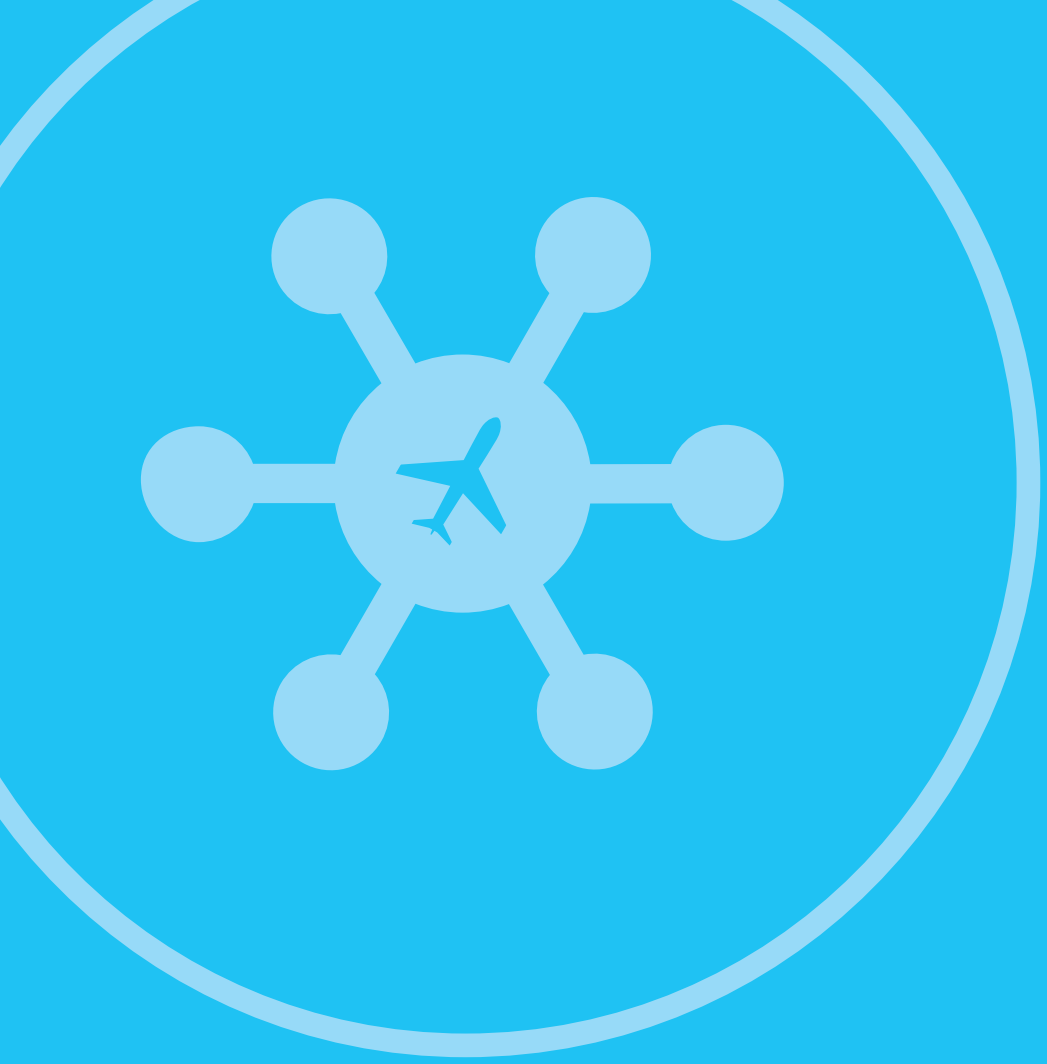

Building the Case for the Connected Aircraft

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Executive Summary

Connected Airline is a term used to represent the culmination of a decade-long paradigm shift in airline operations. The topic has recently gained momentum as a result of technology adoption by airline operations, which is advancing at a pace not previously seen in the industry. The recent and successful introduction of technology programs such as broadband IP connectivity for passenger services – 55% of aircraft are expected to be equipped with inflight connectivity by 2024[1] – and mobile tablet programs for crews, including Electronic Flight Bags (EFBs), are a few of the technology enhancements driving fleet infrastructure changes toward the Connected Airline. This has led to the incremental integration of new technology aboard aircraft.

Connected Airline programs are already changing operational procedures from aircraft communications currently in place in an effort to improve operational efficiency (OE). For example, Aircraft Communications Addressing and Reporting System (ACARS), a legacy electronic data communications service between aircraft and ground stations (already widely implemented on commercial fleets), is now being considered an "app" on new IP broadband networks.

Despite several technological advancements and recognized support within the industry, airline implementation of the Connected Airline has been sluggish. The reality is that while the Connected Airline is transformational, the initiative's complex, multi-dimensional nature involves numerous stakeholders with fragile financial dependencies.

Suppliers have invested considerable capital, intellectual property, and resources to develop differentiated connectivity offerings for airlines. This lack of standards has resulted in confusion over services and deep concern about investing into the wrong technology. Given this, how can an airline build the business case for overall connectivity in support of the Connected Airline?

Building the Case for the Connected Airline presents a comprehensive technology overview of the Connected Airline to help airlines effectively undertake the Connected Airline project and drive the business case by building an understanding of:

- The evolution of the Connected Airline and how it will revolutionize the aviation industry
- Key stakeholder requirements (i.e. Flight Operations, Maintenance, and Inflight Services and Aircraft Systems) and the Connected Airline opportunities
- Recommended steps to build the Connected Airline business case

1 The Future of Aeronautical Connectivity Report. Valour Consultancy. October 2014.

Evolution of the Connected Airline

Historically, the capacity of each connected aircraft defined the operational connectivity for aircraft systems, which included relatively slow links. Since high-speed, broadband IP connectivity for passenger services debuted in 2004 with Connexion by Boeing, the term "connected aircraft" has expanded to include a larger, "nose-to-tail" communications perspective. Although unable to replicate terrestrial networks, new aircraft IP networks deliver bandwidth in amounts significantly larger than legacy communications systems.

Further, the rapid adoption of Wi-Fi personal electronic devices and consumer-off-the-shelf (COTS) hardware has become a significant component of airline technology investment, driving costs to a new low and unlocking many previously unfeasible projects for airline operations. Various EFB tablet projects at airlines around the world demonstrate the cost advantage of COTS equipment.

In this paper, the broader Connected Airline is defined as the majority of its fleet having an onboard wired and wireless IP data network, onboard data server, and one or more high-speed, broadband connections available for passenger connectivity and airline operations. In the past, this concept in a more limited scope has been referred to as "E-Enablement" by flight operations to describe the integration of aircraft IT networks with ground systems.

Three primary technology trends have been catalysts for the Connected Airline concept:

Mobile device adoption

Portable computing platforms providing robust storage on small user interfaces have helped drive the business case for many airlines to transition to new technology solutions. Traditional paper-based flight bags have transitioned to EFBs – potentially saving airlines over 22 million gallons of fuel each year[2]. Further, cabin crew operation automation projects have been implemented to equip cabin crews with wireless smart devices. The preference for these wireless smart devices has compelled airlines to view them as essential networked devices requiring constant connectivity while aboard an aircraft.

Utilization of Big Data

The unwavering shift to leverage "big data" (e.g. the enormous amounts of sensor and other analytical data collected from aircraft systems) on aircraft such as the Boeing 787 and Airbus A350 have enabled airlines to employ limited predictive maintenance and optimized flight routing. The application of analytic tools running against new data sets significantly increases the benefit of big data, while helping airlines to realize even more value over time.

2 The Future of Aeronautical Connectivity Report. Valour Consultancy. October 2014.

Rise of Cloud Computing

The advent of cloud computing in the early 2000s has made it possible to store virtually unlimited amounts of data in a low-cost, accessible format. Within the aviation industry, cloud computing can lead to application hosting (either whole or in parts) with associated big data residing on an airplane server either directly connected or network-connected. The rise of cloud computing has added a new level of functionality to mobile devices, with applications utilizing cloud-based processing and big data capability. Cloud computing also enables airlines to employ Software as a Service (SaaS), which can eliminate hardware and capital software purchases with updates via on-demand software.

While the aviation industry has seen incremental technology enhancements on the operational side (such as tablet-based EFBs and equipping cabin crews with the latest mobile technology to handle retail transactions), these technology trends make the Connected Airline technically and economically feasible.

According to Valour Consultancy estimates, the Connected Airline could save the aviation industry over **$1 billion** annually.[2]

There is general industry consensus that the Connected Airline represents the future of airline operations and will bring significant operational efficiencies, thereby lowering operating costs and/or increasing revenue. This is crucial for an industry where processes and costs must be continually streamlined to maintain profitability. According to Valour Consultancy estimates, the Connected Airline could save the aviation industry over $1 billion annually[3].

In addition to reducing operating costs, new communication technology within the Connected Airline can:

- Reduce costs, leading to improved unit costs
- Enhance performance and efficiencies of airline crews and overall operations
- Provide additional value-added services to passengers
- Drive predictive maintenance actions, thus improving dispatch statistics

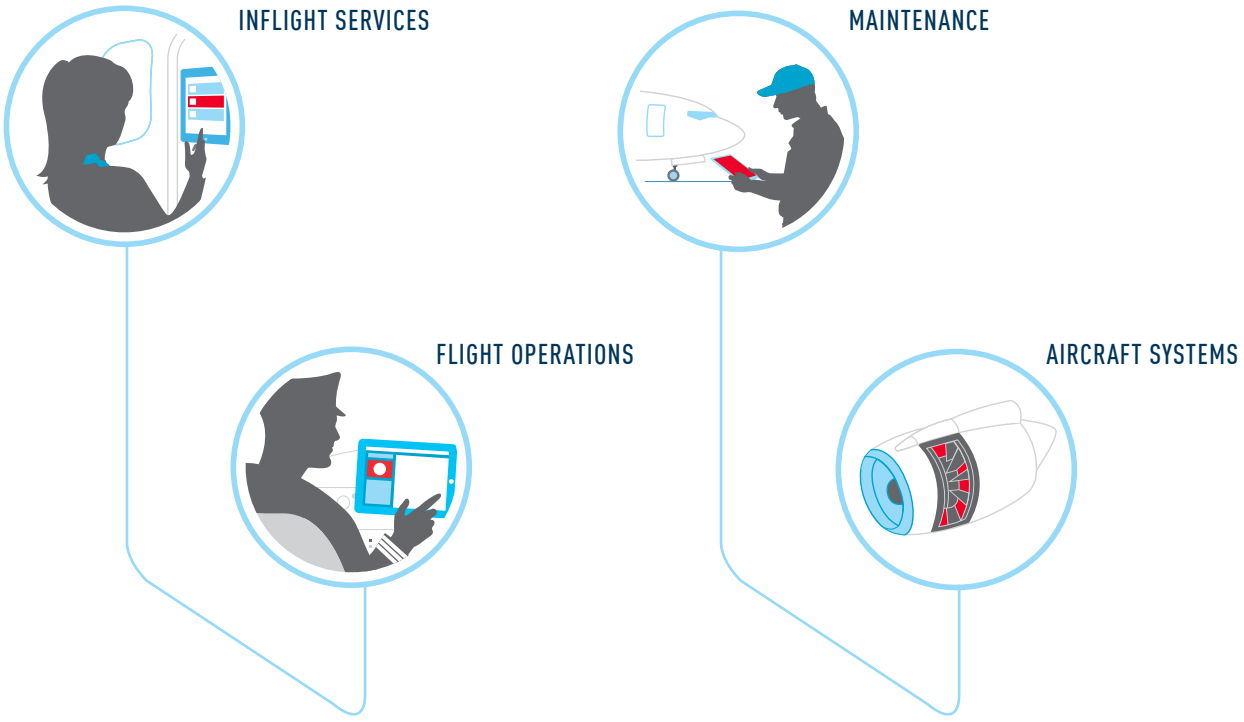
Components of the Connected Airline already showcase improved operational procedures today. Over 30 years ago, ACARS revolutionized archaic manual time-reporting processes with electronic data messaging between aircraft and ground stations. The effect saved airlines significant costs and opened the door to additional applications. Designed to reduce workload and improve data integrity, ACARS, has illustrated its operational efficiency benefits, and new uses are being applied continuously. Migration of most ACARS messages to an IP network would not only reduce messaging costs, but also continue to widen opportunities for airlines through improved bandwidth and application hosting capabilities.

ACARS is just one aspect of the broader Connected Airline. The fully Connected Airline of the future is taking shape now and will ultimately revolutionize the way we fly.

3 The Future of Aeronautical Connectivity Report. Valour Consultancy. October 2014.

Four Components of the Connected Airline

There are four key components that together enable airlines to realize the full capabilities of the Connected Airline. Airlines have taken a cautious approach by choosing to implement only one component (such as passenger connectivity) with a roadmap to achieve a complete Connected Airline over time. While this approach can minimize initial capital and time investment, it can also lead to many pitfalls, which can slow or halt progress toward fully realizing the Connected Airline concept. For example, differing requirements, if not considered together in the beginning, can require changes during upgrades, which can ultimately become more costly. That's why understanding the complete model and interconnectivity of the four components of the Connected Airline is essential before launching a Connected Airline initiative.



Various stakeholders are recognizing the need for automation and connectivity, especially operators of the Boeing 787 and Airbus A350 – the next generation of wide body planes. The following section will explore each component and look at stakeholder requirements and Connected Airline opportunities within each group.

Inflight services

Inflight services, including the passenger services component, is unique in the Connected Airline model for its ability to not only reduce costs and boost productivity, but also generate ancillary revenue. Airline ancillary revenue has increased dramatically, with $31.5 billion reported across the industry in 2013 – an increase of 1200 percent from 2007[4]. While flight operations, maintenance, and other departments are typically more automated (and hence more prepared to adopt a Connected Airline strategy), inflight often leads with broadband connectivity simply as a revenue-generation tool or passenger service component.

Passenger services/connectivity has been the fastest growing section of broadband IP aircraft connectivity, including both air-to-ground (ATG) and satellite-based communications (SATCOM). Passenger connectivity has developed into a market with many models, where airlines have introduced both free and for-pay services. The passenger-paid model has, for many airlines, provided the business case to launch broadband connectivity onto aircraft, with planned growth for operations over time. Similarly, airlines with "free" passenger models have also indicated their expectation to share the overall cost of the systems with operations. For many airlines, combining passenger connectivity with operational needs may be the only viable means to accomplish a Connected Airline strategy.

Inflight Services Group Requirements

Inflight services has distinct needs to accommodate the full provisioning of services due to the diversity of cabin operations and passenger experience. Often the focus starts with passenger services, then ramps up to operational support of the cabin crew with connectivity, particularly when adopting tablets for crew use.

There are several factors that the inflight stakeholder group will identify as essential for the Connected Airline:

- **Bandwidth:** Needs for passenger services are increasingly large, with per-aircraft requirements often driven to 5-10 Mbps
- **Revenue management system:** A fully capable revenue management system for passenger services, including portal, registration/sign on, credit card processing, and merchandising capacity
- **CRM capabilities:** Many cabin crew programs plan to use connectivity to support the cabin crew with maximum passenger information capabilities, which require secure access to ground-based applications
- **Integration capabilities**
  - Provides API interfaces to third party applications (e.g. moving map or airline mobile apps)
  - Interface with either the in-seat IFE system or tie to a wireless IFE system, along with requisite software APIs
  - Voice over IP (VoIP) calling to the ground with medical applications (e.g. MedLink)
- **Network security:** The shared use of the network in the cabin is driving many of the network security requirements for in-cabin wireless. This includes use of multiple SSIDs, access security methods, and strong implementation of destination-specific controls.

4 CarTrawler Survey of Airline Ancillary Revenue. IdeaWorksCompany (sponsored by CarTrawler). July 16, 2014.

Opportunities for Inflight Services

As most airline programs have launched with an emphasis on the revenue component, it would be natural for this to be the main driver for the inflight business case. However, the emphasis on most programs shifts considerably over time to the operational uses of the network by the crew. The following table provides examples of how the Connected Airline can be applied to inflight and the resulting benefits, which ultimately will empower cabin crew and enhance customer service:

INFLIGHT SERVICES APPLICATION	BENEFIT
Integrate customer loyalty programs into crew-issued tablets / smart devices	Arm inflight crew with passenger-specific information such as meal preferences or allergies Enable unique entertainment options for your high-value customers (HVC) Provide specific and real-time passenger information to and from the cabin crew Increase customer loyalty with personalized service
Generate ancillary revenue	Support Point-Of-Sale (POS) transactions in cashless cabins Minimize fraud with real-time credit card transactions – especially important for fast growing luxury airlines that offer extensive on-board duty free shopping Enable passenger-paid network use Allow multiple advertisers and sponsorship opportunities (targeting potential, analytics, and other items even if the access is free) Extend onboard seat upgrade opportunities
Enable two-way crew communications with Operations Center (including AOC)	Provide valuable logistics for crew with refreshed arrival information Increase communication to harmonize cabin crew and cockpit with ground maintenance teams: » Reduce repair delays and increase maintenance crew preparedness to have the right tools for needed repairs based on cabin crew reporting issues while inflight (through Electronic logbook /eTechlog or crew reporting) » Mitigate the impact of irregular operations

Implementing universal real-time credit card verification and minimizing revenue lost due to fraud could potentially equate to around **$90m** in recoverable onboard duty-free sales on an annual basis.[5]

5 The Future of Aeronautical Connectivity Report. Valour Consultancy. October 2014.

Flight Operations

Of the four components of the Connected Airline, flight operations has been the most technical and automated organization. For the last 30 years, it has almost exclusively driven aircraft connectivity decisions. Many Connected Airline projects inside flight operations begin with an extension of existing connectivity, such as ACARS or classic SATCOM. Over time, ACARS has transformed into a sophisticated data link solution that is tightly woven into airline operational automation. However, when it is not functioning, airline personnel must resort to backup systems to provide flight crews with key information such as weather patterns, takeoff performance numbers, and weight and balance closeouts.

Legacy communications have become saturated and comparatively expensive. New opportunities driven by mobile technology have shifted attention to the adoption of IP networks on aircraft. The implementation of IP networks on aircraft has similarly pushed an evaluation of broadband connectivity (to the ground) for most commercial aircraft types – including regional aircraft. A full implementation of the Connected Airline is IP-based, which requires a dramatic shift in both software and networks.

Flight Operation Stakeholder Group Requirements

Although actively driving increased bandwidth consumption (with the introduction of COTS hardware into flight operations with tablet-based EFB programs, for example), Connected Airline requirements for flight operations are less focused on pure bandwidth and more focused on the following requirements:

- **Persistent, resilient coverage**
  - Connectivity to the aircraft at ground level and cruise altitudes, with consistent bandwidth available and a seamless experience to the end user (pilot)
  - Matching airlines' operational geographies (including domestic and international services) with coverage needs
  - Graceful support of application operations during coverage gaps
- **Integration capabilities**
  - Aircraft data bus (essentially a highway on which data travels within a computer) integration should be managed through currently deployed protocols, allowing access to data on the aircraft and on the ground in both real-time and delayed-delivery methods (via avionics bus)
  - ACARS protocol integration will allow legacy applications to continue to function over IP networks for non-safety-of-flight purposes
- **Data harmonization:** Data synchronization across multiple devices onboard the aircraft in real time, like the eTechlog application – an electronic replacement for aircraft paper-based technical logs/log books or multiple EFBs
- **Quality of Service (QOS) customization**
  - The ability to prioritize applications and data when congestion occurs
  - Destination-limiting capabilities such as whitelisting (allowing certain content to be free to view) or blacklisting (preventing non-approved traffic to certain websites)
- **IP connectivity:** Real-time optimization data (e.g. weather patterns and updated load factors) and crew communications (e.g. data messaging)

» **Hosting capabilities:** Ability to host applications on the aircraft to augment certified avionics/ applications

» **Network security:** The shared use of the network in the cabin is driving many of the network security requirements of in-cabin wireless. This includes use of multiple SSIDs, access security methods, and strong implementation of destination-specific controls

Opportunities for Flight Operations

The opportunity for flight operations to improve its processes through the Connected Airline is significant. Not only are current operations able to gain efficiencies, but new applications and communications can also enable better decision-making tools and evolved operations workflows.

The following table provides examples of how the Connected Airline can be applied to flight operations, which ultimately help reduce delays and improve the comfort of crews and passengers:

It is estimated that the adoption of a tablet-based EFB can save the aviation industry over **$36m** annually[6].

FLIGHT OPERATIONS APPLICATION	BENEFIT
Integrate live flight route and performance systems	Adjust flight plans vertically (altitude optimization), geographically (route optimization), or temporally (time-based speed optimization) to identify more efficient routes Provide actionable fuel and time savings opportunities
Connect EFBs	Aid in strategic decision-making by allowing the most current information to be utilized for the flight
Enable real-time (or near-real-time) graphical weather map	Access to graphical weather tools plus real-time route optimization capabilities aids in strategic decision-making (i.e. "what-if" calculations) Simplify complex ACARS workflows to provide a more intuitive user experience
Facilitate turbulence mapping	Increase safety and comfort for crew and passengers Reduce airframe strain, maintenance, and costly unscheduled inspections by avoiding and accurately recording turbulence events

6 The Future of Aeronautical Connectivity Report. Valour Consultancy. October 2014.

Access automated aircraft reporting	Maintain positioning by tracking airline assets (e.g. airplanes, crew, etc.) Obtain an alternate feed for the Aircraft Situation Display (ASDI) input with a global coverage scale Enable geo-fencing notifications of airplanes entering/exiting virtual geographical boundaries Decrease unscheduled maintenance delays and launch predictive maintenance programs
Enable two-way crew communications with Operations Center (including AOC)	Streamline crew scheduling and management while minimizing delays Increase communication to harmonize flight operations and cabin crew with maintenance teams to mitigate the impact of irregular operations
Shift functionality from legacy data link systems to modern broadband connectivity	Reduce legacy ACARS dependencies Introduce modern interface (e.g. EFBs on tablets) and new communication features (e.g. sent verifications, read notifications)

Maintenance

Although maintenance personnel are typically on the ground when performing their duties, they are typically not connected to airline data networks when on or near the aircraft. Current mobility programs for maintenance rely on expensive and difficult-to-support cellular data network connections (via SIM), which can erode cost savings rapidly. For maintenance departments, access to real-time information related to the aircraft is essential. To allow for better access to accurate data, airline maintenance organizations have been successfully adopting tablets for personnel.

eTechlog solutions have been available for many years and offer significant payback; however, these solutions have failed to penetrate the airline industry in large part due to a lack of the need for reliable and affordable connectivity.

Maintenance Stakeholder Group Requirements

Due to the regulated nature of maintenance, and the primarily ground-based connectivity needs, this department brings a unique set of requirements to the Connected Airline. The following list provides requirements of the Connected Airline from the maintenance stakeholder group perspective:

- **Access**
  - Access to an eTechlog (if used) on the aircraft
  - Use of electronic task cards
- **Network security:** Secure access on a protected network with access controls and restricted data flows
- **Persistent, resilient coverage**
  - Coverage outside of the aircraft within a short distance from the doors
  - Domestic and international coverage at airports both inside and outside the aircraft
- **Integration capabilities:** A means to auto-populate aircraft data into maintenance systems, making this data accessible to the mechanics when visiting the aircraft

Opportunities for Maintenance

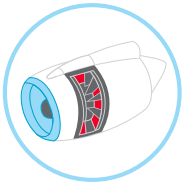
Maintenance has championed the benefits of the Connected Airline for many years. As next-generation aircraft such as the Boeing 787 and Airbus A350 include more robust OEM-supported maintenance programs, the concept of "predictive" maintenance has come closer to fruition, which is likely the largest potential aircraft maintenance benefit enabled by connectivity. Combining the mobile mechanic with more accessible aircraft data, the airline is able to reduce repair timing and accomplish real cost savings.

Below are examples of how the Connected Airline can be applied to bring accurate information to maintenance teams in an effort to reduce aircraft down time, improve turn times, and reduce maintenance costs:

MAINTENANCE APPLICATION	BENEFIT
Predict maintenance needs	Feed larger amounts of sensor data inflight into predictive maintenance algorithms to predict component and other failures prior to failure events. Maintenance is able to receive notifications during flight and prepare for repairs at the next station
Connect maintenance tablets	Optimize parts and resource management by utilizing data originating on the aircraft during flight (through eTechlog or crew reporting) Facilitate electronic task cards for better parts management and resource utilization. This keeps the maintenance resource closer to the aircraft during their shift Allow mechanics and crew to quickly access more detailed information (including video and other multimedia items) with paperless documentation

Access automated aircraft reporting	Streamline maintenance documentation processes with an electronic logbook Enable digital signoff, which can greatly improve time to clear aircraft for the next flight
Enable two-way crew communications with Operations Center (including AOC)	Increase communication to harmonize ground maintenance teams with flight crews: » Increase maintenance team preparedness with inflight communications from flight crews (through eTechlog or crew reporting) » Mitigate the impact of irregular operations

Aircraft Systems



The machine-to-machine (M2M) component of Connected Airline, which is the automation and connectivity around aircraft systems, provides the most potential for value in the overall business case. When comparing Connected Airline to the historical evolution of ground networks, it is clear that the "Internet of Things (IoT)" emerging from the intersection of cloud computing, broadband IP connections, and big data will become integral to connected aircraft as well.

Aircraft systems are also the most difficult-to-integrate element of the Connected Airline. Today's avionics are currently "connected," but it is often done through legacy OEM specific protocols (such as ACARS) or across an ARINC-formatted data bus, which can be too limiting. Additionally, this connectivity is typically point-to-point or point-to-storage on the aircraft, and not intended for large file transfers or routine data exchange.

As ground devices get "smart" there is ongoing discussion that the aircraft hardware will also become increasingly "smart" and networked into the aircraft in order to communicate. Very few examples of this exist today, but it is an area of significant discussion within the supply chain, and it appears that prototypes and opportunities will come in the next few years. In the meantime, the emphasis is on integrating current aircraft system data with improved applications, running on the IP network to provide airline value.

Aircraft Systems Requirements

Aircraft systems already connect to a legacy, proprietary communications infrastructure. Supplementing this current capacity with new IP connectivity, and leveraging standard tools such as APIs, can present unique opportunities to the airline. However, once the standards are in place for many applications, transportability between aircraft will increase. The list below provides important aircraft system requirements:

» **Avionics considerations**
  – Match conformity to current avionics standards for receiving, transmitting, and recording aircraft data
  – Access to current avionics data buses

» **Network security**
  – Secure access on a protected network with access controls and restricted destinations
  – On-aircraft storage in a partitioned database separate from passenger public access

» **Persistent, resilient coverage:** Connectivity on the ground and in the air

» **Data capabilities:**
  – Partial download and upload capabilities
  – Intelligent routing capabilities (e.g. "store and forward" and "least-cost routing" functions)

Opportunities for Aircraft Systems

Introduction of the aircraft systems component of the Connected Airline is the full realization of the "Internet of Things" on the aircraft. Examples of how the Connected Airline can be incorporated into aircraft systems allowing data accessibility from nose to tail include:

AIRCRAFT SYSTEMS APPLICATION	BENEFIT
Integrate with aircraft systems	Develop a homogenized framework for implementing services across different aircraft types and configurations Complete diagnostics and data mining on aircraft, allowing for enhanced operations and better predictive aircraft management "Aircraft Health Monitoring" (AHM) or "Engine Health Monitoring" (EHM) Reduce resource allocation for basic auditing of components on fully networked aircraft Route data intelligently (e.g. "store and forward" and "least-cost routing" functions) Eliminate manual aircraft "touches" to retrieve data Maximize eTechlog capabilities, with a reduction in hardware and power on the aircraft
Communicate and send better data with Connected Airline system operations centers	Monitor teams across connected fleets Obtain real-time snapshots of aircraft and crew readiness Improve overall interaction with flight crews
Collaborate with supply-chain partners and OEMs to drive efficiencies	Take advantage of Software as a Service (SaaS) supplier opportunities. Enabled by connectivity, SaaS eliminates the costly and cumbersome need to buy, install, and manage software on individual devices Allow partners the opportunity to evaluate the real-time performance of equipment

Much has been made of real-time aircraft monitoring and positioning, particularly in light of recent aircraft losses. Given the recurring nature of this conversation, it is important to note that airlines have not yet found a viable business model to achieve this objective. The Connected Airline provides a partial path to this goal, but may require additional technology and value to be implemented on any operational scale (unless subsidized by the connectivity supplier).

Building the Business Case for the Connected Airline

The Connected Airline is a complex, multi-dimensional initiative, and to ensure project success it is critical to build a solid business case. The following best practices are recommended:

- Select a project lead
- Understand key stakeholder requirements and fleet capabilities
- Prioritize investment based on ROI requirements
- Be cognizant of regulatory/certification considerations
- Improve ground systems

Select a project lead

The Connected Airline initiative will involve numerous stakeholders with fragile financial dependencies and potentially competing priorities; thus, identifying a champion to lead the project should be the starting point.

In many airlines, this is often a leader from the inflight or marketing department, due to the initial push into the project via passenger connectivity. Flight operations is also a strong candidate for leading the effort, given the understanding of aircraft regulations and experience with legacy communications. Often, IT is given a strong voice in the process, but there are unique challenges to aircraft networking that the project lead will have to manage through the process, therefore it is recommended to make IT a strong support, but not the project lead.

Having a project lead manage a cross-functional team made up of representatives from key stakeholder groups will help drive project efficiencies.

Understand key stakeholder requirements and fleet capabilities

Once a lead and a project team are established, it is critical to work closely with key stakeholder departments to understand and collect project requirements. Although the four

components described in this paper provide a basis, each airline has a unique operational environment. The lead should engage directly with these departments to collect their needs.

Fleet composition plays a pivotal role in how an airline can implement a proper business case for the Connected Airline. As retrofit and linefit scenarios differ widely, the number and type of new deliveries will drive specific cases. Additionally, leased aircraft also provide special challenges for airlines given the terms included for return condition. Different OEMs also have applied special conditions on networking for certain aircraft, which could have an impact on the business case investment for the airline. Investing time and effort into identifying these inputs will increase the probability of a successful case.

Prioritize investment based on ROI requirements

Once the inputs are collected, the project lead will be primarily responsible for prioritizing the investment to develop a viable business case for launch, attempting to maximize the upside with minimal investment. This plan should represent a go-to-market strategy that outlines the basic system for installation, final configuration, and investment roadmap. Although each airline has different ROI criteria, the lead should incorporate all revenue forecasts with operational efficiency savings to combine towards the return, based on investment schedule.

Incremental investment is often the airline approach to the business case, keeping capital costs low and allowing for graduated costs and returns. However, with the rapid evolution of technology, it is recommended that the airline attempt to maximize the basic platform, while allowing flexibility during the ramp to final configuration. For example, configuring the system primarily for passenger connectivity, without addressing various regulatory and operational concerns for Flight Operations, may limit the usability of the system and inhibit the business case.

Be cognizant of regulatory/certification considerations

The Connected Airline is sure to receive more than its share of scrutiny from government regulators. Already, both Boeing 787 and Airbus A350 programs have received "special conditions" related to the "connected" aspects of their design. As the market continues to grow in both numbers of suppliers as well as applications, airlines should assume that regulators will become more interested in the approach.

Areas where aviation regulatory bodies could potentially get involved include:

- New aircraft certification
- STC and network approvals
- T-PED and other testing
- Operational approvals for automation
- Cyber security
- Increased scrutiny on "strategic" versus "tactical" decision-making

Ground System Improvements

The implementation of the Connected Airline is not singularly aircraft-focused. It also entails significant effort and support via ground systems such as operational databases, the Systems Operations Center (SOC) Platform, and human resources. In many ways, the Connected Airline only achieves maximum value in combination with improvements made in the current

automation of airline operations. Given the advanced nature of ground-based technology, this is often less complex than other areas of the Connected Airline, but nonetheless requires attention to meet the business case.

Operational Databases

The Connected Airline introduces the concept of "big data" to aviation in an operational capacity that has heretofore been lacking. Although aircraft have been capable of collecting megabytes of sensor data on flights for many years, the lack of a reliable high-capacity network has limited airlines to collecting highlights and utilizing technology like removable drives or optical readers to capture this data. Timeliness of data receipt and analysis further complicates productive use of this data, as manual retrieval or a physical aircraft "touch" is typically required to retrieve it.

The Connected Airline brings opportunities to amalgamate data at levels that are many times higher than those that current systems provide. With this opportunity comes a requirement to process the data, which outpaces avionics capabilities. Hence, to achieve the Connected Airline, there is a definitive need to operationalize databases on the ground by providing suitable storage (accounting for scale and scope) as well as accessibility for advanced applications to conduct significant analysis.

Systems Operations Center (SOC) Platform

Beyond the data generation of new automation, the Connected Airline also introduces new and advanced real-time communication capabilities between crews onboard and the operations center on the ground. To maintain cost controls, much of the work conducted in the SOC is now heavily automated, including when, what, and how much information is transferred between the aircraft and operations team. In general, airlines identify that a parallel data set (in the aircraft and in the SOC) is the ideal plan for managing shared responsibility and operations of the aircraft. Keeping that data set together requires a significant connection, as applications continue to increase in both size and number.

Connecting the SOC to the aircraft is happening today, but on a very sporadic basis. The goal would be to connect the SOC to the aircraft virtually all the time to allow for knowledge sharing and improved decision processes. Below are benefits of enabling advanced connectivity with SOC:

- **New, contextual-based communications with flight crews:** Communications can now include voice and video and can reside within other applications, which enables improved contextualization in communications
- **Connect Electronic Flight Folders (EFF):** Current messages over ACARS are text-based, difficult to parse, and can be difficult to get more information posted, whereas connected EFFs are graphical and connected to other applications
- **Shift operations center from the airport to the aircraft:** Connecting the SOC to aircraft allows crews to communicate and get the most up-to-date information from the flight deck, which can reduce delays
- **Real-time status of aircraft and crew readiness:** Enables efficiencies such as conducting pre-flight briefs on the aircraft (saving about 30 minutes) or allowing crews to proactively notify the SOC if they are hitting their duty limits during delays, allowing the SOC to communicate schedule changes prior to landing

Concluding Remarks

Airlines apply business case requirements for new technology, and the Connected Airline is no different in this regard. This white paper has not only outlined the requirements and opportunities around the Connected Airline to build understanding, but has also provided best practices on how to make the business case.

Airlines indicate that there is a business case for the Connected Airline, but the lack of an installed base also shows it is challenging to convert such awareness into a viable operational model. Overwhelmingly, airlines that have come closest to the Connected Airline, those with more than 70% of their fleets with IP connectivity greater than 1.5 Mbps in the air and on the ground, have justified the investment through passenger connectivity services. Once the service has been deployed for passengers, the network can be explored as a viable path for operational data. Legacy data networks, although widely deployed (classic SATCOM is installed on over 10,000 commercial aircraft[7]), do not have the potential to support the fully-integrated Connected Airline.

To make the business case for the Connected Airline, it is essential to prioritize the investment based on ROI requirements. The Connected Airline does require a front-loaded capital investment for network components on the aircraft and a new connection link off the aircraft. The Connected Airline is a natural evolution of this new automation ecosystem and is poised to launch a new era of efficient operations that will transform the aviation industry.

7 http://www.runwaygirlnetwork.com/2014/03/27/inmarsat-eyes-global-aero-distress-service/

About Gogo

Gogo is a leading global aero-communications service provider to the commercial and business aviation markets, offering inflight internet, entertainment, text messaging, voice, and a host of other communications-related services. Our reliable, flexible, and innovative offerings include connectivity applications to support airline operational services, enabling new opportunities in every facet of aviation.

Gogo Airline Operational Services

Gogo® Crew Connect

Gogo Crew Connect is a mobile voice and Over-The-Top (OTT) messaging communication solution for airlines, optimized for the Gogo network.

Crew Connect keeps crews connected with airline operations and dispatch while inflight and during layovers – allowing crew members to stay connected to important flight-specific information and improving communications to help mitigate the impact of irregular operations.

Gogo® Ramp Connect

Gogo Ramp Connect is a secure network leveraging the Gogo network to provide connectivity in and outside the aircraft, in the hangar, on the ramp, and at the gate – transforming the aircraft into a secure Wi-Fi hot spot.

gogoair.com/connectedfleets