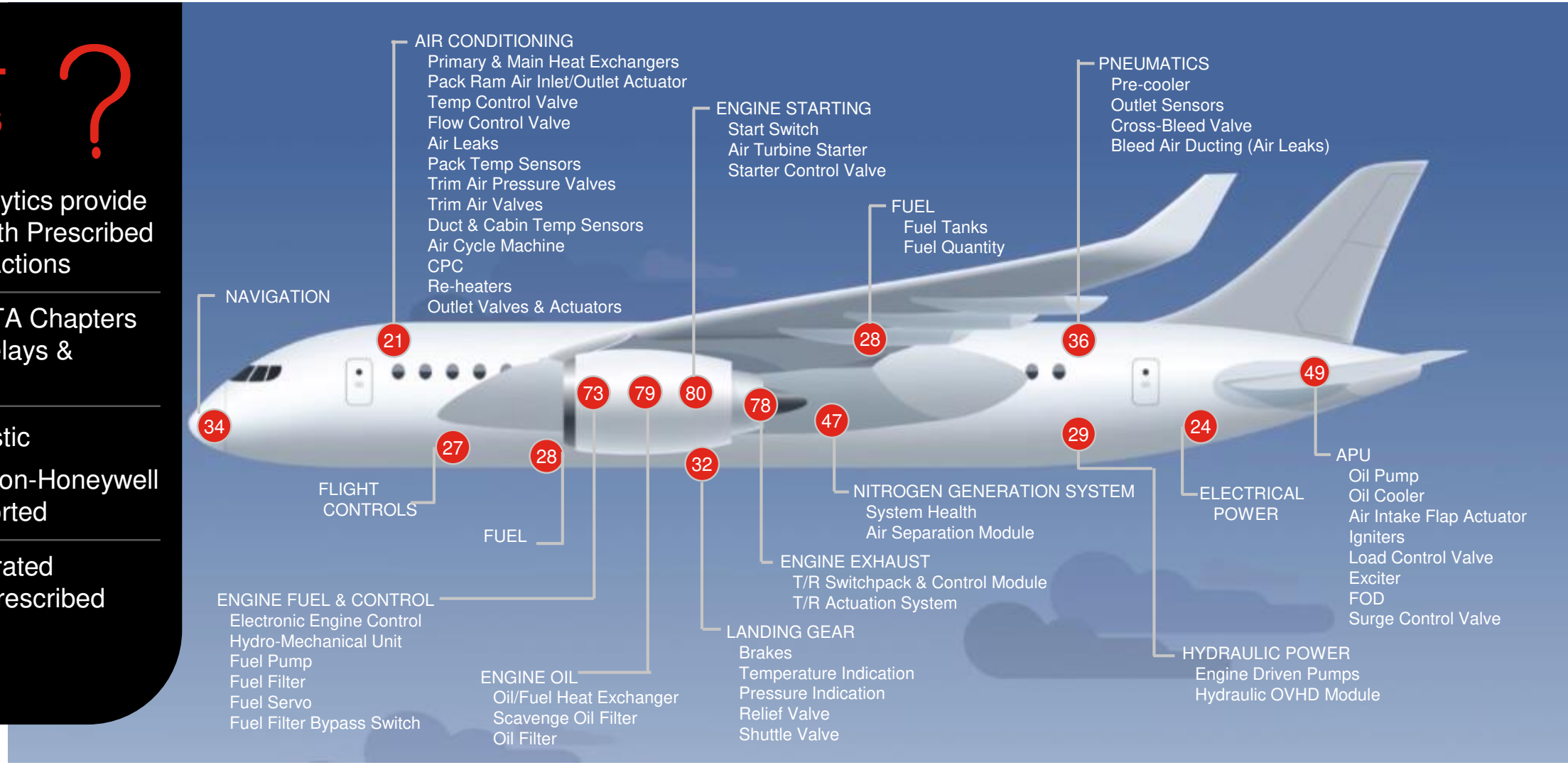
Advanced analytics provide notifications with Prescribed Maintenance Actions

Focused on ATA Chapters with highest delays & cancellations

Platform agnostic

Honeywell & Non-Honeywell systems supported

High Demonstrated Accuracy on Prescribed Maintenance



Honeywell Internal

OUR SOLUTION

HONEYWELL FORGE FOR AIRLINES

SOLUTION FEATURE SET

Data Enablement

- Rapid Deployment
- Secure Data Environment
- Open APIs and easy integration into customer systems
- On-premise data storage for data integrity

Tech Ops

- Fleet Heath Monitoring & Performance
- Operational interruptions
- Project prioritization
- Reduce maintenance disruptions
- Reduced delays and cancellations

Flight Ops

- 100+ Pre-loaded Analyses
- Fuel consumption models
- Safety Trends & Analysis
- Run Partner Models
- Instant Flight Performance Reports
- Real-time weather information

Ground

- Reduce Equipment Needs by 15%
- Improve Turn Times by 30%
- Enable Airport Capacity Growth

Closed Loop Execution

- Alerts & Notifications
- Maintenance Ticketing System
- Self Service Support

Boost operational improvement, performance management & non-aircraft productivity

HONEYWELL FORGE
SHAPE THE FUTURE OF AIRLINE BUSINESS

THANK YOU