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Aircraft information management system (AIMS) analysis

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ABSTRACT: The systems integration of the modern Airplane Information Management System (AIMS), both within the AIMS system and with the other systems on the airplane, represented the most complex system integration effort ever undertaken at Honeywell Air Transport Systems Division. The technological innovations in the AIMS design, coupled with an aggressive program schedule, were major factors in the AIMS challenge. Aircraft and equipment manufacturers had to work closely together to complete the design and development of AIMS in a time frame that supported the goal. With teams from the two companies working as one unit, redundant activities were eliminated, technical and program problems were identified and solved rapidly, and schedule time was saved by both teams helping with tasks that were traditionally considered to be the other team's job.

KEY WORDS: Management system, Aircraft, Information, Core processor module, input/output modules, ARINC, Graphic generator.

I.INTRODUCTION

When Manufacturer introduces a new airplane model chances are there will be new technology aboard never before seen by the airline customer. Manufacturers put new technology on an airplane because it is customer-driven or it does what a previous model did - only better. Both reasons apply on the modern aircraft with its Airplane Information Management System (AIMS).AIMS is the computing system behind these avionics systems on the modern aircraft: Primary Display System, Central Maintenance Computing System, Airplane Condition Monitoring System, Flight Data Recorder System, Data Communication Management System, Flight Management Computing System, Thrust Management Computing System. Although AIMS provides some new functionality these AIMS-supported systems have similar functionality on other airplanes. But the implementation of these systems with AIMS on the modern aircraft is very different. It is the first use of the integrated modular avionics concept on a commercial air transport. This approach to avionics design bas economic and technical advantages over traditionally separate systems. These systems require large amounts of information from nearly all other airplane systems and from each other. Airplane systems that previously required separate interfaces to these display, maintenance, recording. and communications systems are now simplified. This article introduces AIMS and discusses: Flight and maintenance crew interface, Physical implementation of the AIMS hardware and software.

II. AIMS CREW INTERFACE DESCRIPTION

AlMS provides the majority of the flight and maintenance crew interfaces. All display of flight-critical information control of flight planning and performance, maintenance, and performance monitoring interfaces are controlled byAIMS [1].

AIMS has two cabinets that do the calculations for the avionics systems. These cabinets are located in the Main Equipment Center. Each cabinet has a chassis with eight line replaceable modules. There are four input/output modules (IOMs) and four core processor modules (CPMs) in each AIMS cabinet.

There are three spare slots in each cabinet for future growth. All of the line replaceable modules are built with a common hardware and software architecture. The IOMs and CPMs communicate along a backplane data bus in the chassis. The chassis distributes power to the modules along the backplane power bus. The left and right cabinets communicate with each other along four ARINC 629 data busses.

The IOMs transfer data between the software functions in the AIMS CPMs and signals from the rest of the airplane (Figure 3). AIMS interfaces with more than 100 line replaceable units. These interfaces include 32 connectors to the following ARINC systems: 629, 429, 636 (fiber optics), 717, 453, and 618. Interfaces also include RS 422 and 232 (display unit video bus). as well as analog and discrete inputs and outputs.

The CPMs supply the software and hardware to do the calculations for all of the functions that AIMS supports. To keep a necessary separation between the functions each function is "partitioned" or treated as a separate program and stored in its own memory area. The partitions permit multiple functions of varying criticality to use the same hardware and be in the same CPM.

There are four types of CPMs:

- Communication
- Basic.
- Graphics Generator.
- Airplane Condition Monitoring Function.

AlMSuses four types of software:

- Operational Program Software. This is the core software and the application software for the avionics functions. There is a unique software part number for each type of line replaceable module. That is the CPM/Communication modules in both cabinets have the same software, all CPM/Graphics Generator modules have the same software, and all input/output modules have the same software. The core software of the operational program software acts as an operating system and allows the different functions to share the CPM's processor.
- Operational Program Configuration Data Files. These files set the configuration for the airplane. These data files replace hardware program pins which set the configuration on older model airplanes. There is only one operational program configuration data file part number for the AIMS cabinets.
- Airline Modifiable Information (AM). These files give the airlines more flexibility to further define their airplane's configuration. Several AIMS functions have AMI. There is a separate software part number for each AMI. (For more on AMls, see page 49 sidebar. "AMI: Customizing the modern aircraft 'Look and Feel. '")
- Navigation Database. There is one database for AIMS- the navigation database. The flight management computing function uses this database. This database is defined by a single part number.

III. ANALYSIS OFSYSTEMS SUPPORTED BY AIMS

The following aircraft systems are supported by AIMS [2].

Primary Display System. AIMS controls formats and shows information in many different formats on six liquid crystal display units in the flight deck. Many of these displays are familiar to modern Boeing jetliners including: Airplane status, Navigation data, flight plan data, Maintenance page data, Engine indicating and crew alerting data. The modern aircraft also introduces two new display formats: Checklists, Communication data. The primary display function of AIMS does the calculations for the primary display system. Pilots use the primary flight display format to see airspeed, attitude, altitude, vertical speed, heading, flight mode and other critical information. It is normally seen on the outboard left and right displays.

The Engine Indication and Crew AlertingSystem (EICAS) display is normally shown on the center upper display unit. EICAS provides primary engine indications ,warning. caution. and advisory messages. EICAS communication messages inform the crew if there is an incoming data message from the airline, cabin call or ground crew call. EICASmemo messages remind pilots of non flightcritical actions they have taken(APU RUNNING. etc.). The EICAS display also shows gear, flap, fuel and pressurization indications.

The navigation display provides flight plan, navigation and approach information. It normally shows on theinboarddisplay units.

The secondary engine display format shows engine parameters not required for continuous display.The status page format shows messages related to the dispatch status of the airplaneas well as hydraulic, APU and oxygen information.

Maintenance page data formats supply detailed information useful in the analysis and repair of airplane systems. There are 19 types of maintenance pages: examples include engine exceedance andfire protection pages.

The electronic checklist display format new on the modern aircraft is an electronic version of the flight crew's normal and non-normalchecklists. AIMS senses the positionof many switches, controls and otherdata and will automatically indicate completed items. The flight crew uses a cursor control device to mark the remaining completed items on the checklists.

The communications display format is anew way to send and receive text messages via the ACARS (ARINC Communication and Reporting System) datalinksystem. The flight crew uses the cursor control device and the control display unit keyboard to send and receive text messages to and from the ground.

The secondary engine display, status pages, maintenance pages,checklists. and communications pages aremulti-function display formats. Multifunction display formats can show on the inboard or lower center displays.

Central Maintenance Computing System (CMCS). CMCS collects, stores and displays maintenance data for most of the modern aircraft systems. The central maintenance computing function of AIMS does the calculations for the CMCS. Rather than using the control display unit, the crew uses a maintenance access terminal (MAT) in the flight deck. Maintenance personnel can also use portable MATs (PMATs) or optional side displays to operate the CMCS.

The MAT and side displays are located in the flight deck. A PMAT is located in the Main Equipment Center. Other locations where you can use aPMAT are the nose wheel well, behind the main wheel well,flightdeck and the stabilizer/jackscrew area. The MAT, PMAT and side displays communicate with the CMCFs through afther optics interface. The MAT, PMAT. and side displayhave a simple user interface. On theMAT and PMAT the crew uses a trackball to access functions organized under five main menus. On the side displays the crew uses a cursor control device.

The cenlra1 maintenance computing function gets fault reports from member systems and records this information in fault history in a common formal called maintenance messages. When the primary display system shows a flight deck effect(warning, caution, advisory, status etc.).the central maintenancecomputingfunction correlates or matches the flight deck effect to the maintenance message.

This gives the maintenance crew diagnostic information to address the causeof the flight deck effect. Other CMCS functions include:

- loading interface for more than 80 line replaceable units.
- Input monitoring.
- Configuration reporting.
- Access to shop faults in line replaceable units.
- Onboard engine balancing.
- Report capabilities to printer. Disk drive. and data link to ground

Airplane Condition Monitoring System (ACMS). ACMS monitors Records and reports information for maintenance performance troubleshooting and trend monitoring data. The crew uses the MAT, PMATs or optional side displays to operate ACMS. The airplane condition monitoring function of AIMS monitors airplane systems for user-defined triggers. When a trigger, such as engine start, altitude, or airspeed.is sensed, ACMS makes a report of different parameters.

The reports are recorded in eitherACMSmemory or an optional quick access recorder.The quick access recorder functionformats and sends The data to the tapeor optical disk quick access recorder. Reports are defined two ways. The usercan define a report from the MAT orPMAT. Reports can also be defined bythe AMI file for the ACMS. Boeing deliversa baseline AMI file forACMS with13 report definitions for engines, APU,and environmental systems.

Flight Data Recorder System. This system records mandatory and optional flight data for the most recent 25 hours of operation. The digital flight data acquisition function of AIMS collects ARINC 429, ARINC 629 analog and discrete data. It puts the data into one digital format (ARINC 717) and sends it to a solid state flight data recorder in the rear of the airplane. There is no dedicated flight data recorder system accelerometer on the modern aircraft. Instead.the air data inertial reference unit supplies longitudinal, lateral and vertical accelerations to AIMS to passon to the flight data recorder.

Data Communication Management System. This system supplies three functions:

- ACARS datalink.

- Flight deck printer support.
- Avionics local area network interface toAIMS.

The data communication management function of AIMS supports the above functions. The flight deck communication function ofAIMS supports the flight crew interface of the ACARS datalink, the control display unit (CDU). The flight deck communication function providesairline-definable "forms" for specific types of messages. The airplane willprovide any available information. Suchas present position or fuel on board.

Four AIMS systems can use the flightcompartment printer:

- ACARS datal ink.
- Central maintenance.
- Airplane condition monitoring.
- Primary display (for printing of maintenance data pages).

The data communication management function is the interface between these systems and the flight deck printer. It stores and prioritizes print requests in theorder shown above, and then sends the information to the flight deck printer.

The data communication management function also supports the interface between AIMS and the avionics local area network. This network uses fiber optics

AIMS communicates to the MAT,PMATs and the optional side displays over the avionics local area network. TheMAT and optional side displays are directly connected to the avionics local area network. The PMAT's access to the avionics local area network is through a broider(bridge router).

Flight Management Computing System. As on all modern Boeing airplanes, the flight management computing system reduces flight crew workload with these basic functions:

- Navigation.
- Flight planning.
- Performance management.
- Navigation radio tuning.

The flight management computing function of AIMS supplies these functions.

It gives vertical and lateral guidance forall phases of flight except takeoff andlanding. the flight management computingsystem also gives navigation informationto the flight crew on the forwarddisplays. The flight management computingfunction memory contains a navigationdatabase. This database has informationon:

- NAVAID locations.
- Waypoims.
- Departure/arrival procedures.
- Company flight plans.

The flight planning function uses flightcrew entries to create the lateral flightplan. The performance management function of the flight management computingsystem uses the aerodynamic model of the airplane and night crew entries to calculate the most economical profile for the vertical flight path. The flight crew entries are:

- A cost index.
- Cruise altitude.
- Airplane gross weight.

The navigation radio tune function automaticallytunes the navigation radios for position and display update.The primary crew interface for the flight management computing system are thethree CDUs. The flight crew enters data on either the left or the right CDU. The centerCDU is a back up if the left or rightone fails. If both flight management computing functions have failed the modern aircraft CDUs can serve as a backup and calculatelateral guidance commands. TheCDUs also allow the flight crew to manually tune the navigation radios. In addition, the CDU provides access to the satellite communication system, as well as the passenger address and cabin interphone system. The CDU will command the maintenance data pages to shown a multi-function display and it can also act as an alternate Electronic Flight Instrument System (EFIS) control panel or display select panel.

Thrust Management Computing System. The thrust management computing system moves the thrust levers when commanded; it gives thrust limit displays and the autothrottle modes during takeoff and all flight phases. The thrust management computing system also supplies trim commands to the engines. The thrust management computing function of AIMS supplies these functions, which are similar to those found on other modern Boeing airplanes. Other components of the thrust management computing system are two auto throttle servo motors, auto throttle arm and mode switches on the mode control panel, take-off go around (TO/GA) switches and autothrottle disconnect switches.

The thrust management computing function calculates auto throttle commands based on flight crew entries flight management computing function calculations and external sensor inputs. The thrust management computing functions ends these commands to the autothrottleservo motors to move the throttles. Each throttle has its own autothrottle servomotor rather than all throttles sharing oneas on other airplanes.
The thrust management computing function supplies autothrottle modes and calculates thrust limits. The autothrottle modes show on the primary flight display and the thrust limits show on theEICAS display. The flight crew select the auto throttle modes from the mode control panel and the TO/GA switches.
The flight crew selects thrust limits from the thrust limit page on the CDU. Thrust limit selection occurs automatically when the flight management computing systemis in the vertical navigation mode.

IV. AIMS DESIGN

The philosophy behind the AIMS architecture is toprovide a host platform where avionics applications (e.g.,Flight Management, Displays) can share commonplatform resources [3]. A block diagram of the AIMSarchitecture is in Fig. 4.1.

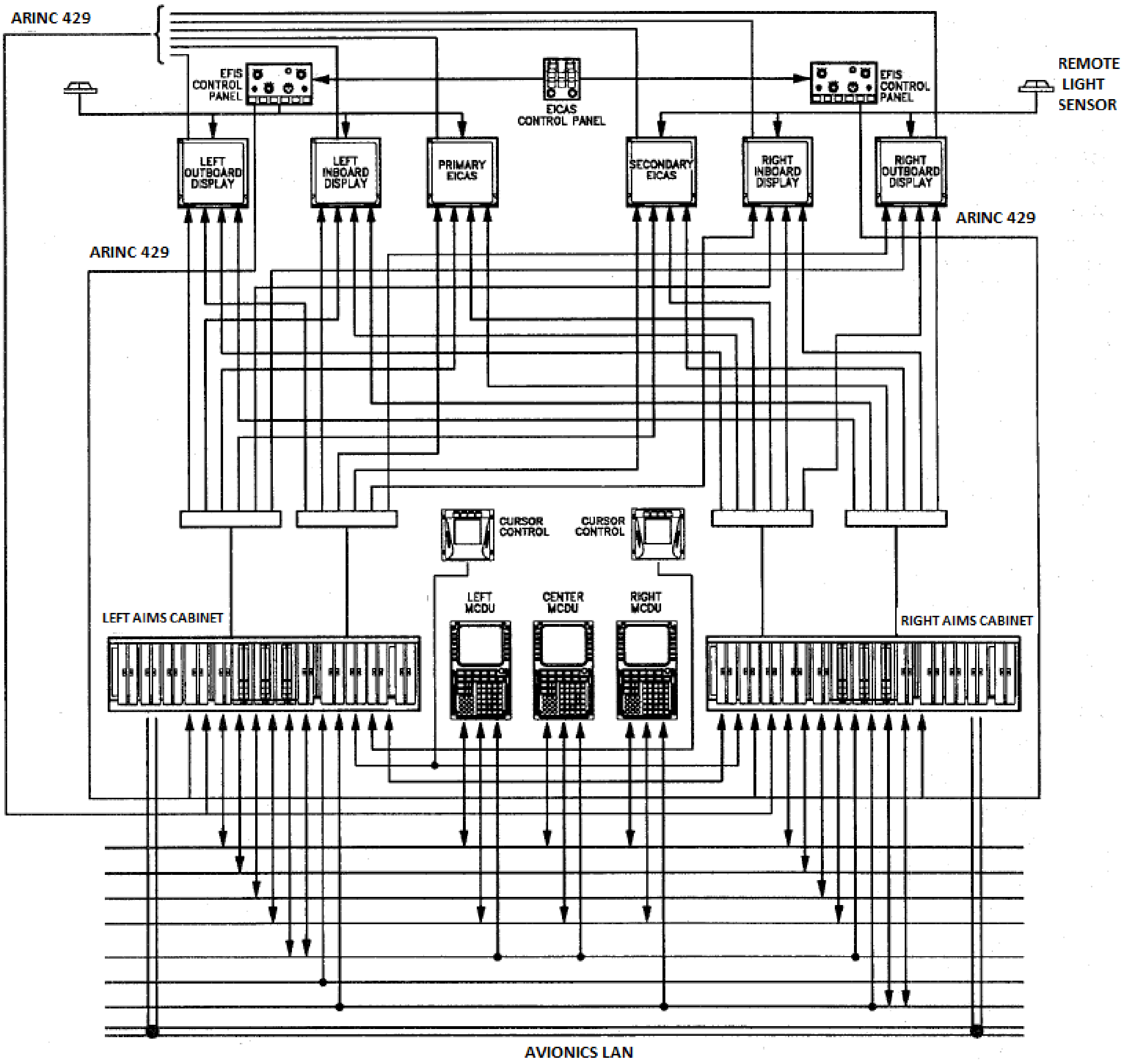

Fig.4.1 AIMS Architecture

AIMS Baseline Architecture AIMS system consists of dual cabinets in the electronics bay that each contain 4 core processor modules (CPMs)and 4 input/output modules (IOMs), with space reserved in the cabinet to add one CPM and two IOMs to accommodate future growth. The shared platform resources provided by AIMS are:common processor, power supply, and mechanicalhousing;common input/output ports, power supply, and mechanical housing; common backplane bus (SAFEbus'") to move data between CPMs and between CPMs and IOMs; and common operating system, built-in test (BIT) and utility software.

Instead of an individual application residing in a separate Line Replaceable Unit, applications are grouped together on CPMs. The IOMs transmit data from the CPMs to other systems on the airplane, and receive data from these other systems for use by the CPM applications. A high-speed backplane bus, called SAFEbus'", provides a 60Mbit/second data pipe between any of the CPMs and IOMs in a cabinet. Communication between AIMS cabinets is through four ARINC 629 serial busses [4].

The robust partitioning provided by the architecture allows applications to use common resources without any adverse interactions. This is achieved through combination of memory management and deterministic scheduling of application software execution. Memory isallocated before run time, and only one application partition is given write-access to any given page ofmemory. Scheduling of processor resources for each application is also done before run time, and is controlled by a set of tables loaded onto each CPM and IOM in the cabinet. This set of tables operates synchronously, and controls application scheduling on the CPMs as well as data movement between modules across the SAFEbus'".

Hardware fault detection and isolation is achieved via a lock-step design on the CPMs, IOMs, and the SAFEbus . Each machine cycle on the CPMs and IOMs is performed in lock-step by two separate processing channels, and comparison hardware ensures that each channel is performing identically. If a miscompare occurs,the system will attempt retries where possible before invoking the fault handling and logging software in the operating system. The SAFEbus'" has four redundant datachannels that are compared in real time to detect andisolate bus faults.

V. CONCLUSION

The teaming approach used by Equipment and aircraft manufacturers, AIMS project was instrumental in the success of the program. System design, integration, verification, and program management activities were conducted in an atmosphere of open communication and with a desire by both companies to do whatever was required to get the job done. The result of this commitment to teaming is not only a state-of-the-artavionics system on the world's newest transport airplane. Itis a model for a better way to develop avionics systems in the future.

REFERENCES

[1] R. Black, M. Fletcher, "Next-Generation Space Avionics: A. Highly Reliable Layered System Implementation" , Honeywell Intl, Glenade, AZ

[2] J. Schmalzel, F. Figueroa, J.Morris, S. Mandayam, and R. Polikar, "An Architecture for Intelligent systems Based on smart Sensors", IEEE Transactions on instrumentation end measurement, Vol 54, #4, August 2005, pp 1612-1616

[3] F. Figueroa and J. Schmalzel, "Rocket testing and integrated system health management", pp.373-392, Eds L/Wang and R/ Gao, Springer seriesin Advanced Manufactuiring Springer Verlag, UK, 2006

[4] F. Figueroa, R. Holland, J. Schmalzel, D/ Duncavage, A. Crocker, R. Alena, "ISHM Implementation for Constellation Systems", AiAA Conference 2005