ATN AIRBORNE IMPLEMENTATION

Christophe Hamel
Honeywell International Inc.

Tom Judd
Honeywell International Inc.

Ketan Nguyen
Honeywell International Inc.

Bryan Rowe
Honeywell International Inc.

Kevin Wohlers
Honeywell International Inc.

PRELIMINARY NOTE

This Honeywell paper is not intended to promote ATN. It is to share with the industry findings and considerations further to a six months Honeywell study conducted on feasibility of ATN airborne integration and under which conditions it can be achieved.

PREAMBLE

Both in Europe and the US, ATC delay seriously affects airline operations. Delays are expected to increase and exceed those experienced before September 11th.

The ATC delay situation in Europe is very serious. According to a EUROCONTROL study published in October 1999 (Medium-term Capacity Shortfalls 2003-2005) “the average en route delay per flight by the year 2005 is estimated between 17.1-36.8 minutes, according to the assumptions retained, if there is nothing more undertaken than national and supra-national Capacity Enhancement Plans known” at that date.

Past studies conclude that digital data link is a key enabler to reduce delay. In 1995 the FAA published the results of a data link benefits study entitled “User Benefits of Two-way datalink ATC Communications: Aircraft Delay and Flight Efficiency in Congested En Route Airspace” in which ATC productivity was increased, thereby decreasing airline delay, by using data link to reduce voice frequency congestion.

At the same time there are spectrum availability and congestion problems looming for airline current AOC operations, with the potential for a large negative economic impact.

As a part of the answer, the ICAO Aeronautical Telecommunication Network (ATN) provides an interoperable datalink network to support Air Traffic Services.

INTRODUCTION

Congruent with existing forces of globalization, the current trend is to go away from discrete entities (markets, systems, economies, technologies etc.) to integrated ones.

By attempting to federate sub-networks, to provide common applications and information over worldwide interoperable hardware and software, ATN appears to be a perfect illustration of this phenomenon.

ATN implementation is raising a broad range of political, institutional, legal and technical issues that obviously cannot all be encompassed in this short paper.

Here, Honeywell is offering a perspective that was not yet fully appraised since a number of elements, such as the ATN airborne integration costs, had not been thoroughly studied.

In effect, until very recently ATN developments and notably ATN airborne implementation impacts were only roughly assessed.

Honeywell is in a unique position to conduct an in depth analysis on the Airborne ATN Implementation, since Honeywell is

?? The only avionics manufacturer to handle fully-integrated avionics suites from Flight Management Systems (FMS), through Communications Management Units (CMU), Displays, MCDUs (Multi-Function Control and Display Unit) to VHF, HF or SATCOM links, and

?? A member of Aeronautical Communication International, LLC[1] (ACI). ACI is under contract to ATN Systems Inc. to produce a DO-178B Level C

[1] ACI is a joint venture between THALES ATM, Honeywell, Sofréavia, and THALES Avionics.

ATN Router compliant to the 9705 Ed 2 SARPs. This router has been specifically designed as the first portable avionics software capable of being ported to both ground and airborne platforms.

This has been achieved by a dedicated Honeywell team over several months of analysis on the type of applications required for various programs across the world, the various aircraft generation and fleets, the trade-offs between the possible architectures, the capabilities of the different avionics platforms involved, and the operational and technical requirements.

This paper is to provide an overview that will help the aircraft operators and the aeronautical community at large to better grasp the challenges attached to the airborne ATN implementation.

INTRODUCTION TO ATN

Identified as the next generation data communications network for the Aeronautical Community, the Aeronautical Telecommunication Network is to provide communication services that meet the safety and performance requirements of the industry through a reliable, robust, high-integrity worldwide data network.

ATN CHARACTERISTICS

The main infrastructure components of the ATN are based on:

?? connection to ground existing LAN, leased lines and X.25 networks,

?? connection to mobile communications over satellite, VHF/HF Data Link and Mode S transponder sub-networks,

?? Airborne and Ground Intermediate Systems (IS) or Boundary Intermediate System (BIS), responsible for connecting various types of sub-networks together, in charge of routing messages across these sub-networks according to the requested class of service and the current availability of the network infrastructure,

?? Airborne and Ground End Systems (ES), that host the application services and the upper layer protocol stack (for end-to-end liability purposes) and communicate with peer systems. Note: This refers to an end system from an ATN stack perspective. An end-system contains the full seven-layer stack interfacing to an application (user of the communication stack service). The application may be distributed to another system as well.

When compared to the existing ACARS (character oriented), ATN (bit oriented) is expected to offer better performance (transit delays, reliability, throughput, availability) with a built-in inter-network design and dynamic routing capability. It also provides Network Scalability limited by all available sub-networks' capacity. As the End-to-End service is independent from the Sub-networks, and the encapsulation technique used is independent from sub-network technology used to forward data, ATN allows Interoperability of Applications & Networks. Finally, ATN Routing policy is based on Policy and Quality of Service (QoS) and Security Control, with capacity of traffic segregation (consistent priority scheme, traffic types), authentication hooks at networks and application level and End-to-End reliability. The Security Control is based on the sub-network reliability but is essentially enforced by end-user control (end-to-end). QoS also encompasses characteristics such as reliability, cost, and transit delay, priority/security as already mentioned above and below.

ATN BENEFITS

ATN has been designed to provide to the Air Traffic Services end-user fewer transmission/interpretation errors, improved flight safety thanks to improved access to information (policy based routing), reduced workload and improved productivity by providing automation tools for routine information exchanges. Moreover, being an open standard for new functionality and upgrades ATN is designed to be a federated network for all types of traffic and since ATN uses compressed data with very efficient encoding communication its overall operations costs will be reduced.

HONEYWELL INVOLVEMENT IN THE ATN SOFTWARE DEVELOPMENT

As mentioned in the introduction, through ACI, Honeywell is deeply involved in the development of the ATN Stack. As shown in Figure 1 blow, the OSI ATN architecture, as developed by ACI, is composed of several key elements that provide data routing services based on Customer requirements and that allow display of communicated data to End Users. The main elements are the Ground Boundary Intermediate System (GBIS), the Ground End System (GES), the Airborne End System (AES), and the Airborne Boundary Intermediate System (ABIS). The ABIS and GBIS can function as both a Boundary Intermediate System (BIS) and End system (ES) at the same time.

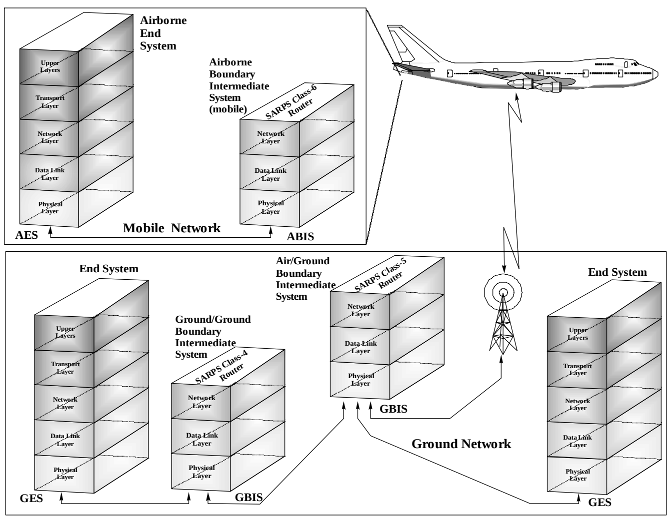

Figure 1. The ATN Structure

The required software modules are developed based on the ICAO Standards for the ATN and according to the RTCA DO178B guidelines for development of Level C (essential) certified software. The set of configurable OSI (Open System Interconnection) protocol layers and applications - i.e. the Router Reference Implementation (RRI) and the Application Service Elements (ASE) - compose the "heart" of the ATN elements.

These software modules, (GBIS, GES, and AES/BIS) are ready to be ported on customer target platform and conFigured as required. ACI has designed these software modules under FAA document 8110.97 (Guidelines For Approving Reused Software Life Cycle Data) such that the porting effort is significantly minimized with the following effort needed for certification:

?? integration code has to be developed in order to reconFigure the RRI and ASE code

?? RRI software requires significant adaptation to be compatible with VDL Mode 2[2]

?? RRI software requires minor adaptation to be compatible with SATCOM and HF Datalink

?? certification documentation requires an upgrade to reflect the new porting environment.

<u>ACI and current ATN development</u>

ACI delivered its first ground-side products in early 2000 for evaluation in the FAA CPDLC Build 1 ground network. Successful evaluation of the router led the FAA to select the RRI router to support CPDLC-1 at Miami ACC with 4 routers delivered to FAA and installed in October 2001.

DATALINK PROGRAMS

A number of datalink communication initiatives are taking place in the world.

Future Air Navigation System (FANS) implementation in the South Pacific demonstrated that digital datalink can be implemented in an air traffic operational environment. FANS-1/A was the first step in datalink's evolutionary path to provide data link capability for procedural airspace.

Today Petal IIe (Preliminary EUROCONTROL Test of Air/Ground Data Link, extension) trials in Europe to evaluate data link operational implementation issues are now successfully completed. PETAL-IIe was the third in a series of operationally oriented air/ground data link trials conducted by EUROCONTROL using ATN among other infrastructures such as FANS 1/A, Modes S, and the Northern European ADS-B Network (NEAN). The aim of PETAL-IIe (and its predecessor PETAL-I & II) was to allow currently active aircrew and controllers to examine and modify the international operational procedures and use of air/ground datalink in CNS/ATM.

FANS PROGRAMS

FANS-1/A technology is being mostly implemented in the Oceanic and remote areas across the Asia/Pacific and North Atlantic regions, the United States and Europe. The number of FANS-1/A aircraft continues to increase along with the number of FIRs supporting FANS-1/A services.

FANS-1/A is established in a great number of FIRs and will continue to play an important role in airspace where it is currently implemented.

The current FANS-1/A ATS providers are:
Auckland, New Zealand; Bangkok, Thailand; Brazil; Brisbane/Melbourne, Australia; Cairo, Egypt; China (Kunming, Chengdu, Lanzhou, Urumqi); Colombo, Sri Lanka; Gander, Canada; Hanoi, Vietnam; Hong Kong, China (stand alone system for R&D); India (Calcutta/Chennai); Jakarta, Indonesia; Johannesburg, South Africa; Iceland (planning); Kuala Lumpur, Malaysia (planning for "pre-operational system"); Las Palmas, Canary Islands (Spain); Madagascar; Madrid, Spain; Magadan, Russia; Mauritius (testing); Nadi, Fiji; Oakland/Alaska/New York, USA (CPDLC only); Santa Maria (Azores); Shanwick, UK/Ireland (ADS only); Singapore; Taegu, South Korea; Tahiti, French Polynesia; Tashkent, Uzbekistan; Tehran, Iran; Tokyo, Japan; Ulaan Bator, Mongolia; Yangon, Myanmar (Burma) - (reference: ATC Datalink News Web Site).

ATN PROGRAMS

The lessons learned from FANS-1/A and Petal IIe operations are being used to develop ATC data link for radar-controlled airspace in the US and Europe programs, respectively Build1 & 1a and Link 2000+.

These two ATN programs are to make use of the CM, ADS and CPDLC applications as defined in SC189 Interoperability Requirements for ATS Applications and Services Using ATN Baseline 1 in a document jointly developed by RTCA SC-189 and EUROCAE WG-53 known as ED110/DOxxx).

<u>EUROCONTROL Link 2000+</u>

The EUROCONTROL ATM Strategy for 2000+ identifies datalink as one of the key enablers for the coming decade.

The initial objective of the LINK 2000+ Program is to plan and co-ordinate the implementation of operational

[2] VDLM2 specification was not mature when the ATN was developed. However VDLM2 requirements have been developed by ACI and this effort is in the design phase. Prototype VDL Mode 2 software is also in development.

air/ground data link services for Air Traffic Management (ATM) in the core area of Europe in the timeframe 2000-2007 using ATN over VDLM2.

By using the initial set of instructions described in Figure 2, datalink will bring reductions in communication workload for controllers and pilots, increase communication reliability, and allow airborne and ground-based systems to exchange information.

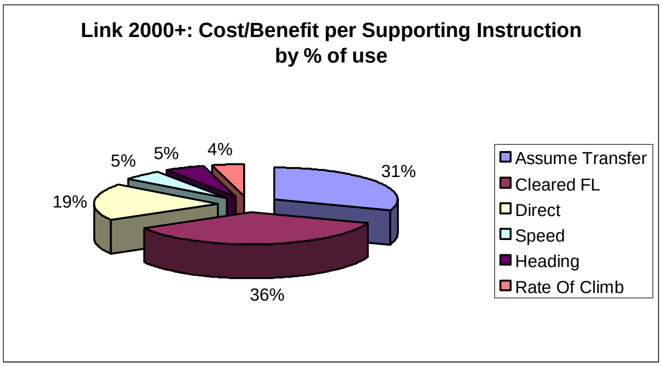

Figure 2. The Link 2000+ Supporting Instructions (EUROCONTROL EATCHIP III Evaluation and Demonstration Phase 3b – Air/Ground datalink experiment – Final report)

The interoperability specifications (PUB 28) provide those of the services selected by LINK 2000+ that will support the above instructions. Those specific services are:

?? DLIC - Data link Initiation Capability

?? FLIPCY - Flight Plan (Route) Consistency

?? ACM - ATC Communications Management

?? ACL - ATC Clearances

?? AMC - ATC Microphone Check

These initial services, as a part of the CPDLC application, will be supported by a set of messages that will be implemented both in the airborne and ground equipment to support the functions provided in Figure 2. Link 2000+ will implement the Context Management (CM) Application needed to correlate the aircraft flight identifiers used by air traffic controllers to the aircraft network addresses used by the ATN to exchange data between network users.

The program will evolve and as it gains experience will increase the number of applications and will migrate toward a more advanced step "Air Ground Cooperative ATS" with the aim of implementing and using more applications and supporting more complex messages as described in ED110/DOxxx.

Carriage requirement in Europe

EUROCONTROL is currently encouraging European States and users to get equipped so as to get up-to speed on datalink exchange and to reach a significant state of equipage by 2007. In the meantime, an ENPRM (EUROCONTROL Notice of Proposed Rule-Making) is being worked with the European stakeholders with the intention of mandating datalink in 2007-8.

FAA PROGRAM

The FAA has undertaken an effort to implement the ATN in the US.

The CPDLC program is designed to enhance the domestic National Airspace System (NAS) En-Route environment by providing the capability for controllers and pilots to communicate through the exchange of digital messages. CPDLC is being implemented in an evolutionary manner. The first step in this evolutionary process is known as CPDLC Build I or CPDLC-I and will be a single site deployment (Miami) that is to implement a limited set of air traffic services by October 2002. These services are also part of the PUB-28 document:

?? TOC - Transfer of Communication

?? IC - Initial Contact

?? ASM - Altimeter Setting Messages

?? Pre-defined Controller Messages

In addition to this limited set of services, the CPDLC-I program is implementing the Context Management (CM) Application.

In support of the CPDLC-I program, the FAA has formed a partnership with ARINC to provide an ATN compliant A/G communications sub-network service. This sub-network will use VDL Mode 2 (VDLM2) to deliver digital data messages between air traffic controllers and pilots.

Information learned during the CPDLC-I operational evaluation will be fed back into the following evolutionary development process allowing subsequent phases of CPDLC to be more effective.

As further steps:

?? CPDLC Build IA will expand upon the CPDLC Build I services to a total of nine ATC services including transmittal of clearances. The CPDLC Build IA program is fully funded and its key site initial operational capability is scheduled for 2005 with national deployment planned for all ARTCCs afterward.

?? Build II is expected to be the next major expansion of data link capability across the NAS. Build II to date comprises five subsequent steps, named "spirals". Those spirals have been identified to provide integration with fielded decision support tools as well as expand and extend data link services to other flight domains. The implementation of these spirals may or may not be sequential and will be dependent on industry needs. The first spiral implementation of Build II at a key site is planned for 2006+ but following the Build 1A re-planning, this is likely to be delayed as well.

Carriage requirement plan in the US

The FAA is encouraging US users to equip on a voluntary basis and expects the number of datalink-aircraft will increase as knowledge and confidence is gained throughout the various builds and spirals.

AIRBORNE ATN IMPLEMENTATION ALTERNATIVES

On the airborne side, the best way to provide the most economical solution is to be able to spread a unique cost of development over the largest possible number of platforms. Based on this, Honeywell has studied some of the various ATN airborne architectures, their implementation feasibility, as well as the potential available market, depending on a set of hypotheses.

FMS & CMU INTERFACE ISSUES

The airborne ATN implementation alternatives are depending on the required interface (i.e.: integration between the Flight Management and the Communication Management functions) levels, the aircraft architectures and capabilities.

Services, Applications, Messages and Parameters

To reach the expected benefits of datalink, the various programs are defining sets Services (cf.: para. 5.2.1. & 5.2.2.) that are supported by globally defined Applications. As an illustration AMC can be supported by CPDLC.

In turn, these applications are calling for Messages and in this example, the Message (Up-link) used in CPDLC to support AMC is UM157 " Check Stuck Microphone".

Some Messages defined within these Applications are self-sufficient while others require insertion of Parameters such as [LEVEL] in the Up link Message #6 or UM6: "Expect [Level]".

Services considered and integration level

For the time being, both because of the current economy and the level of development and experience with datalink, the implementation of applications has to be affordable and to bring near term benefits for the airlines (and Air Traffic Service Providers, ATSP) to support the business case.

Therefore, simple messages such as UM6 above can be easily handled without any interface to an FMS. The [level] parameter can be supplied by an ADC or an IRS.

On the other hand, certain complex messages, such as Down link Message DM78 "AT [time] [distance] [tofrom] [position]", require parameters that are exclusively computed by the FMS or a similar navigation computer. In this case the "TO/FROM" information is maintained by the FMS only.

In the early implementations such as CPDLC-I and Link 2000+, complex messages will not be used and therefore interface to the FMS will not be required initially[3].

However, the longer-term ATM capacity will be more reliant on a successful and deeper FMS-CMU integration. Therefore, there is a need for defining the optimum solution that will accommodate both the short term goals as well as ensuring a migration path to the time when the end-to-end system and infrastructure will be mature enough to support functions enabled by airborne integration.

DATALINK ARCHITECTURES UNDER CONSIDERATION

A number of airborne architectures are already or being defined.

FANS Current Architectures

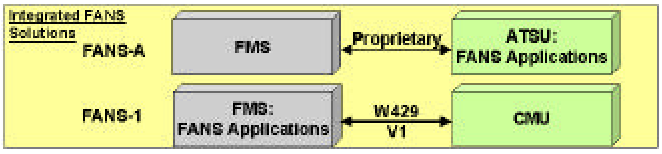

Figure 3. Current FANS Architectures

As per Figure 3 and from top to bottom:

1/ FANS-A is resident in the ATSU and some data required to support the ADS, AFN and CPDLC applications is provided by the FMS. However, the FANS protocol and ACARS network do not provide the same level of integrity, availability and continuity as those expected from an ATN environment.

2/ FANS-1 applications are integrated in the FMS while the CMU acts as an ACARS router. ADS, AFN and CPDLC applications are supported. Again here, the FANS protocol and ACARS network are not likely to provide the same level of integrity, availability, and continuity has those expected from an ATN environment.

Note: The Boeing 777 FANS architecture is a hybrid architecture with applications split between FMS and CMU (CMU in the 777 is called Flight Deck Communication Function).

[3] Although not required, FMC integration will improve benefits realization for both CPDLC-1 and LINK2000+. Complex messages are part of LINK2000+ and, even for non-complex messages such as transfer of communications, cockpit integration enhances cockpit resource management, as well as end-to-end safety, and increases overall benefits for all message types. So, while not required, even in the initial step airborne integration is desirable.

Current and Possible ATN architectures descriptions

Honeywell has evaluated some of the ATN solutions. Those are illustrated in Figure 4.

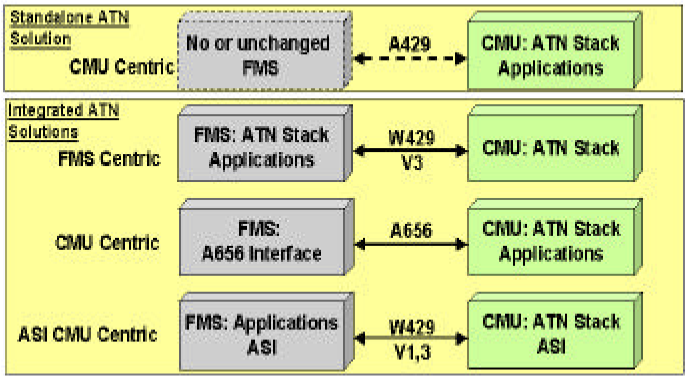

Figure 4. Current and Possible ATN Architectures

As per Figure 4 and from top to bottom:

1/ The ATN non-integrated solution is based on a standalone CMU that includes both the Applications (ADS/CPDLC/CM) and the ATN stack. The CMU will be able to perform functions requiring parameters that can be extracted from other avionics via existing interfaces. The parameters required for Link2000+ or Build 1 can be obtained from avionics such as the ADC, the GPS and IRS. In this solution the ATN stack porting takes place only once on the CMU and therefore meets the criteria of a single development cost spread across a large number of platforms.

2/ Of the ATN integrated solutions, the most demanding in terms of development costs is the one where all the Applications are FMS resident and the ATN stack has to be implemented in both the FMS and the CMU. As mentioned in the introduction, the ATN stack has to be ported into every variant of FMS and in the CMU with a direct and significant increase in development cost.

3/ In this solution, the Applications and the ATN stack are CMU resident and the FMS/CMU integration is made through an A656 interface. Despite the fact that this interface is defined (ARINC Grey cover available), it has not been fully developed yet. Honeywell has evaluated the development effort required for this interface and, although the final cost will depend on how much of the ARINC characteristic is implemented, it is likely to be more costly than other possible interfaces.

4/The last solution represents an architecture where the Applications reside in the FMS, the stack is ported in the CMU once and the integration is conducted through the ASIs (Application Service Interface – above the ASEs). This solution provides both the savings associated with one-only-porting of the ATN stack and to the use of ASI instead of developing a dedicated interface.

Note: Honeywell didn't consider the DSI (Dialogue Service Interface) approach (below the ASEs) because ACI's ASEs don't currently operate independently of the ATN stack and this was believed to be the lower cost and risk approach. In this regard, it is expected that the DSI approach (which does have some technical advantages over the ASI approach) will require more development effort than the ASI solution but less than the CMU centric approach. It should be noted that the ACI RRI product exposes the DSI such that the ACI RRI product could be used for a DSI type architecture approach; it is just that the ACI ASEs couldn't easily be used in such an approach.

DEVELOPMENT OF THE OPTIMUM SOLUTION(S)

As per the Figure 5, all above considerations about Programs with theirs Services & Supporting Data and the identified ATN Architectures have been confronted with Market information on existing and future aircraft types, fleets and operations in order to define the preferred solution(s).

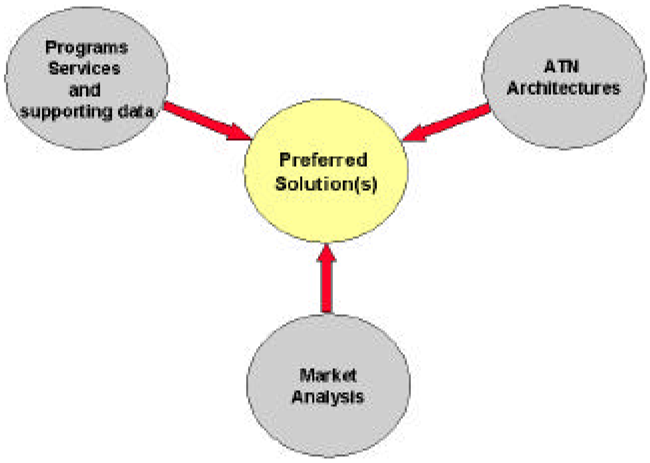

Figure 5. Considerations for Defining the Preferred Solution(s)

Each of those three constituent elements have been respectively considered from the following standpoints:

PROGRAM AND TRANSITION

Generic to any major avionics transition a number of factors have to be taken into account:

?? Airframe avionics configuration and implementation,

?? Avionics development and availability,

?? Airspace carriage requirements,

?? Worldwide air transport fleets operations, particularly within European and US regions, and

?? The many implications in terms of operations, training, infrastructure, safety, procedures.

ATN ARCHITECTURES AND SUPPORTING AIRBORNE PLATFORMS

Depending on the platforms available on given aircraft, the evolution to ATN may or may not require hardware upgrades to the existing avionics. This is related to the current microprocessor and memory capacity of either the FMS or the CMU, and size of the software to be ported.

In some cases the cost associated with the hardware upgrade would be prohibitive and has been considered in the price sensitivity analysis to decide whether an aircraft type with a given avionics generation would be retrofitted or not. Hardware upgrades might include avionics and wiring changes through Service Bulletins (SBs) or Supplemental Type Certificates (STCs).

MARKET ANALYSIS AND SCENARIO & HYPOTHESIS

To better assess this transition, Honeywell has considered the following scenario based on a set of hypotheses provided later in this paper.

Scenario

Only the air transport fleet and operations have been considered here.

The scenario considered by Honeywell assumes that both the US and European programs will support only ATN datalink in domestic airspace. Having in mind the precedence of the existing FANS aircraft in the oceanic regions, it is expected that there will be a 'strong' demand for ATN on narrow-body fleets and a moderate/low demand for ATN on wide-body fleets. As the ATN implementation will expand there will be diminishing demand for FANS 1/A. This will lead to a better amortization of the ATN development costs. Therefore an ATN solution is required for all different aircraft types. Finally, in this scenario the use of continental FANS was not foreseen.

Hypotheses

Hypotheses used by Honeywell assume that:

?? FANS-1/A services used primarily in oceanic and remote areas and ATN services offered in domestic airspace will co-exist for a period of time with Distinct communications infrastructure and Different message definitions/structure.

?? The ATN service availability in the US and European regions is here considered as a prerequisite for aircraft operators to equip.

?? Despite the limited evidence on expected benefits per type of services/applications/messages it was assumed that the aircraft operators would equip as the service would become available in Europe and in U.S. by 2007.

?? A 10 year business case where the two first years consist of the necessary investment to support the product development and eight years for the potential fleets to get equipped. The two years development for the avionics is assumed to end so as to allow airframe equipage in accordance with the above availability of the service.

?? The equipage rates considered over the eight year period are different for wide and narrow body aircraft and vary for the different options depending on various parameters such as aircraft generation, architecture and equipment capabilities. It also assumes worldwide forward fit and retrofit, costs to airlines and is based on Honeywell 's assessment of the current developments in the related industry activities (FAA Builds, EUROCONTROL Link2000+, RTCA FFSC, AEEC, etc…)

ARCHITECTURES COMPARISON BASED ON PROVIDED SCENARIO & HYPOTHESES

Based on the above scenario and hypothesis, Honeywell evaluated the opportunity for adopting one of the depicted ATN architectures.

The estimated prices vary significantly among the evaluated ATN architectures. Figure 6 shows the relative differences between each architecture and what the contribution of the FMS and CMU is to these prices.

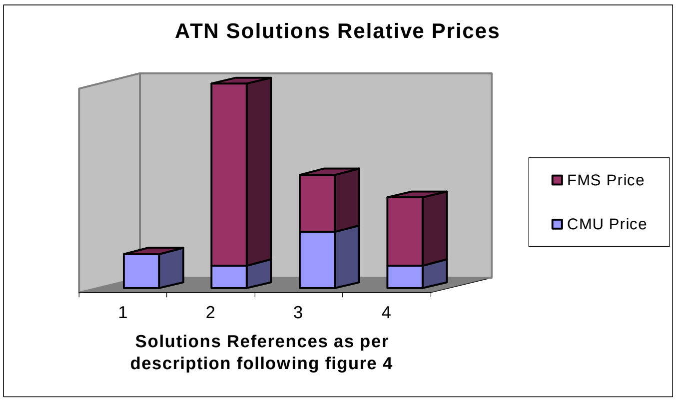

Figure 6. ATN Solutions Relative Estimated Price between the FMS and the CMU of the Presented ATN Solutions

As per Figure 4, Solution 1 is the Standalone, 2 the FMS centric, 3 the CMU centric and 4 the ASI CMU centric.

The standalone solution is the lowest cost. Although cost benefit can be realized today with it, it will require additional expenditures to migrate towards an integrated solution.

While the "CMU Centric" Solutions appear to be lower cost than the "FMS Centric" ones, for the reasons already mentioned earlier (cf.: paragraph 5.2.1.), of the integrated architectures the "ASI CMU Centric Solution" appears to be the lowest cost. Note: It is believed that a DSI approach would have slightly higher development costs.

MIGRATION FROM A STANDALONE TO AN INTEGRATED SOLUTION

If the industry elects a standalone solution first and then desires to evolve to an integrated one, here are 3 possible alternatives:

Path A: From Standalone to Integrated CMU Centric Solution

1. The ATN and the ASE developments including the non-complex applications are in place in the CMU and working.

2. In order to evolve to an Integrated Solution there is a need to evolve from non-complex Application Development to a complex Application User and to add an interface to the FMS (e.g., A656-like) with the following characteristics.

    ?? A Standardized Interface would allow working with any airplane's FMS (so long as the FMS supported that interface).

    ?? Look and feel would be the same from one airplane type to another (independent of FMS); assuming same CMU is used.

    ?? If the interface fails or the FMS doesn't support a CMU interface, then Standalone CMU could still work (with very little difference in look and feel).

    ?? The interface to FMS could evolve in increments:

        ?? Standalone (No Interface)

        ?? Package 1 upgrade could include the handling of complex or non-complex parameters as foreseen in the set of messages to be used initially in Build 1 and 1A and Link 2000+.

        ?? Package 2 upgrade could include the more complex parameters and/or messages that are foreseen on the long term.

Path B: From Standalone to Integrated FMS Centric Solution

1. Again, ATN would be initially in place to support the CMU as an end system

2. ATN interface to FMS would have to be implemented

3. Application and ASE developed for the standalone CMU would have to be redeveloped for the FMS

4. The CMU would have to Figure out, if able, whether FMS applications were operating and standalone takes over. That would be complicated.

5. Standalone vs. FMS based applications would change look and feel. Different FMS platforms would imply different ATN implementations.

6. The FMS would have to be implemented with the ATN stack & ASE.

Path C: From Standalone to Integrated ASI-CMU Centric Solution

1. This would involve the same issues as evolving to the FMS oriented solution with the difference that the ATN stack doesn't need to be implement in the FMS.

Of the paths described above the following can be derived:

?? As already mentioned, the Standalone CMU is the lowest cost approach but it supports a lower level of functionality.

?? While ASI-CMU centric approach is the lowest cost integrated approach, it doesn’t evolve well from the CMU standalone approach.

Migration Path Summary

Therefore, from the migration paths provided above, it can be inferred that a gradual approach can be adopted, i.e. develop a Standalone CMU airborne installation able to handle messages sets initially required by the European and US programs and upgrade (where feasible) the CMU and FMS avionics to a CMU Centric solution.

Nevertheless, regardless of the final desired integrated solution, any two-step approach will involve higher costs than if the desired ATN integrated solution would have been implemented initially.

A phased approach (from Standalone) seems to be the most likely, affordable approach.

CONCLUSION

Based on this study, on our knowledge of the ACI product, our impact assessments of the various solutions and paths and provided that a consistent approach is adopted, it appears that, relative to a FANS solution, the cost of the ATN implementation is justifiable.

In fact the issue of affordability coupled with the lack of a compelling business case makes a phased datalink implementation the most likely scenario. Therefore, it stresses the need to ensure early that datalink implementations have clearly defined and cost-effective growth paths. Also, availability of the services and the highest aircraft rate of equipage will allow better returns on investments.

Therefore, the airborne architectures, including the level of avionics integration, will directly affect the air-ground capability that will, in turn, drive operational benefits.

In addition, aircraft state and flight plan intent data will be critical to longer-term CPDLC implementation. The FMS maintains the flight plan and the navigation database and therefore a cost-effective and human-centered designed interface involving those FMS functions are critical to achieving the full potential of ATC datalink. Moreover, isolating the ATN stack in a single unit minimizes the development costs and designates the CMU as the most logical home for this software.

It appears essential that a collaborative decision, between all parties involved, is needed to minimize the initial development and implementation costs therefore increasing the chances for a successful business case.

CONTACT

For any questions you can contact Christophe Hamel, Honeywell CNS/ATM Solutions at

christophe.hamel@honeywell.com.

DEFINITIONS, ACRONYMS, ABBREVIATIONS

Acronym	Translation
A 656	ARINC 656
A or W429 Vx	ARINC Williamsburg 429 Version x
ACARS	Aircraft Communication Addressing and Reporting System
ACC	Area Control Center
ACI	Aeronautical Communication International
ACL	ATC Clearances
ACM	ATC Communications Management
ADC	Air Data Computer
ADS	Automatic Dependent Surveillance
AEEC	Airlines Electronic Engineering Committee
AES/BIS	Airborne combined End System/Boundary Intermediate System
AMC	ATC Microphone Check
AOC	Airline Operation Communication
ARTCC	Air Route Terminal Control Center
ASE	Application Service Elements
ASI	Application Service Interface
ASM	Altimeter Setting Messages
ATC	Air Traffic Control
ATN	Aeronautical Telecommunication Network
ATS	Air Traffic Services
ATSP	Air Traffic Service Provider
ATSU	Air Traffic Service Unit
CMU	Communication Management Unit
CM	Context Management
CNS/ATM	Communication Navigation Surveillance / Air Traffic Management
CPDLC	Controller Pilot Datalink Communication
DLIC	Data link Initiation Capability
DSI	Dialogue Service Interface
ENPRM	EUROCONTROL Notice of Proposed Rule-Making
EUROCAE	European Organization for Civil Aviation Equipment
EUROCONTROL	Europe Organisation for the Safety of Air Navigation
FAA	Federal Aviation Authority
FANS	Future Air Navigation System
FFSC	RTCA Free Flight Steering Committee
FIR	Flight Information Region
FLIPCY	Flight Plan (Route) Consistency
FMS	Flight Management System
GBIS	Ground Boundary Intermediate System
GES	Ground End System
GPS	Global Positioning System
HF	High Frequency
IC	Initial Contact
ICAO	International Civil Aviation Organisation
IRS	Inertial Reference System

Acronym	Translation
LAN	Local Area Network
MCDU	Multi-function Control and Display Units
NEAN	Northern European ADS-B Network
Petal	Preliminary EUROCONTROL Test of Air/Ground Data Link, extension
QoS	Quality of Service
RRI	Router Reference Implementation
SARPs	Standard And Recommended Practices
SATCOM	Satellite Communication (radio)
SBs	Service Bulletins
SC	Special Committee
STCs	Supplemental Type Certificates
TOC	Transfer of Communication
UM	Up link Message
US	United States
VDL	VHF Digital Link
VDL M2	VHF Digital Link Mode 2
VHF	Very High Frequency (radio)
WGx	Working Group x