

INTEGRATED INFORMATION SYSTEM (I²S)

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ABSTRACT

The airline of the future will survive or thrive based on its ability to manage a wide variety of information. The aircraft will become a mobile information platform, collecting and distributing operational, maintenance, safety, administrative, entertainment and passenger specialty information. Rockwell Collins has formed a new business unit to focus on providing information management solutions and communication alternatives to improve flight operations, maintenance and cabin services. The approach is to provide fully integrated, end-to-end solutions that connect the aircraft applications to peer applications on the ground, which will improve system efficiencies, enhance cost savings,

provide airline-competitive advantages and expand passenger services. The Rockwell Collins offering is based on the concept of an integrated information system (I²S). This family of integrated applications will be managed on a system built on a scalable, open architecture and distributed over a wide variety of communication facilities. Some of these facilities might be traditional data links, while others might be unique, airline-owned and-operated communication networks. By managing the information and providing a set of high-integrity communication paths, the airline can begin to recognize benefits and savings from these improved efficiencies and customer services.

AIRLINE INFORMATION

We live in the information age. This has been made possible by advances in technology that allow us to access information in a variety of ways. Cellular phones, message-capable pagers, computer networks and the Internet all exist to exchange information. Timely access to information is critical in today's highly competitive environment.

Today, airlines operate a variety of information networks, each performing a specific task. The real

value of the data is compromised if it is not converted into intelligence. Consider a simple passenger record. A frequent flier record indicates passenger preferences and travel itinerary. This data can help during the reservation process and during the boarding and flight cycles. The passenger can be assured of connecting gates and follow-on travel details based on common access to information. This level of customer service can help ensure a satisfied customer and repeat business.

Airline information takes many forms, including:

Administrative data

- Cargo control
- Baggage handling
- Electronic logs
- Aircraft records
- Crew scheduling
- Fuel records

Operational data

- Out/Off/On/In times
- Navigation databases
- Weather
- Flight planning
- Departure and arrival clearances
- Flight safety records

Maintenance data

- Engine trend data
- Maintenance logs
- Central maintenance computer statistics

Cabin data

- Cabin inventories
- Duty-free inventories

Passenger data

- Passenger records
- Reservation services
- Credit card information
- On-board ticketing
- Baggage

By coordinating this diverse set of data between the aircraft and ground systems, strategic planning and tactical execution can both be accomplished.

Such improved information management pays significant benefits in reduced operating costs and improved revenues.

MANAGING INFORMATION

The ultimate goal of information management is to make of the aircraft and its users another node on the airline network. By integrating or managing the data for the passengers, the cabin staff and the maintenance functions, the overall operation strives to reduce disruptions.

Managing the information availability and distribution allows the airline to:

Reduce maintenance-related turnaround time at the gate by:

- Earlier fault reporting
- More accurate fault reporting

- Improved, less expensive documentation handling
- Improved use of maintenance resources
- Improved, faster parts delivery to the aircraft
- Improved, faster troubleshooting
- Faster use of minimum equipment list (MEL) procedures
- Quicker sign-off procedures

Improve passenger “handling” by:

- Providing better, more timely, more complete information
- Providing more individualized service
- Providing more access to self-help services

Improve aircraft servicing by:

- Fast and accurate communication of servicing needs
- Faster, less labor-intensive database transfers

Increase airborne efficiency by:

- Better use of advanced planning systems
- Better use of new flight techniques such as dynamic routing, controlled time of arrivals and variable speed control

- Reduction of average takeoff thrust by optimizing power for each takeoff operation

Improve revenue-generating ability by:

- Optimizing fuel reserves
- Increasing cargo payloads
- Increasing passenger seating
- Improving asset utilization

DATA VS. INTELLIGENCE

The value of data is in how it is manipulated to provide information of value-intelligence to a decision-maker.

Within the airline community, there is a very broad set of information managers in differing roles. Passenger service agents, maintenance technicians, pilots and others need to make timely decisions to support individual and team tasks. To make their jobs easier, the data that provides the source for the information must be managed to provide intelligence.

Considering the requirements placed on today's pilot, the data must be managed to provide information and intelligence. The pilot's limited ability to react to incremental

data elements will compromise his or her ability to form an effective decision. Resolving the data into information will help support the development of situational knowledge and ultimately lead to decisions or solutions concerning the task at hand.

As new applications develop, there is more focus on converting data to decisions. We find that developing applications are offering solutions or are initiating communication exchanges in the background to allow air and ground collaboration and resolution of tasks. This allows the information or intelligence users to be more effective in their primary functions.

THE BENEFITS OF INFORMATION MANAGEMENT

The benefits of information management are measured in terms of increased revenues and reduced direct operating costs. By automating some of the personnel-intensive operations and taking advantage of the aircraft as a node

on the network, information can be exchanged rapidly during taxi, ramp and gate periods. The human activities can focus on passengers and tasks necessary for efficient airline operations.

Managing information can help reduce operational costs by reducing disruptions. Airline disruptions are generally distributed among four types:

1. Departure delays
2. Departure cancellations
3. En-route delays
4. En-route diversions

Any of these can also lead to two types of secondary (downstream) disruptions, including additional cancellations and departure delays. By coordinating information

between the ground and the aircraft, the costs of these disruptions can be reduced.

Disruption costs are unique for each user and must be treated as such. Nevertheless, there is reason to believe that, because of similar operating costs and passenger revenues for similar flight segments, one airline's experience will approximate another's.

Cancellations cost the airline both revenue and passenger satisfaction.

TYPICAL COSTS OF CANCELLATION

Aircraft Type	Primary Event Only	Primary Plus Downstream ¹
130 passenger domestic	\$3,700	\$11,700
150 passenger domestic	\$6,200	\$20,000
180 passenger domestic	\$8,200	\$30,500
300 passenger domestic	\$13,500	\$37,000
300 passenger international	\$21,700	\$40,000 to \$60,000 ²
400 passenger international	\$20,000 to \$50,000	\$70,000 to \$180,000

Table 1 – Costs resulting from passenger losses and other causes when a flight is canceled

The typical causes of flight cancellations are for unscheduled aircraft maintenance, weather and other flight operations reasons. Figure 1 shows that nearly one-third

of cancellations at one major airline were caused by maintenance issues that required resolution before the aircraft was available for additional operations.

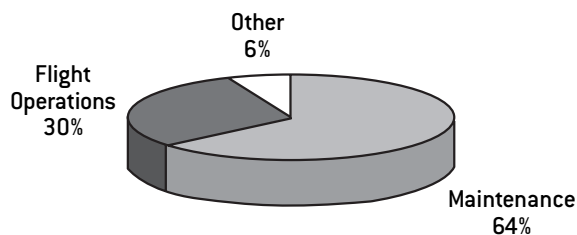


Figure 1 – Main causes of cancellations

Table 2 below shows the rounded values of a departure delay as used by one major US carrier to calculate departure delay costs.³

Departure Delay Time (In Minutes)	Typical Domestic Narrowbody Costs ⁴	Typical International Widebody Costs
15	\$25 per event ⁵	\$85 per event
30	\$1,500 per event	\$500 per event
45	\$3,000 per event	\$650 per event
60	\$5,400 per event	\$2,000 per event
75	\$6,000 per event	\$2,200 per event
90	\$6,000 per event	\$3,000 per event

Table 2 – Costs resulting from passenger losses and other causes when a departure is delayed (typical cases)

For this “typical” airline,⁶ about one-third of departure delays were caused by maintenance, and nearly half were

longer than 15 minutes. Twenty-five percent of these delays were longer than 60 minutes.

¹A cancellation *always* results in a downstream effect. To balance the system, another flight must be subsequently canceled or the aircraft must be ferried to reposition it for the subsequent departure.

⁴Includes down-line losses where applicable.

²International cancellation costs are highly dependent on location of departure and destination.

⁵The very large difference in cost per event between 15 minutes and 30 minutes results from the step-nature of this airline’s description of this non-linear function.

³Calculating departure delay costs is complicated. Basically, it accounts for the fact that passengers begin to “give up” on a flight that is delayed beyond some point. It is easier to give up on a domestic flight for a number of reasons, including the availability of alternatives.

⁶A typical airline in this case is a full-service international major carrier. Other airlines such as regional or charter carriers can have widely different experiences and costs.

THE I²S CONCEPT

The concept of I²S is based on the aircraft and ground systems exchanging data over cost-effective communication networks. For the aircraft to participate as a node on the network, its connectivity and information processing must be integrated into the wide- and local-area networks, servers and applications on the ground.

integrated set of solutions for the airline community. These applications have been defined as modules to allow an airline to use those elements that offer the greatest benefits. Rockwell Collins has also developed the necessary avionics infrastructure to assure that the ground and airborne applications can exchange information in a high-integrity, robust environment.

Rockwell Collins has worked with the leading developers of applications in defining and developing a fully

Figure 2 on page 6 illustrates the relationships between the aircraft and the ground systems.

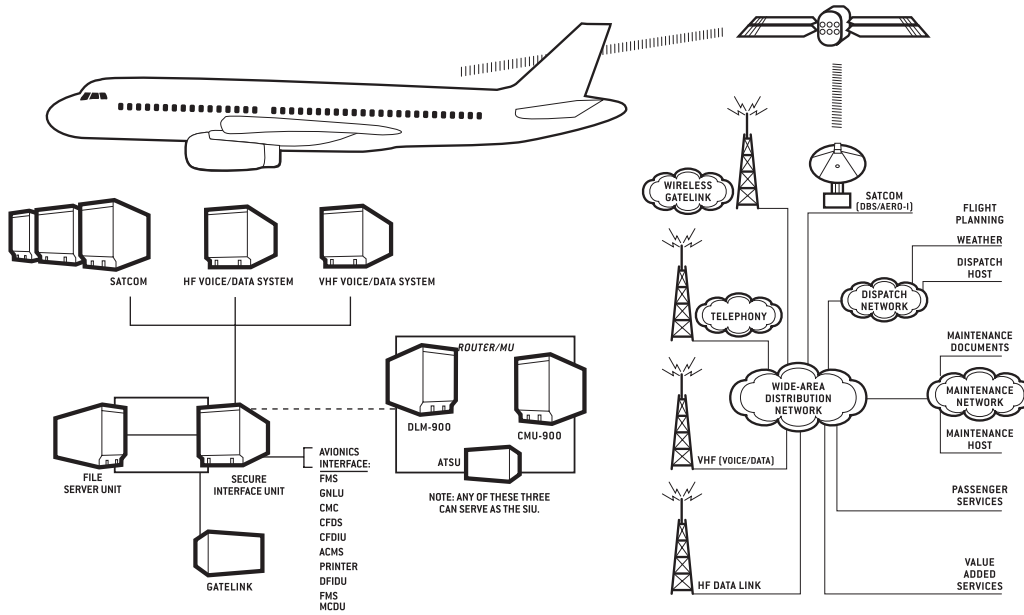


Figure 2 – Aircraft and ground relationships

THE GLOBAL STANDARDIZED GATELINK

To fully realize the promise of I²S, an innovative wireless gatelink architecture is required. A gatelink which can be used by all airlines, all over the world. A gatelink with the reliability and security necessary for aircraft to tie back into their own IT networks. A gatelink for all airport network activities and the ground infrastructure, including service companies, ground handling, catering and point-of-sale operations.

Rockwell Collins is leading the effort to develop this standard. By working in a cooperative effort with global industry leaders, airport authorities and regulatory considerations, Rockwell Collins is creating a global, interoperable standardized system architecture solution that is truly open. This gatelink is designed to operate fully within international regulatory concerns and individual country protocols, while the network is designed to tie in multiple locations worldwide.

THE APPLICATIONS

One primary objective of I²S is to improve the efficiency of airline functions by providing easy access to and navigation through vast amounts of technical data.

I²S offers a single, centralized source of information for the flight crew, cabin staff and maintenance teams. Its use in both “classic” and “glass” aircraft can reduce the expense of manually issuing and updating navigation and aircraft performance manuals. Electronic updates via the communication subnetworks can update the aircraft’s reference, performance and navigation databases, simplify cabin logistics and provide real-time information exchanges for maintenance purposes.

Furthermore, by updating databases through new communication technologies, an airline can significantly reduce the time and expense associated with maintaining large amounts of required documentation including data on its airplanes.

In future applications of I²S, flight plans, performance, fuel, weather, NOTAMs, navigation revisions and other data will be supplied directly into the flight management system. Enhanced communication infrastructures can integrate with I²S to ensure reliable communication of maintenance information (fault reporting) to the ground. The ability to transfer large files inexpensively while the aircraft is in motion allows more information to be transferred easily, permitting new applications at low cost.

Navigation data and flight plans will continue to reside in the flight management computer. However, traditional paper charts can be replaced with electronic data displayed on appropriate screens and will move with geographic references provided by the precision position sensors. While much of the information needed to navigate an instrument approach is currently available on the navigation displays of glass cockpit aircraft, additional information such as landing minimums, decision altitudes, minimum descent altitudes and minimum sector altitudes can be presented on an appropriate display as desired.

Cabin applications that track duty-free, catering and other service inventories are also available. In conjunction with passenger records and preferences, these functions allow an international carrier to reduce its payload and improve operating margins by allowing the passenger to retrieve duty-free purchases at the destination airport instead of carrying these items on board the aircraft.

Seat-back applications will grow as new Internet technologies mature. It is likely that an airline will be able to generate revenue by selling advertising time on the seat-back systems. The aircraft will have mass storage capabilities that support video-on-demand and other entertainment enhancements. Access to games and, ultimately, gambling will become a reality with new seat-back applications.

THE ROLE OF COMMUNICATION

While the value to the customer is based on the ability to exchange information and to manipulate a variety of applications, the system requires a stable, high-integrity communication environment. This environment will consist of airline-owned and airline-operated networks, service provider-based networks and a variety of public and proprietary systems.

The system concept allows the airline to manage the data links to provide the necessary communication performance. Routing policies will be held in the communication

management platform or router to ensure that the airlines maintain freedom of choice. The policies that determine the routing parameters might be cost, quality of service, priority of message or other user-selectable conditions. In some cases, the data will be considered critical and will have routing policies dictated by the air traffic authorities.

The key to the performance of the system will be the air and ground routers that will select the appropriate path to ensure that the applications can exchange information in a timely and accurate way.

THE ROLE OF ROCKWELL COLLINS

Rockwell Collins recognizes that the real value of new communication and information management hardware comes from the work it performs. The company can draw on its highly experienced airline operational experts to design new applications that help airlines develop new applications. It is the combination of a capable information and communication platform and value-added applications that provides extensive economic success.

Rockwell Collins has extensive experience and resources in applications software development for airline operations. Applying this expertise effectively reduces a customer airline's communication costs while expanding its information management capability across its fleet. Past

work on electronic library techniques already has identified applications, including:

- Electronic references for various cockpit and maintenance technical documentation for faster troubleshooting
- Semiautomated (with pilot control) maintenance malfunction reporting to reduce maintenance-related delays and cancellations
- Smart maintenance history to avoid unnecessary repetition of repairs or maintenance procedures
- Improved parts management for faster maintenance response and inventory control
- Improved coordination between the cockpit, dispatch and maintenance control and line maintenance to ensure MEL procedures, payload and planning efficiency

- Faster maintenance sign-offs and documentation procedures to reduce turnaround times
- Less expensive navigation database updating
- Improved performance management systems to optimize engine thrust use, increase payload and reduce “getting numbers” delays
- Graphical NOTAMS and graphical weather to reduce unnecessary lateral track excursions
- Semiautomated ETA and fuel state updates to improve flight control and reduce technical fuel stops
- Semiautomated flight changes, including holding, diversions, go-arounds and weather detours, to reduce en-route disruptions and delays

Additionally, Rockwell Collins has demonstrated leadership in avionics design and development and certification initiatives. The true value to the customer will be recognized when a fully integrated set of applications can be hosted on airborne platforms and information can be exchanged with ground counterparts in a seamless, efficient manner. Providing this value is the focus and promise of Rockwell Collins’ new I²S business unit.

In terms of communication management, Rockwell Collins is a recognized leader in data link protocols and communication policies. The company has a legacy family of products that has been modified to include these new applications and to ensure that new, proprietary communication infrastructures can be supported. While the platform is based on an open-system structure, specific data link environments can be supported. This includes telephony subnetworks, wireless gatelinks, tethered gatelinks and Ethernet interconnections. We’re leading the effort by working with airlines and industry leaders worldwide to create and develop a standardized wireless gatelink architecture. Rockwell Collins’ leadership in display integration and technologies will support the presentation of information on the flight deck, cabin and passenger compartments. Next-generation air traffic applications, maintenance functions, operational performance computing, cabin services and passenger entertainment systems will all be linked through the integrated information system to ensure the highest quality of service at the minimum cost.

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